Minerals yearbook: Metals and minerals (except fuels) 1952. Year 1952, Volume I 1955

Bureau of Mines
Washington, D. C.: Bureau of Mines : United States Government Printing Office, 1955

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

MINERALS YEARBOOK

METALS AND MINERALS (EXCEPT FUELS)

Volume I

1952

Prepared by the staff of the
BUREAU OF MINES
MINERALS DIVISION
Paul Zinner, *Chief*
Charles W. Merrill, *Assistant Chief*

UNITED STATES DEPARTMENT OF THE INTERIOR

DOUGLAS McKAY, *Secretary*

BUREAU OF MINES

JOHN J. FORBES, *Director*

THOMAS H. MILLER, *Assistant Director for Operations*

OFFICE OF THE DIRECTOR:

ARNO C. FIELDNER, *Chief Fuels Technologist*
E. D. GARDNER, *Chief Mining Engineer*
O. C. RALSTON, *Chief Metallurgist*
PAUL W. McGANN, *Acting Chief Economist*
DONALD G. WELSH, *Chief Counsel*
ALLAN SHERMAN, *Chief, Office of Minerals Reports*
H. J. SLOMAN, *Assistant to the Director*
J. H. HEDGES, *Special Assistant to the Director*

DIVISIONS:

PAUL ZINNER, *Chief, Minerals Division*
LOUIS C. McCABE, *Chief, Fuels and Explosives Division*
JAMES WESTFIELD, *Chief, Health and Safety Division*
W. E. RICE, *Chief, Administrative Division*

REGIONAL OFFICES:

SINCLAIR H. LORAIN, *Regional Director, Region I (Juneau, Alaska)*
STEPHEN M. SHELTON, *Regional Director, Region II (Albany, Oreg.)*
HAROLD C. MILLER, *Regional Director, Region III (San Francisco, Calif.)*
JOHN H. EAST, JR., *Regional Director, Region IV (Denver, Colo.)*
MELDEN E. VOLIN, *Regional Director, Region V (Minneapolis, Minn.)*
CLIFFORD W. SEIBEL, *Regional Director, Region VI (Amarillo, Tex.)*
P. T. ALLSMAN, *Regional Director, Region VII (Knoxville, Tenn.)*
HAROLD P. GREENWALD, *Regional Director, Region VIII (Pittsburgh, Pa.)*
ELMER W. PEHRSON, *Regional Director, Region IX (Washington, D. C.)*

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1955

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. — Price $4 (cloth)

FOREWORD

The presentation of the Minerals Yearbook, 1952, in three volumes initiates a change made necessary by an increase in Yearbook material that could no longer be published under a single cover without increasing the book to a thickness that caused binding problems and to a weight that inconvenienced the reader. The change is one of several made over the years to meet expansion in the mineral industry and new needs of the reading public.

From initiation of this series as "Reports Upon the Mineral Resources of the United States" published in 1867 by the Treasury Department, the series has appeared as "Mineral Resources West of the Rocky Mountains," as a part of the "Annual Report of the Geological Survey," as "Mineral Resources of the United States," and as the "Minerals Yearbook," the first volume of which covered 1932 and carried the title, "Minerals Yearbook, 1932–33."

In the current three-volume presentation, volume I is made up of chapters on mineral commodities, both metals and nonmetals, but exclusive of the mineral fuels. Included also are a chapter reviewing these mineral industries, a statistical summary and recapitulation, and chapters on mining technology, metallurgical technology, and employment and injuries.

Volume II, which is devoted to the mineral fuels, consists of chapters on each mineral-fuel commodity, as well as chapters reviewing the industry as a whole, a statistical summary, and an employment and injury presentation.

Volume III is made up of chapters covering each of the 48 States, plus chapters on Alaska, the Territories and island possessions in the Pacific Ocean, and the Territories and island possessions in the Caribbean Sea, including the Canal Zone. Volume III also has a chapter recapitulating its statistics in summary form on a regional basis and another presenting employment and injury data regionally.

The Minerals Yearbook will continue to present the year's development in the mineral industry with enough background data to give significance to the current record. The three-volume Yearbook permits fuller coverage in all phases of the reports, but major expansion has been undertaken in the regional presentation (volume III) and in the review of technologic developments and problems.

The Bureau of Mines wishes to acknowledge again the cooperation of industry and of many Government groups in the preparation of the yearbook. Among the latter, some of the State geological surveys and mining bureaus are of great importance, particularly in their help in gathering and preparing the material that appears principally in volume III.

J. J. Forbes, *Director*.

ACKNOWLEDGMENTS

The chapters in this volume of the MINERALS YEARBOOK, except for the four review chapters, were prepared by the staff of the Minerals Division. The following supervised preparation of the chapters: C. H. Johnson, chief, Base Metals Branch; N. B. Melcher, chief, Ferrous Metals and Ferroalloys Branch; F. J. Cservenyak, chief, Light Metals Branch; H. D. Keiser, chief, Rare and Precious Metals Branch; G. W. Josephson, chief, Construction and Chemical Materials Branch; and W. F. Dietrich, chief, Ceramic and Fertilizer Materials Branch. Overall supervision for the volume and its coordination with the chapters appearing in volume III was carried out by Charles W. Merrill, assistant chief, Minerals Division.

The Bureau of Mines, through cooperative agreements with State and Territorial agencies, has been assisted in the collection of domestic mine-production data and supporting information appearing in this volume. For this assistance acknowledgment is made to the following cooperating State organizations:

Alabama: Geological Survey of Alabama
Alaska: Alaska Territorial Department of Mines
Arkansas: Division of Geology
California: Division of Mines
Delaware: Delaware Geological Survey
Florida: Florida Geological Survey
Georgia: Department of Mines
Illinois: Illinois State Geological Survey
Indiana: Indiana Department of Conservation
Iowa: Iowa Geological Survey
Kansas: State Geological Survey of Kansas
Kentucky: Kentucky Geological Survey
Louisiana: Louisiana Geological Survey
Maine: Maine Geological Survey
Maryland: Department of Geology
Michigan: Michigan Department of Conservation
Mississippi: Mississippi Geological Survey
Missouri: Division of Geological Survey
Montana: Montana State Bureau of Mines and Geology
Nevada: Conservation and Survey Division
New Hampshire: Mineral Resources Committee
New Jersey: Bureau of Geology and Topography
New York: New York State Science Service
North Carolina: Division of Mineral Resources
North Dakota: North Dakota Geological Survey
Oklahoma: Oklahoma Geological Survey
Oregon: State Department of Geology and Mineral Industries
Pennsylvania: Bureau of Topographic and Geologic Survey
South Carolina: South Carolina Geological Survey
South Dakota: State Geological Survey
Tennessee: Tennessee Department of Conservation
Texas: Bureau of Economic Geology
Utah: Utah Geological and Mineralogical Survey
Virginia: Department of Conservation and Development
Washington: State of Washington Division of Mines and Geology
West Virginia: West Virginia Geological and Economic Survey
Wisconsin: Wisconsin Geological and Natural History Survey
Wyoming: Geological Survey of Wyoming

The data presented in the MINERALS YEARBOOK are largely based upon information obtained from mineral producers, processors, and users, and acknowledgment is made of this indispensable cooperation given by industry.

PAUL ZINNER.

CONTENTS

Review of the Mineral Industries[1]

(Metals and Nonmetals Except Fuels)

By Herbert E. Striner[2] and Gabrielle Sewall[3]

THE NATIONAL economy in 1952 reached a plateau at full employment under the continued stimulus of the war in Korea. The rate of expansion of defense-plant facilities, and defense-goods inventories, began to decrease in 1952. This slower rate of expansion was reflected in the mineral industries. In 1952 the national income derived from the metal-mining and nonmetallic-mining and quarrying industries was 4 percent above the 1951 level. Such income in 1951 had been 21 percent above that in 1950, which, in turn, had been 20 percent above that in 1949. The value of metallic-mineral production in 1952 was $1.6 billion as compared with $1.7 billion in 1951. The value of the production of nonmetallic minerals was $2.2 billion in 1952 compared with $2.1 billion in 1951.

Pronounced fluctuations in output of metals and metal products occurred during 1952. These fluctuations were related, in very large part, to the steel strike during the middle of the year which sharply curtailed output of steel. During the long period of high-level steel output that preceded the strike, metal fabricators built up substantial working stocks, which enabled most manufacturers to maintain output through June. The shortage of steel did curtail production in many lines that depend upon steel as a raw material; these included automobiles, heavy equipment, and certain types of farm equipment.

With continuance of the Korean emergency, the Federal Government maintained a high degree of regulation and control in those minerals fields where national security was involved. Such regulatory functions involved allocation of critical materials and provided incentives to private industry for higher production levels of necessary raw materials and finished goods, encouragement of mineral exploration, and the analysis and planning of future production goals.

World production of minerals and metals was, in general, greater in 1952 than in 1951; most principal commodities showed an increase over that year in output. The United Nations' world mining index (fuels and nonfuels) average for 1952 was 3 percent greater than that for 1951.

NATIONAL INCOME ORIGINATED

An important economic indicator that relates the rate of growth of an industry to that of the entire economy is the proportion of national income originating within each specified industry. National income originated in an industry is the sum of business income

[1] Fuels are covered in several instances in this chapter but only where specifically indicated. This occurs where data on the particular subject were available only for the mining industry as a whole, not broken down into the fuels and nonfuels components.

[2] Economic analyst.

[3] General economist.

and payments to employees. The data in table 1 indicate that the various mining and primary metal industries did not, in 1952, account for as much of the national income as they had in 1951. Indeed, while national income increased absolutely during this period, the majority of the industries shown in table 1 had absolutely decreasing industry incomes. There is no doubt that part of this was due to the steel strike in 1952.

TABLE 1.—National income originated within the mineral industries in the United States, 1943–47 (average) and 1948–52, by industries [1]

[Millions of dollars]

Industry	1943–47 (average)	1948	1949	1950	1951	1952	Change from 1951 (percent)
All industries, total	183,038	223,469	216,259	240,632	278,373	291,629	+5
Metal mining	431	686	568	5,202	6,010	5,984	(2)
Percent of total	0.24	0.31	0.26	2.16	2.16	2.05	−5
Nonmetallic mining and quarrying	250	434	448	496	574	595	+4
Percent of total	0.14	0.19	0.21	0.21	0.21	0.20	−5
Stone, clay, and glass products	1,378	2,154	2,089	2,663	3,062	2,865	−6
Percent of total	0.75	0.96	0.97	1.11	1.10	0.98	−11
Iron and steel and their products [3]	7,758	8,713	7,629	10,109	12,402	11,474	−7
Percent of total	4.24	3.90	3.53	4.20	4.46	3.93	−12
Nonferrous metals and their products	1,845	2,079	2,138	2,478	3,151	3,150	(2)
Percent of total	1.01	0.93	0.99	1.03	1.13	1.08	−4

[1] Survey of Current Business, vol. 33, No. 7, July 1953, p. 16, and National Income Suppl., 1951, pp. 159–175.
[2] Less than 0.5 percent.
[3] Including ordnance.

Of all the industries shown in the table, only nonmetallic mining and quarrying increased its income absolutely, by 4 percent. The nonferrous metals-and-their-products industry income remained about the same during 1951–52, while its portion of the national income was reduced from 1.13 to 1.08 percent. This latter figure was still, however, higher than the 1950 figure (1.03 percent). The total metal-mining figure (2.05 percent of the 1952 national income) was below both the 1951 and 1950 figures (2.15 and 2.16 percent, respectively).

Largely on account of the 1952 strike, the iron and steel income dropped sharply from 4.46 percent of national income in 1951 to 3.93 percent in 1952. In absolute terms iron and steel income was 7 percent below the level it attained in 1951.

BUSINESS POPULATION

The average number of mining and quarrying firms, including those mining fuels, in operation during 1952 was the highest for any year for which data are available (1929–52). The number of entries in 1952 was at the same high level of 1951. The number of firms discontinuing operations during 1952 was slightly higher than in 1951. (See table 2.) Mining and quarrying firms were 1 percent of the total number of United States firms in all industries. (Similar data for mineral manufacturing firms were not available.)

Table 3 shows the number of establishments (not firms) in the primary metal industries. Most of the increase that took place occurred in the group of establishments employing 1 to 249 people.

TABLE 2.—Number of mining (including fuels) and quarrying firms in operation, newly entered, and discontinued in the United States, 1940–52 [1] [2]

[In thousands]

Year	Average number in operation	Total newly entered	Total discontinued
1940	35.6	5.3	3.6
1941	37.2	4.6	3.9
1942	35.4	1.7	5.2
1943	32.1	2.4	4.7
1944	31.4	3.5	3.1
1945	32.2	4.0	3.0
1946	33.8	4.7	3.1
1947	35.2	4.9	3.1
1948	37.2	5.3	4.0
1949	37.0	3.6	4.5
1950	37.0	4.1	3.7
1951:			
1st half	(3)	2.3	1.8
2d half	(3)	2.0	1.8
Total	37.4	4.3	3.6
1952:			
1st half	(3)	2.5	2.0
2d half	(3)	1.8	1.8
Total	38.1	4.3	3.8

[1] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business, vol. 34, No. 1, January 1954, p. 6.
[2] Units counted are "firms" as opposed to "establishments" such as plants in the case of manufacturing. A firm is defined as a business organization under one management with either an established place of business or at least one paid employee. However, no attempt is made to combine corporations owned or controlled by the same interests. Discontinued businesses include closures of all kinds without reference to the reason for going out of business. New businesses include only firms which have been newly established. A firm which is maintained as a business entity but which undergoes a change of ownership is not counted as a discontinuance.
[3] Data not available.

The number of plants employing the much larger numbers of employees remained relatively stable. This, of course, says little concerning the mortality of establishments within each of the industry groups. That is, it is conceivable that the turnover rate of firms within a group could be relatively high while the total number in the group remained fairly stable.

TABLE 3.—Number of establishments and employees in primary metal industries in the United States, 1951–52, by average employment of establishment [1]

Average employment of establishment [2]	Number of establishments	All employees
1–249 employees:		
1951	4,592	198,460
1952	4,621	197,990
250–499 employees:		
1951	418	150,200
1952	401	144,764
500–999 employees:		
1951	234	162,380
1952	228	160,457
1,000–2,499 employees:		
1951	161	252,955
1952	165	259,645
2,500 and more employees:		
1951	85	480,215
1952	85	476,714
All establishments:		
1951	5,490	1,244,210
1952	5,500	1,239,570

[1] U. S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures: Ser. MAS–52–6, Nov. 27, 1953.
[2] Average employment is based on reported employment totals for the payroll periods ended nearest the 15th of March, May, August, and November.

VALUE OF SHIPMENTS OF MINERAL MANUFACTURES

The value of shipments of aluminum and aluminum-base alloy wire increased 33 percent in 1952—the most sizable percentage increase for the selected mineral manufactures shown in table 4. The value of shipments of aluminum wire, aluminum plate, sheet, and strip, and all other aluminum products, rolled, drawn, and extruded, rose steadily for the years shown.

Natural graphite displayed the largest percentage drop (17 percent) among the items that declined in value of shipments in 1952. Pig iron, other blast-furnace products, gray-iron castings, and malleable iron castings, commodities affected by the steel strike, also dropped sharply in shipment value. The greatest dollar-volume drop occurred for pig-iron, a decrease of approximately $255 million. Among the nonferrous metals, almost without exception, the value of shipments in 1952 either remained close to the 1951 level or increased. In the nonmetallic-mineral-manufacturing group, for construction products as a whole, there was also an increase.

TABLE 4.—Value of shipments of selected mineral manufactures in the United States, 1950–52 [1]

[Millions of dollars]

Product	1950	1951	1952	Change from 1951 (percent)
Pig iron	2,366.8	2,814.1	2,559.3	−9
Other blast-furnace products	110.9	144.3	123.8	−14
Ferroalloys and other additives	345.9	405.7	413.3	+2
Gray-iron castings	1,422.5	1,762.4	1,555.2	−12
Malleable iron castings	213.4	289.6	255.9	−12
Steel castings	474.6	790.9	862.5	+9
Copper rolled, drawn, and extruded, copper and copper-base-alloy mill products	1,044.3	1,096.3	1,163.9	+6
Aluminum plate, sheet, and strip	329.6	343.8	359.0	+4
All other aluminum products, rolled, drawn, and extruded	193.8	249.7	292.3	+17
Magnesium products, rolled, drawn, and extruded	10.7	17.9	18.7	+4
Iron and steel forgings	666.9	939.9	989.7	+5
Aluminum and aluminum-base-alloy wire	19.0	24.8	33.1	+33
Copper and copper-base-alloy wire	260.3	272.0	270.0	−1
Nonferrous forgings	52.9	83.2	108.8	+31
Nonferrous castings, including die	726.8	915.2	905.0	−1
Hydraulic cement, excluding cost of shipping containers	604.0	685.3	712.0	+4
Clay refractories	126.7	171.1	161.9	−5
Concrete products	563.5	733.6	746.8	+2
Gypsum products	206.4	234.6	223.4	−5
Lime, excluding cost of shipping containers	84.6	93.7	92.8	−1
Mineral wool (from rock, slag, and glass)	115.7	134.1	138.3	+3
Abrasive products	324.7	376.4	346.4	−8
Asbestos products	276.7	334.5	332.2	−1
Natural graphite, ground, refined, or blended	10.6	12.7	10.6	−17
Nonclay refractories	112.0	155.8	138.6	−11
Sheet-mica products, except radio parts	29.2	48.9	45.1	−8

[1] U. S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures: 1949 and 1950 volume, pp. 90–91 and Ser. MAS–52–1, Aug. 27, 1953, pp. 13–15.

What is undoubtedly of most significance is the comparison between 1950–51 and 1951–52 levels of shipments. Most 1951 shipments were markedly greater than those in 1950, even after allowance for higher dollar values, while in 1952 a tapering-off of shipments over those in 1951 is in evidence. There is little doubt that the steel strike did affect output in related industries, to what extent for each industry is difficult to assess, but a number of the products in table 4 display a degree of leveling off in 1952 that cannot solely reflect a shortage of steel. When other indicators of economic activity, to be found elsewhere in this chapter, are considered along with "value of shipments" data it becomes even more clear that 1952 mineral demand was tapering off because of a general curtailment in the rate of increase of economic activity in the United States. It is, of course, important to realize that an absolute increase can take place but that the rate of increase is perhaps a more important indicator of future markets.

STOCKS

Physical Stocks.—As is indicated by figures compiled by the Bureau of Mines shown in table 5, more physical stocks of mineral ores and primary production rose in 1952 than declined. The most radical stock increases took place in manganese, nickel, molyb-

TABLE 5.—Stocks of ore and primary mineral products in the United States at end of year, 1943–47 (average) and 1948–52 [1]

Item	1943–47 (average)	1948	1949	1950	1951	1952	Change from 1951 (percent)
Iron ore at mines (thousand long tons)	5,023	6,285	5,334	5,726	5,600	5,528	−1
Manganese ore at plants including bonded warehouses (thousand short tons)	722	641	928	827	546	1,249	+129
Tungsten ores and concentrates at producers, consumers, and dealers (short tons, 60 percent WO_3 basis)	3,551	6,145	5,313	5,608	4,477	3,178	−29
Chromite, all grades, at consumers plants (thousand short tons)	336	602	757	606	638	754	+18
Nickel (thousand pounds):							
At plants	20,116	21,600	17,868	11,813	11,417	16,233	+42
In transit	1,454	1,938	472	488	411	185	−55
Total	21,570	23,538	18,340	12,301	11,828	16,418	+39
Molybdenum in concentrates at mines and consumers plants (thousand pounds, Mo content)	19,427	21,206	19,159	4,326	5,058	6,856	+36
Copper at primary smelting and refining plants (thousand short tons, Cu content):							
Refined copper	87	67	61	26	35	26	−26
Blister and materials in solution	270	183	261	232	182	185	+2
Total	357	250	322	258	217	211	−3
Lead at or in transit to primary smelters and refineries (thousand short tons, Pb content):							
Refined	27	29	61	29	18	31	+72
Antimonial	6	10	9	7	7	12	+71
In base bullion	28	32	36	32	31	40	+29
In ore, matte, and in process	86	76	96	70	68	66	−3
Total	147	147	202	138	124	150	+21
Zinc, slab, at primary smelters (thousand short tons)	180	19	91	8	21	81	+286
Bauxite at processors, producers, and consumers (thousand long tons, dried equivalent)	3,879	4,023	4,185	3,810	4,070	4,745	+17
Aluminum at primary reduction plants (short tons)	31,262	13,171	29,101	16,636	8,125	7,274	−10
Beryl at principal consumers plants (short tons, 10 percent BeO content)	517	1,042	2,322	2,621	1,417	2,492	+76
Cement at mills (thousand barrels)	16,068	11,084	14,706	13,217	18,224	16,066	−12
Fluorspar, finished, at mines and plants (thousand short tons)	126	184	168	184	182	278	+53

[1] Stocks in the National Stockpile are not included.

denum, lead, zinc, beryl, and fluorspar. The severest stock decreases took place in tungsten ores and concentrates and refined copper. Iron ore was relatively stable, with a decrease of 1 percent, and cement and primary aluminum were down 12 and 10 percent, respectively.

The stock picture in 1952 was very different from the 1950–51 situation. In 1951 only six major group items appearing in table 5 increased over 1950 stocks. These items were chromite, molybdenum, refined copper, zinc, bauxite, and cement. In 1952, 12 items showed stock increases; they included those that had stock increases in 1951, except for refined copper and cement.

Manufacturers' Inventories.—Table 6 compares the value of inventories at the end of 1952 and 1951 in the hands of selected mineral manufacturing industries. (Increases in inventories, together with expenditures on new plant and equipment, constitute business investment.) These inventories are broken down into two classes: (1) Finished products and (2) materials, supplies, and work in process. For the manufacturing portion of the United States economy as a whole, the total inventories at the end of 1952 amounted to \$39.9 billion, an increase of 4 percent over the \$38.3 billion reported for the end of 1951. Since the wholesale price index, on an average monthly basis, for all commodities was 111.6 in 1952 as compared with 114.8 in 1951, the 4-percent increase in inventories would have to be adjusted for the lower wholesale prices in 1952. Such an adjustment would then result in an estimated physical inventory increase of approximately 7 percent for all manufacturing industries. With regard to the mineral industries shown in table 8 only minor changes in the wholesale price index occurred between 1951 and 1952. The monthly average wholesale price index for iron and steel went from 123.2 in 1951 to 124.7 in 1952, for nonferrous metals from 124.2 to 123.5, for concrete from 112.3 to 112.5, and for gypsum the index was unchanged during the 1951–52 period. Thus, the percentage value changes in 1952, as shown in table 6, can be viewed as fairly close to what the adjusted physical change figures would be.

As a possible indicator of a leveling off of market demand, perhaps the "finished-products" category is more informative than the total inventory change or change in the inventory of "materials, supplies, and work in process." This last group could indicate a changing rate of production activity. Aside from such limiting factors as unavailable transportation, strikes, etc., when "finished-goods" inventory begins to increase sizably, it usually indicates a relative easing of demand.

Among the industries shown the primary zinc producers undoubtedly faced increasing market difficulties in 1952. The 1952 year-end inventory of primary zinc was approximately 2½ times that of 1951, indicating a serious slowdown in the rate of sale of the finished product. The inventory of materials, supplies, and work in process rose only 17 percent in 1952. No other industry in table 6 even approximated the degree of increase in inventory of finished goods which occurred in primary zinc.

TABLE 6.—Value of manufacturers' inventories for selected mineral manufacturing industries in the United States, at end of year, 1947 and 1950–52 [1]

[Millions of dollars]

Industry	1947			1950			1951			1952			Change from 1951 (percent)		
	Total	Finished products	Materials, supplies, and work in process	Total	Finished products	Materials, supplies, and work in process	Total	Finished products	Materials, supplies, and work in process	Total	Finished products	Materials, supplies, and work in process	Total	Finished products	Materials, supplies, and work in process
Blast furnaces and steel mills	997.7	218.2	779.5	1,318.1	307.3	1,010.8	1,488.6	340.5	1,148.1	1,786.5	399.5	1,387.0	+20	+17	+21
Iron and steel foundries	178.6	48.8	129.8	216.7	50.4	166.3	281.8	72.0	209.8	289.7	74.5	215.2	+3	+3	+3
Primary nonferrous metals:															
Copper	61.3	18.1	43.2	65.9	20.5	45.3	54.0	15.1	38.9	58.3	14.6	43.7	+8	−3	+12
Lead	52.1	9.0	43.2	58.7	17.7	41.0	59.9	13.5	46.4	55.8	13.8	42.1	−7	+2	−9
Zinc	38.5	6.6	31.9	31.5	3.2	28.2	37.4	5.6	31.8	51.5	14.2	37.3	+38	+154	+17
Aluminum	19.8	3.6	16.2	26.2	4.4	21.8	31.8	2.8	29.0	40.8	2.2	38.6	+28	−21	+33
Other	5.2	2.9	2.3	10.3	1.7	8.5	17.3	8.2	9.1	18.2	5.6	12.6	+5	−32	+38
Secondary nonferrous metals	80.9	26.0	54.9	95.8	38.1	57.7	94.0	31.7	62.3	95.2	36.1	59.1	+1	+14	−5
Nonferrous metal rolling and drawing:															
Copper	125.6	19.9	105.7	108.5	14.1	94.4	107.3	13.2	94.1	134.4	17.9	116.5	+25	+36	+24
Aluminum	57.0	6.4	50.6	82.7	11.4	71.3	78.9	9.0	69.9	91.9	11.5	80.4	+16	+28	+15
Other	34.6	12.7	21.9	44.1	12.8	31.3	54.5	14.4	40.1	59.4	15.1	44.3	+9	+5	+10
Nonferrous foundries	52.8	13.1	39.7	72.6	15.0	57.6	86.3	17.6	68.7	93.5	17.3	76.2	+8	−2	+11
Concrete products	34.8	22.4	12.4	64.0	(2)	(2)	79.8	(2)	(2)	83.9	(2)	(2)	+5	----------	----------
Gypsum products	11.9	2.8	9.1	13.1	4.0	9.1	17.4	5.5	11.9	16.2	6.1	10.1	−7	+11	−15
Lime	8.6	1.3	7.3	7.4	1.1	6.4	10.6	1.7	8.8	10.3	1.7	8.6	−3	0	−2
Mineral wool	8.4	2.3	6.0	9.0	2.2	6.8	12.8	3.9	8.9	12.1	4.4	7.7	−5	+13	−13
Cement, hydraulic	72.5	13.4	59.1	90.8	(2)	(2)	116.9	(2)	(2)	116.1	(2)	(2)	−1	----------	----------

[1] U. S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures: Ser. MAS–51–2, Nov. 25, 1952, and MAS–52–2, Oct. 1, 1953.
[2] Withheld because the estimate did not meet Census publication standards.

Primary copper, aluminum, and other primary nonferrous metals except lead and zinc were in a position of a reduced finished-goods inventory at the end of 1952. The construction-materials industries were generally well off, in that inventories of finished goods either remained the same or were up 13 percent at the most, while the materials, supplies, and work in process inventories were down from 2 to 15 percent.

In the case of the iron and steel categories, inventories of finished products might have been higher if the strike had not taken place. As it was, iron and steel foundry inventories were only slightly above those a year earlier.

FOREIGN TRADE

Imports and Exports.—In 1952 both the value of United States imports and that of exports of metallic and nonmetallic minerals and their products increased over those in 1951, with the percentage increase for imports being over three times that for exports (see table 7). (A rough calculation indicates that about three-quarters of the increase in value of imports resulted from a net overall in-

TABLE 7.—Foreign trade of the United States in metallic and nonmetallic minerals and their products, 1950–52, by commodity group [1]

[Thousands of dollars]

Commodity group	1950	1951	1952	Change from 1951 (percent)
IMPORTS FOR CONSUMPTION				
Nonmetallic minerals:				
Stone, cement, lime, gypsum	11,169	13,684	12,180	−11.0
Clays and clay products	14,357	21,664	17,389	−19.7
Precious stones and imitations	155,509	175,753	176,610	+.5
Other nonmetallic minerals [2]	94,636	119,284	111,222	−6.8
Total	275,671	330,385	317,401	−3.9
Metallic minerals:				
Iron ore and concentrates	44,027	59,555	82,903	+39.2
Ferroalloys	111,869	132,905	200,228	+50.7
Nonferrous metals except precious	854,819	829,801	1,362,287	+64.2
Total	1,010,715	1,022,261	1,645,418	+61.0
Total imports	1,286,386	1,352,646	1,962,819	+45.1
EXPORTS OF DOMESTIC MERCHANDISE				
Nonmetallic minerals:				
Stone, cement and lime	9,102	12,401	13,983	+12.8
Clays and clay products	41,564	59,601	56,956	−4.4
Other nonmetallic minerals including precious [2]	89,420	114,238	109,002	−4.6
Total	140,086	186,240	179,941	−3.4
Metallic minerals:				
Iron ore	15,717	30,997	37,404	+20.7
Ferroalloys, ores, and metals	3,001	5,575	7,796	+39.8
Nonferrous metals except precious	146,825	186,565	240,854	+29.1
Total	165,543	223,137	286,054	+28.2
Total exports	305,629	409,377	465,995	+13.8

[1] U. S. Department of Commerce, Bureau of the Census, Statistical Abstract of the United States, 1954: Washington, 1954, pp. 917 and 919.

[2] Excludes fuels, glass, and related products.

crease in the volume of imports, while the remainder resulted from a preponderance of unit-value increases over unit value decreases.) The disparity in the increases widened the relative gap between imports and exports of such commodities to the extent that in 1952 there was \$4⅕ of mineral imports per dollar of exports while in 1951 there had been only about \$3⅓ of imports per dollar of exports. The overall increase in trade in minerals and their products was due to a substantial increase in trade in metallics, which more than compensated for a slight slackening of trade in nonmetallics. For metallics the percentage increase for imports was over twice that in exports, while for nonmetallics both imports and exports decreased by about the same limited extent.

Tariffs and Other Regulations.—Suspension of the import excise tax on copper, copper scrap, copper-bearing ores, and copper concentrates was continued during 1952. On February 12, 1952, Public Law 257 suspended the duties on lead (except scrap, already duty free); but, because of the lead price decline, they were reimposed on June 26, and the suspension of duty on lead scrap was revoked on July 1. The rates reinstated were 1$\frac{1}{16}$ cents per pound on refined lead, ¾ cent per pound on the lead content of ores and concentrates, and 1$\frac{1}{16}$ cents per pound on the lead content of lead scrap, dross, and reclaimed lead.

Duties on zinc in zinc-bearing ores (⅗ cent per pound), and in blocks, pigs, and slabs ($\frac{7}{10}$ cent per pound) were suspended February 12 under Public Law 258 but reimposed July 23 because of the price situation. The duty suspension on zinc scrap continued through 1952 as did those on ferrous scrap and aluminum scrap.

Under the new terms of the supplementary trade agreement with Venezuela, effective October 11, 1952, the duties on iron ore, granular or sponge iron, and pig iron and iron kentledge (pig iron used for ballast), which were established under the General Agreement on Tariffs and Trade, were generalized to that country. Venezuela, not being a member of GATT, had not previously been granted these duty rates. The rates are as follows: Granular or sponge iron, 62½ cents per long ton; pig iron and iron kentledge, 60 cents per long ton; and iron ore, including manganiferous iron ore, free.

The Export Control Act of 1949 continued to be administered by the Office of International Trade, U. S. Department of Commerce, to limit the strategic materials exported from the United States (*See* Defense Mobilization, Office of International Trade).

In addition, under the Battle Act of 1951 (Mutual Defense Assistance Control Act), approved October 26, 1951, and administered by the Director of Mutual Security, Executive Office of the President, efforts were continued to control the strategic exports from the entire Free World to the Soviet bloc. Embargo provisions of this act went into effect on January 24, 1952, and considerable progress was made during the year toward a more effective control system, involving development of alternative markets and sources of supply.[4]

---

[4] Director of Mutual Security, 1st and 2d semiannual reports to the Cong. on Mutual Defense Assistance Control Act of 1951: Oct. 15, 1952 and Jan. 16, 1953.

342070—55——2

The number of minerals under international allocation by the International Materials Conference was reduced in 1952 because of improved supply-demand situations. (*See* Defense Mobilization, International Materials Allocation.)

LABOR

The tapering off of the defense economy during 1952 is evidenced by decreasing production-worker employment in most industrial segments shown in table 8. Iron mining experienced the most serious drop—14 percent—while lead-zinc mining and nonferrous foundries were the only industries showing gains (2 and 3 percent, respectively) during 1952. Lead-zinc mining was the only one of the metal-mining group to show a continual increase in its production-worker force during 1950–52; the 1950–52 trend for the entire metal-mining group was downward. In the primary-metal-industry group only nonferrous foundries in 1952 increased over 1951 in its production-worker force, but 1951 had been severely lower than 1950—approximately 8 percent.

TABLE 8.—Annual average employment of production and related workers in the mineral industries in the United States, 1948–52, by industries [1]

[In thousands]

Industry	1948	1949	1950	1951	1952	Change from 1951 (percent)
Metal mining	88.6	89.0	89.4	88.4	83.8	−5
Iron	32.6	30.4	31.9	33.8	29.1	−14
Copper	20.0	24.3	24.8	22.4	22.3	(2)
Lead and zinc	19.2	18.1	17.2	17.8	18.1	+2
Nonmetallic mining and quarrying	87.6	83.7	85.2	89.2	88.6	−1
Primary metal industries	1,082.8	939.9	1,052.9	1,132.1	1,039.7	−8
Blast furnaces, steel works, rolling mills	536.8	476.7	535.6	560.2	486.5	−13
Iron and steel foundries	230.9	188.9	204.0	237.1	223.4	−6
Primary smelting and refining of nonferrous metals	46.8	43.3	45.4	42.3	42.0	−1
Secondary smelting and refining of nonferrous metals	(3)	(3)	(3)	10.2	9.2	−10
Rolling, drawing, and alloying of nonferrous metals	86.0	70.6	80.7	90.8	90.1	−1
Nonferrous foundries	73.2	63.3	78.8	72.8	74.9	+3
Other primary metal industries	109.1	97.1	108.4	118.9	113.7	−4

[1] U. S. Department of Labor, Bureau of Labor Statistics.
[2] Less than 0.5 percent.
[3] Data not available.

The general upward trend in wages continued in 1952, as can be seen in table 9. Both hourly earnings and average weekly earnings of production and related workers in the mineral industries rose, on the average, approximately 6 percent. The increase in hourly earnings was slightly higher than the increase in weekly earnings because of the slight decrease in the average length of the workweek.

Average weekly earnings rose most sharply in iron mining and the least in iron and steel foundries. Average hourly earnings increased most in the copper-mining industry (11 percent), while the smallest increase took place in the hydraulic-cement-manufacturing industry (4 percent). Both average weekly and average hourly earnings for all mining and manufacturing categories shown in table 9 increased over 1951.

TABLE 9.—Average earnings and hours of production and related workers in the mineral industries in the United States, 1948–52, by industries

[U. S. Department of Labor]

Industry	1948	1949	1950	1951	1952	Change from 1951 (percent)
AVERAGE WEEKLY EARNINGS						
Iron mining	$58.32	$58.91	$61.96	$72.68	$80.34	+11
Copper mining	65.81	63.96	72.05	78.54	85.73	+9
Lead-zinc mining	61.37	64.79	66.64	76.11	81.60	+7
Nonmetallic mining and quarrying	55.31	56.38	59.88	67.05	71.10	+6
Cement, hydraulic, manufacturing	54.76	57.49	60.13	65.21	67.72	+4
Concrete, gypsum, and plaster products, manufacturing	56.49	57.77	62.64	68.25	70.65	+4
Blast furnaces, steelworks, and rolling mills	62.41	63.04	67.47	77.30	79.60	+3
Iron and steel foundries	58.45	55.09	65.32	71.66	72.22	+1
Primary smelting and refining of copper, lead, and zinc	57.14	58.99	62.37	69.38	75.06	+8
Primary refining of aluminum	58.95	61.95	63.97	70.97	76.08	+7
AVERAGE WEEKLY HOURS						
Iron mining	41.3	39.8	40.9	42.5	43.9	+3
Copper mining	45.2	42.3	45.0	46.2	45.6	−1
Lead-zinc mining	41.3	41.4	41.6	43.0	42.5	−1
Nonmetallic mining and quarrying	44.5	43.3	44.0	45.0	45.0	0
Cement, hydraulic, manufacturing	41.9	41.6	41.7	41.8	41.8	0
Concrete, gypsum, and plaster products, manufacturing	44.8	43.8	45.0	45.2	45.0	(1)
Blast furnaces, steelworks, and rolling mills	39.5	38.3	39.9	40.9	40.0	−2
Iron and steel foundries	40.7	37.2	41.9	42.4	40.8	−4
Primary smelting and refining of copper, lead, and zinc	40.9	40.1	40.9	41.3	41.7	+1
Primary refining of aluminum	41.4	41.3	40.9	41.5	41.8	+1
AVERAGE HOURLY EARNINGS						
Iron mining	$1.412	$1.484	$1.52	$1.71	$1.83	+7
Copper mining	1.456	1.512	1.60	1.70	1.88	+11
Lead-zinc mining	1.486	1.565	1.60	1.77	1.92	+8
Nonmetallic mining and quarrying	1.243	1.302	1.36	1.49	1.58	+6
Cement, hydraulic, manufacturing	1.307	1.382	1.44	1.56	1.62	+4
Concrete, gypsum, and plaster products, manufacturing	1.261	1.319	1.39	1.51	1.57	+4
Blast furnaces, steelworks, and rolling mills	1.580	1.646	1.69	1.89	1.99	+5
Iron and steel foundries	1.436	1.481	1.56	1.69	1.77	+5
Primary smelting and refining of copper, lead, and zinc	1.397	1.471	1.53	1.68	1.80	+7
Primary refining of aluminum	1.424	1.500	1.56	1.71	1.82	+6

[1] Less than 0.5 percent.

The leveling off of the economy during 1952 is reflected in the average weekly hours worked in the mining and primary-metal industries (*see* table 9). Except for iron mining, primary smelting and refining of copper, lead, and zinc, and primary refining of aluminum, the average workweek of the mining or manufacturing industries either remained unchanged over 1951 or was shortened. Iron and steel foundries had an average workweek in 1952 that was 4 percent shorter than in 1951—the most extreme reduction of the group.

PRICES[5]

The wholesale price-index movements for metallic and nonmetallic minerals formed varied patterns during 1952. For iron and steel, the wholesale price index was 127 in December 1952, as opposed to 123 in December 1951 (1947–49=100). The price index for iron and steel remained stable throughout 1952 until August, when it went from 122 to 127.

The nonferrous-metals wholesale price index declined from the December 1951 figure of 124 to 122 in December 1952. The monthly indexes moved up and down, with a high of 125 in February and a low of 120 in June 1952. The July recovery to 124 lasted through September, when the index reached 125, and then in October dropped to 123.

Clay-products prices rose during 1952. The wholesale price index was 121.4 in December 1951 and varied only a tenth of a point during the first 9 months of 1952, until October, when it rose to 124.6. The indexes for concrete products and gypsum products remained stable throughout 1952. The wholesale price index for concrete products was 112.4 in December 1951 and 112.7 in December 1952. The same index for gypsum products was 117.7 in December 1951 and remained there throughout 1952.

Price movements of commodities purchased by the mining and primary-metal industries were also mixed. The wholesale price index of coal rose from 108.9 in December 1951 to 116.1 in December 1952. Most of this increase took place during the fourth quarter of 1952. The price index for electricity rose only slightly during 1952—from 98.0 in December 1951 to 98.5 in December 1952. During the same period, the petroleum and products index declined from 110.8 to 107.9. Also during the same period the lumber and wood-products index declined from 120.3 to 119.7.

BUSINESS INCOME, TAXES, AND DIVIDENDS

Although there was an absolute increase in metal- and nonmetal-mining corporate-dividend payments in 1952, business income, and taxes, as can be seen in table 10, were lower than in 1951. The table presents income, tax, and dividend data, with an average for the 5-year period, 1943–47, and annual figures for 1948–52.

Table 11 shows the incomes, taxes, and dividend rates of the metallic-mineral-manufacturing industries. For these enterprises

[5] Wholesale price indexes referred to are those of the Bureau of Labor Statistics, U. S. Department of Labor.

TABLE 10.—Income, taxes, and dividend payments of mining industries in the United States, 1943–47 (average) and 1948–52, by industries [1]

[Millions of dollars]

Item and industry	1943–47 (average)	1948	1949	1950	1951	1952	Change from 1951 (percent)
Income of unincorporated enterprises:							
Metal mining	8	15	7	13	17	15	−12
Nonmetallic mining and quarrying	6	14	12	13	14	13	−7
Total	14	29	19	26	31	28	−10
All industries	32,284	40,146	33,774	38,225	41,980	40,862	−3
Corporate income before taxes: [2]							
Metal mining	163	352	206	384	451	441	−2
Nonmetallic mining and quarrying	69	137	129	165	175	165	−6
Total	232	489	335	549	626	606	−3
All industries	24,611	33,762	27,107	40,976	43,663	39,216	−10
Tax liability:							
Metal mining	45	97	54	116	166	168	+1
Nonmetallic mining and quarrying	27	47	43	64	75	63	−16
Total	72	144	97	180	241	231	−4
All industries	12,134	13,028	10,817	18,247	23,595	20,635	−13
Corporate income after taxes: [2]							
Metal mining	118	255	152	268	285	273	−4
Nonmetallic mining and quarrying	42	90	86	101	100	102	+2
Total	160	345	238	369	385	375	−3
All industries	12,497	20,734	16,290	22,729	20,068	18,581	−7
Net corporate dividend payments:							
Metal mining	62	118	92	130	136	133	−2
Nonmetallic mining and quarrying	22	34	33	42	44	53	+20
Total	84	152	125	172	180	186	+3
All industries	5,248	7,250	7,469	9,125	9,208	9,107	−1
Undistributed corporate income:							
Metal mining	55	137	60	138	149	140	−6
Nonmetallic mining and quarrying	21	56	53	59	56	49	−13
Total	76	193	113	197	205	189	−8
All industries	7,229	13,484	8,821	13,604	10,860	9,474	−13

[1] Survey of Current Business, vol. 33, No. 7, July 1953, pp. 17–18, and National Income Suppl., 1951, pp. 164–175.
[2] Depletion charges are not deducted in arriving at corporate income for national income purposes.

dividend rates in 1952 were below those of 1951 and the decline in income and taxes was even greater. Income retained by corporations after taxes and dividends also decreased. For the iron and steel group this drop was sharp—approximately 41 percent. The nonferrous segment dropped about 18 percent. This, of course, might affect rates of expansion or replacement by internal financing should this drop in undistributed income continue over a long period. It would certainly appear that the minor drop in the dividend rate as opposed to the serious income drop for incorporated enterprises bespeaks an attempt to maintain the previous dividend rate paid stockholders. It is interesting to note that, for all the incorporated enterprises, although the 1952 income levels were well below those in 1951 and 1950, the dividends paid in 1952 were only 2 percent below the 1951 figure and only 0.3 percent below that in 1950. For nonferrous-metal firms, the dividend rate of 1952, which was 2 percent below the 1951 rate, was still 16 percent above that in 1950 for these firms.

TABLE 11.—Income, taxes, and dividend payments of metallic mineral manufacturing industries in the United States, 1943–47 (average) and 1948–52, by industries [1]

[Millions of dollars]

Item and industry	1943–47 (average)	1948	1949	1950	1951	1952	Change from 1951 (percent)
Income of unincorporated enterprises:							
Iron and steel and their products [2]	108	77	59	95	109	83	−24
Nonferrous metals and their products	83	38	29	47	54	41	−24
Total	191	115	88	142	163	124	−24
All industries	32,284	40,146	33,774	38,225	41,980	40,862	−3
Corporate income before taxes: [3]							
Iron and steel and their products [2]	1,670	2,434	1,682	2,954	3,597	2,165	−40
Nonferrous metals and their products	441	556	467	910	1,122	872	−22
Total	2,111	2,990	2,149	3,864	4,719	3,037	−36
All industries	24,611	33,762	27,107	40,976	43,663	39,216	−10
Tax liability:							
Iron and steel and their products [2]	903	964	684	1,400	2,185	1,128	−48
Nonferrous metals and their products	214	209	196	431	664	466	−30
Total	1,117	1,173	880	1,831	2,849	1,594	−44
All industries	12,134	13,028	10,817	18,247	23,595	20,635	−13
Corporate income after taxes:							
Iron and steel and their products [2]	767	1,470	998	1,554	1,412	1,037	−27
Nonferrous metals and their products	228	347	271	479	458	406	−11
Total	995	1,817	1,269	2,033	1,870	1,443	−23
All industries	12,497	20,734	16,290	22,729	20,068	18,581	−7
Corporate dividend payments:							
Iron and steel and their products [2]	301	413	381	538	523	511	−2
Nonferrous metals and their products	98	125	141	158	187	183	−2
Total	399	538	522	696	710	694	−2
All industries	5,248	7,250	7,469	9,125	9,208	9,107	−1
Undistributed corporate income:							
Iron and steel and their products [2]	466	1,057	617	1,016	889	526	−41
Nonferrous metals and their products	130	222	130	321	271	223	−18
Total	596	1,279	747	1,337	1,160	749	−35
All industries	7,229	13,484	8,821	13,604	10,860	9,474	−13

[1] Survey of Current Business, vol. 33, No. 7, July 1953, pp. 17–18, and National Income Suppl., 1951, pp. 164–175.
[2] Including ordnance.
[3] Depletion charges are not deducted in any corporate income for national income purposes.

INVESTMENT

Expenditures for New Plant and Equipment.—In 1952 mining-industry (fuels and nonfuels) expenditures for new plant and equipment were estimated at $880 million, a 5-percent decline from 1951. This contrasts with all manufacturing and public utilities, which increased 11 and 5 percent, respectively, but roughly matches the decreases for transportation and other businesses—7 and 3 percent. (The total for all industry increased 3 percent.) The successive quarterly investments for mining seasonally adjusted and expressed in annal rates, were $930, $900, $830, and $870 million.[6]

[6] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business: Vol. 33, No. 12, December 1953, p. 4.

During 1952 the expenditures for new plant and equipment by the mineral-manufacturing industries in table 12 exceeded the 1951 expenditures of these industries by $409 million, an increase of 35 percent. The 1951 expenditures for new plant and equipment, for the industries shown in table 12, were approximately twice as high as total expenditures in 1950.

TABLE 12.—Expenditures for new plant and new equipment for selected mineral manufacturing industries in the United States, 1947 and 1949–52, by industries [1]

[Millions of dollars]

Industry	1947	1949	1950	1951	1952	Change from 1951 (percent)
NEW STRUCTURES AND ADDITIONS TO PLANT						
Blast furnaces and steel mills	149.8	108.5	89.4	244.3	326.9	+34
Iron and steel foundries	20.7	11.6	12.2	43.1	25.7	−40
Primary nonferrous metals	6.5	9.0	11.0	29.8	117.9	+296
Secondary nonferrous metals	2.6	2.7	1.4	2.9	3.2	+10
Nonferrous-metal rolling and drawing	7.5	10.4	4.9	7.6	11.5	+51
Nonferrous foundries	6.2	3.9	6.0	7.3	7.7	+5
Hydraulic cement	9.2	8.8	10.3	20.9	12.0	−43
Concrete and plaster products	28.9	10.4	(2)	12.5	11.9	−5
Total	231.4	165.3	[2] 135.2	368.4	516.8	+40
NEW MACHINERY AND EQUIPMENT						
Blast furnaces and steel mills	218.6	244.4	249.2	477.4	737.3	+54
Iron and steel foundries	55.0	34.7	41.5	101.8	70.7	−31
Primary nonferrous metals	10.8	18.5	25.9	72.2	110.2	+53
Secondary nonferrous metals	4.6	5.0	4.1	5.8	5.6	−3
Nonferrous-metal rolling and drawing	26.3	52.5	24.5	29.3	47.5	+62
Nonferrous foundries	12.8	7.9	10.2	15.9	14.1	−11
Hydraulic cement	33.3	36.1	40.5	56.2	32.8	−42
Concrete and plaster products	55.1	32.7	(2)	48.7	49.7	+2
Total	416.5	431.8	[2] 395.9	807.3	1,067.9	+32
TOTAL						
Blast furnaces and steel mills	368.4	352.9	338.6	721.7	1,064.2	+47
Iron and steel foundries	75.7	46.3	53.7	144.9	96.4	−33
Primary nonferrous metals	17.3	27.5	36.9	102.0	228.1	+124
Secondary nonferrous metals	7.2	7.7	5.5	8.7	8.8	+1
Nonferrous-metal rolling and drawing	33.8	62.9	29.4	36.9	59.0	+60
Nonferrous foundries	19.0	11.8	16.2	23.2	21.8	−6
Hydraulic cement	42.5	44.9	50.8	77.1	44.8	−42
Concrete and plaster products	84.0	43.1	53.1	61.2	61.6	+1
Total	647.9	597.1	584.2	1,175.7	1,584.7	+35

[1] U. S. Department of Commerce, Bureau of the Census, Annual Survey of Manufactures: Ser. MAS-52-3, Oct. 1, 1953, and MAS-51-1, Nov. 21, 1952.
[2] No breakdown between types of expenditures available for the concrete and plaster products industry.

Percentagewise there was a greater increase in 1952 in expenditures for "new structures and additions to plant" than for additional machinery and equipment. However, in terms of dollars, the greater increase took place for "new machinery and equipment."

In expenditures for new structures and additions to plant the primary-nonferrous metals increased most percentagewise to almost four times the 1951 level. On the other hand, hydraulic cement showed a marked decrease (43 percent) in such expenditures. In the expenditures for new machinery and equipment the nonferrous-metal rolling and drawing industry showed the largest percentage increase (62 percent). The blast-furnace and steel-mills group also showed a large increase, both percentage-wise (54 percent) and dollarwise. As in the case of expenditures for new structures and additions to plant, the hydraulic-cement industry showed the greatest percentage decline (42 percent). It is interesting to note that, for the hydraulic-cement industry, the 1952 percentage cuts in expenditures for both plant and equipment were within 1 point of each other.

United States Foreign Mining and Smelting Investment.—Outflows of capital for mining and smelting investments abroad in 1952 were $278 million—higher than in any previous year. Much of this foreign investment was connected with a few large-scale projects, although a great deal of activity was carried out on a small scale to develop new sources of essential raw materials. The amount of reinvested earnings was below that in 1951, since earnings were reduced by price declines for several metals and minerals.

Several of the largest investments were made in Canada, as can be seen in table 13; these included the iron-ore developments in Labrador. Large investments were also made in Venezuela.

TABLE 13.—Value of United States direct private investment in foreign mining and smelting industries, 1950–52, by areas[1]

[Millions of dollars; reduction of investment (−)]

Area and addition to value	1950	1951	1952	Change from 1951 (percent)
All areas:				
Value at beginning of year	1,011	1,129	1,317	+17
Net capital movements	87	100	278	+178
Undistributed subsidiary earnings	33	56	45	−20
Other changes	−2	32	2	−94
Value at end of year	1,129	1,317	1,642	+25
Canada:				
Value at beginning of year	287	334	400	+20
Net capital movements	29	36	134	+272
Undistributed subsidiary earnings	18	30	14	−53
Other changes				
Value at end of year	334	400	550	+38
Latin-American Republics:				
Value at beginning of year	595	628	736	+17
Net capital movements	29	60	120	+100
Undistributed subsidiary earnings	4	16	15	−6
Other changes		32		
Value at end of year	628	736	871	+18
Western Europe:				
Value at beginning of year	19	21	23	+10
Net capital movements	(2)	(2)	(2)	
Undistributed subsidiary earnings	2	3	3	0
Other changes		−1		
Value at end of year	21	23	26	+13
Western European dependencies:				
Value at beginning of year	75	88	95	+8
Net capital movements	13	2	18	+800
Undistributed subsidiary earnings	2	5	4	−20
Other changes	−2			
Value at end of year	88	95	117	+23
All other countries:				
Value at beginning of year	33	56	61	+9
Net capital movements	16	2	6	+200
Undistributed subsidiary earnings	7	2	9	+350
Other changes		1		
Value at end of year	56	61	76	+25

[1] U. S. Department of Commerce, Office of Business Economics, Survey of Current Business, vol. 34, No. 1, January 1954, p. 6.
[2] Less than $500,000.

DEFENSE MOBILIZATION

Defense Production Act.—The Defense Production Act of 1950 was renewed as Public Law 429, 82d Congress, on June 30, 1952. The same powers over priorities, allocations, and expansion of production as the act originally contained were continued in essentially unmodified form, as far as minerals-expansion assistance was concerned. However, in reviewing the act, Congress made clear that it wished continuation of the policy of relaxing and removing controls as they became no longer necessary to assure attainment of the objectives of the act.

The act as amended authorized designated agencies to incur obligations (borrowing authority) up to $2.1 billions. When borrowing authority was certified for any given program, the total amount certified was to cover either an estimate of the eventual cost of the assistance to the Government, the working capital, or a combination of the two.

The coordinating authority in the materials field remained with the Defense Production Administration. Two interagency committees established in December 1951 were employed to coordinate activities of various Government agencies in the work of providing expansion of supplies of basic materials.[7]

One of these—the Defense Materials Policy Committee—first met in January 1952 to consider and act upon significant materials-policy problems. The principal functions of the committee were the review of the following types of policies and problems: (1) Positions to be taken by the United States representatives in the International Materials Conference; (2) objectives, policies, and programs for procuring materials needed for defense at home or abroad; (3) plans and methods to control or limit price increases for needed materials, including multination action; and (4) plans, programs, and problems referred to the committee by the Office of Defense Mobilization, the DPA Administrator, and the Defense Materials Operating Committee.

The other interagency group—the Defense Materials Operating Committee—exercised functions previously performed by the Vital Materials Coordinating Committee. At its weekly meetings it reviewed the supply-requirements data for National Stockpile materials and planned coordination of supply expansion, distribution of available quantities, and restriction of nonessential uses.

Defense Materials Procurement Agency.—The Defense Materials Procurement Agency, with the assistance of the General Services Administration, continued to offer assistance under the Defense Production Act for the expansion of supply of critical metals and minerals. This assistance was in the form of:

1. Certificates of necessity for rapid tax amortization, permitting the portion of the cost of a facility attributable to the defense program to be written off for tax purposes over 5 years instead of the normal depreciation period.

[7] Joint Committee on Defense Production, Activities: 2d Ann. Rept., Rept. 3, 83d Cong., Oct. 20, 1952, pp. 59–60.

2. Guaranteed markets at guaranteed prices by contract, which could be either a commitment to purchase the output of a project at a negotiated price (in some cases, a premium price) or a general floor-price guarantee for the output produced which could not be sold on the commercial market at or above the floor price.

3. Direct loans, guarantees of loans, and advances against production for investment in facilities or working capital, when private financing was unavailable due to the risk involved.

4. Grants for research and development to stimulate development of new methods that might lead to greater output or conservation of scarce materials.

5. Priorities and allocation of scarce materials.

6. Construction of access roads to sources of strategic minerals.

The agency continued to develop and revise programs for minerals expansion, recommending measures for augmenting supply and negotiating means for developing foreign and domestic projects through various types of assistance, with a view toward supporting mobilization as well as current needs. Revised detailed resource-expansion programs for over 40 minerals were recommended to and approved by DPA. Under the machinery of the overall resources-expansion program, accelerated tax amortizations were certified to the Bureau of Internal Revenue, essentiality of domestic loans certified to the Reconstruction Finance Corporation, and essentiality of foreign loans certified to the Export-Import Bank for final approval of terms. Procurement and floor-price contracts and advances against production were negotiated, executed, and administered within DMPA.

During the year purchase programs at guaranteed prices were authorized, with designation of depots in the United States for purchasing domestic beryl, mica, small lots of manganese, and asbestos. These were in addition to the purchase programs underway for tungsten, manganese, and chromite. Several agents were designated to purchase domestic and foreign columbite-tantalite ores.

By June 30, 1952, certificates of necessity granted on facilities for metal mining amounted to over $700 million and for mining and quarrying nonmetallic minerals, nearly $25 million.[8] By the end of the year, the total for these two categories amounted to over $1 billion,[9] most of which applied to facilities for expanding iron-ore supply.

Since development of mineral bodies requires several years before rated production can be achieved, it was too soon by the end of 1952 for the material-expansion programs to have made significant contributions to increased supplies, but several noteworthy increases in supply can be mentioned. The increased output under domestic tungsten expansion facilitated meeting the requirements of essential programs and continuing additions to the National Stockpile. The supply situation of many scarce commodities began to ease—in particular, lead, zinc, fluorspar, and, late in the year, copper. Indications were that stockpile-addition rates for most materials

[8] Defense Production Administration, Federal Aids for Facilities Expansion: July 10, 1952, p. 6.

[9] Defense Materials Procurement Agency, Defense Production Act, Review of Tax Amortization Program: Progress Rept. 25, Apr. 20, 1953, p. 13 (unpublished report).

would continue to rise during the next few years as a result of expansion programs initiated, and special programs had been instituted when it appeared that extraordinary measures were required to insure completion of the stockpile in a reasonable time.

Defense Minerals Exploration Administration.[10]—The Defense Minerals Exploration Administration continued to analyze exploration proposals and to negotiate and administer exploration expense-sharing contracts. A marked decrease in the number of new applications took place during April, May, and June. This was attributed to the fact that 44 percent of all contracts were for lead-zinc and lead-zinc-copper projects, and a sharp drop in the price of lead-zinc caused an abrupt braking of exploration for these metals.

However, the search continued for domestic deposits of other strategic and critical minerals. Under the DMEA program, exploration projects were carried on in 27 States. Twenty-four minerals were sought, including the titanium minerals, rutile and brookite, which were added to the critical list in January 1952.

Office of Price Stabilization.[11]—The Office of Price Stabilization made major adjustments in its price-control program during the third quarter of 1952, when pressure developed to increase the prices of three basic metals—steel, aluminum, and copper. On the basis of maintaining pre-Korea margins for primary aluminum production, a price increase of 1 cent a pound was allowed on primary pig and ingot aluminum, and a rise of 5 percent was granted in the ceiling prices of primary aluminum products.

To assure continued imports of Chilean copper, the OPS authorized an increase in the prices of copper and brass-mill products, while maintaining the ceiling on domestic copper. Chilean copper, under an agreement with the Chilean Government, was commanding a price 3 cents above the domestic price but below the world market price. The agreement was rescinded by the Chilean Government, and an embargo was announced May 8. To retain the flow of Chilean copper with the least effect on the domestic economy and without resort to subsidies, OPS permitted United States buyers to pass on 80 percent of any excess paid over the domestic ceiling of 24.5 cents per pound. The price of Chilean copper to private purchasers later rose to 36.5 cents.

Price increases in the three basic materials—steel, aluminum, and copper—spread cost increases throughout metal fabrication, and with no adjustment the metalworking industries would have had to bear the brunt of all increases due to increased costs of basic metals, labor, and rail freight. In recognition of this problem, OPS issued General Overriding Regulation 35, enabling purchasers of base metals to pass through price advances to customers at secondary and subsequent stages of fabrication.

Authority was granted for increases of $1 a ton for iron ore, and $40 a ton for ferromanganese.

---

[10] Secretary of the Interior, Annual Report, Fiscal Year Ended June 30, 1952: Pp. 493–494.

[11] Director of Defense Mobilization, 7th Quarterly Report to the President: Oct. 1, 1952, pp. 31–33.

Joint Committee on Defense Production, Activities: House Rept. 1097, 83d Congress, Jan. 7, 1954, pp. 79–80.

In contrast to these increases, the prices of lead and zinc declined below the ceiling price in May owing mainly to unusually large imports and a decreased demand at home and abroad. Price control was not removed from metals during the year.

National Production Authority.—Immediately after the start of the steel strike, June 2, 1952, a number of directions were issued under the appropriate National Production Authority orders to insure that the dwindling supplies of steel would be available for the defense programs during the strike and until production again caught up with demand.

Among the many regulations and directions issued, one of the most important, M–6 A (Direction 3, July 28), provided for maintaining a flow of steel products to military contractors who ordinarily obtained their requirements from warehouse stocks; it also assured small business a portion of the available warehouse stocks and provided, where possible, both small and larger consumers with steel. In addition, it limited the quantity of steel available to any one consumer in order to spread new steel supplies. Direction 15 to CMP Regulation 1 was issued July 29, providing that all scheduled second-quarter and all third-quarter military, atomic energy, and machine-tool orders, bearing the allotment symbol ABCEZ–2 or B–5, for steel, must be filled by November 30 and that, if any conflict developed, the mills must defer nonmilitary orders.

With resumption of steel production, the necessary steps were taken to implement the policy decision to "maintain the CMP pattern essentially as it was on June 2, with the minimum of disruption to mill schedules," and "that the application of special assistance measures would be limited to military and atomic energy programs, the vital machine tool program, and the delivery of tinplate for cans needed to save perishable foods."

National Strategic Stockpile.[12]—Deliveries to the National Stockpile in 1952 were larger than in any previous year. Of the 57 items still incomplete by June 30, progress was made in adding to the inventories of 54. Only 14 percent of the obligations incurred over the 6½ years of the stockpile were incurred in 1952, although 35 percent of the cumulative expenditures were made in that year. For 10 items of the metals and minerals group the stockpile objective had been met by December 31, 1952.

Despite the widely improved supply situation, aluminum, copper, and nickel remained scarce, necessitating diversions to industry of tonnages under contract for delivery to the stockpile. Other diversions, particularly in the early part of the year, included cobalt, acid-grade fluorspar, tungsten, zinc, and later a small quantity of rare earths, as a result of a temporary shortage. Materials released from inventory by Presidential order (all during the early months of the year) were aluminum, copper, cryolite, lead, rutile, and zinc, for allocation to industry. However, the quantities involved were small compared to defense requirements.

Deliveries of material to the stockpile improved during the second half of the year. Material added during the 12-month period was

[12] Department of Defense, Munitions Board, Stockpile Reports to the Congress: Aug. 15, 1952, and Feb. 15, 1953.

valued at $918 million, and the total value December 31, 1952, was $3.8 billion, after adjustment for price changes.

The review of materials-purchase specifications continued to reveal the necessity for changes in grades, packaging, and marking and for changes to give consideration to current technological processes and to world supplies currently available for stockpile purchases.

A review of all stockpiling policy was initiated. This review was aimed at devising policies that would encompass the stockpiling program during partial mobilization periods as well as during full mobilization.

Commodity Credit Corporation.—The Commodity Credit Corporation continued to accept strategic and critical materials produced abroad in exchange for agricultural commodities acquired by that corporation. During the year, approximately $17 million [13] worth of material was transferred to the stockpile, part of which was metals or minerals.

Mutual Security Administration.[14]—Mutual Security Administration's strategic-materials program providing for direct purchase of critical commodities and loans and/or grants for development projects for scarce material resources continued to be administered by the Defense Materials Procurement Agency. To permit DMPA to make purchases or development contracts on behalf of MSA (formerly Economic Cooperation Administration), funds were transferred from time to time in local currency. Through December 1952 the cumulative total commitment amounted to $223 million. Of this total, the equivalent of $89 million was for the purchase of strategic items for the United States stockpile. All expenditures for these purchases were made from the United States portion of counterpart funds. A total of $134 million was committed for developmental projects. Most of this represented loans from the United States portion of counterpart funds, repayable in strategic materials.

Two other assistance programs were administered directly by MSA: (1) Technical aid to underdeveloped areas in the form of geological surveys, aerial photography and mapping projects, and research, training, and professional advice for specific problems encountered in materials recovery; and (2) large sums authorized for the purchase of machinery and equipment under general country programs, some of which was undoubtedly used for mining purposes.

Export-Import Bank.[15]—During 1952 the Export-Import Bank under its own enabling act established credits abroad totaling $114 million for the production of cobalt, copper, manganese, nickel, uranium, tungsten, and sulfur. Another $44 million of credits was established under the Defense Production Act to assist production of zinc, cobalt, copper, and manganese and large additional loans for the development of strategic materials were under consideration at the end of the year.

---

[13] Derived from Department of Defense, Munitions Board, Stockpile Reports to Congress: Jan. 23, 1952, p. 13, and Feb. 15, 1953, p. 11.

[14] Foreign Operations Administration, Monthly Operations Report: Data as of Aug. 31, 1953, pp. 4–6, 32.

[15] Export-Import Bank of Washington, Fourteenth Semiannual Report to Congress for 1952: Pp. 30–31; Fifteenth Semiannual Report: Pp. 24–25.

Office of International Trade.[16]—The Office of International Trade, United States Department of Commerce, under its export-control authority severely limited the quantities of critical and short-supply materials that could be exported from the United States. During the year, some changes were made in degree of control for certain strategic minerals, and antimony, cadmium, bismuth, and graphite were released entirely. Controls were relaxed somewhat on kyanite, chromite, most forms of copper, industrial diamonds, lead, molybdenum, tin, vanadium, and some forms of zinc and aluminum. Restrictions were increased on cryolite, nickel, and some forms of copper.

International Materials Allocation.[17]—The world-wide emergency shortage of raw materials stimulated the United States, the United Kingdom, and France to organize international machinery for maintaining some order between supply and demand. The three countries published a joint declaration on January 12, 1951, stating their agreement to propose international commodity groups to certain other governments; as a result of this action, the International Materials Conference was set up. The Conference had a Central Group with 10 members: Australia, Brazil, Canada, France, India, Italy, the United Kingdom, the United States, and representatives of the Organization of the American States (OAS) and of the Organization of European Economic Cooperation (OEEC). The Group provided geographical representation as well as representation for producer and consumer countries; it set up specific commodity committees, which included the main producers and main consumers and formed a company of responsible government representatives gathered to consider what could be done to deal with whatever seemed to be the immediate problems for particular commodities. Four of the seven committees created covered minerals: The Copper, Zinc, and Lead Committee; the Manganese, Nickel, and Cobalt Committee; the Tungsten and Molybdenum Committee; and the Sulfur Committee. The committee membership included over 85 percent of the Free World production and consumption of the scarce minerals involved.

The committees had powers only to make recommendations to governments. The emergency allocations recommended by them were designed to achieve an orderly and fair distribution of available supplies, with attention to needs for defense, strategic stockpiling, and essential civilian consumption. Under allocating procedure, the total estimated production available to the Free World, both real and potential, was taken into account. Then, an analysis was made of available information to determine whether requirements in a particular quarter would exceed production. The allocations for each participating country were in the form of a "total Entitlement for Consumption"—the quantity of primary material that could be processed or consumed by the country concerned, either from domestic production or imports. The quotas were

[16] Department of Defense, Munitions Board, Stockpile Reports to the Congress: Jan. 23, 1952, pp. 17–19, and Feb. 15, 1953, p. 18.

[17] Winant, Frederick, Summary Statement on the International Materials Conference (through Dec. 31, 1952): Jan. 5, 1953, Hearings, Subcommittee on Minerals, Materials, and Fuel Economics of the Committee on Interior and Insular Affairs, U. S. Senate, 82d Cong., 1st and 2d Sess.; part 4, International Materials Conference, 1954, pp. 1135–1142.

merely limits on exports and imports, which permitted countries, within those limits, to buy from or sell to any countries of the Free World and encouraged them to do so with the least disturbance to normal patterns of trade. In accepting the plan, Governments assumed the responsibility for seeing that their allocations were not exceeded. The methods of distribution and the control of prices within a country were matters for determination by that country. Responsibility for United States representation to the International Materials Conference was placed in the Defense Production Administration by direction of the Office of Defense Mobilization.

During 1952 the International Materials Conference continued in operation and assisted in improving supply-demand balance in a number of materials under review. Allocation of zinc by the IMC was discontinued during the second quarter and of tungsten and cobalt at the end of the fourth quarter. This left only four minerals—sulfur, nickel, molybdenum, and copper—on which allocations were to be continued. While none were made for lead and manganese, both metals had been kept under constant scrutiny until improved supply made this unnecessary.

Review of Metallurgical Technology

By P. M. Ambrose,[1] J. E. Conley,[2] J. C. Barrett,[3] F. D. Lamb,[4] and H. H. Greger[5]

AS A RESULT of research and development spurred by the constantly increasing demand for metals and metallurgical products, many new methods were developed and metallurgical changes made in 1952. This chapter does not purpose to record all the innovations in practice, since such a report would require volumes for a complete detailed presentation. It is intended to present highlights—many supported by adequate references—and to bring before producers and consumers a summary of the apparent outstanding developments in the metallurgical industries.

This, the first consolidated metallurgical review to appear in the Minerals Yearbook, is planned to be continued in succeeding years. Many developments in laboratories will be put in plant practice in the near future, and old methods will be adapted to new uses. For purposes of simplification, this presentation is made under the broad headings of Mineral Dressing, Extractive Metallurgy, and Physical Metallurgy.

MINERAL DRESSING

In mineral dressing there was the usual active interest in improvements in crushing and grinding. New mills under construction and expansion of older plants included some of the world's largest crushing and grinding equipment. The largest primary gyratory crusher, with a 60-inch feed opening, was installed at the Climax Molybdenum Co. plant in Colorado, and construction was begun on an even larger one, also with a 60-inch opening, to be installed at the Reserve Mining Co. plant, Babbitt, Minn.[6] This crusher, when completed, will be capable of crushing run-of-mine taconite ore from a 5- to 6-foot top size at the rate of 3,500 tons an hour.

There was a decided trend during the year toward replacing fine crushers with rod mills. The Bunker Hill & Sullivan Mining & Concentrating Co. installed a 9½- by 12-foot peripheral-discharge rod mill at Kellogg, Idaho, and the Consolidated Mining & Smelting Co. used an 11½- by 12-foot rod mill at its Sullivan plant in British

[1] Chief, Metallurgical Division, Eastern Experimental Station, Region VIII.
[2] Chief, Minerals Processing Branch, Eastern Experimental Station, Region VIII.
[3] Acting chief, Physical Metallurgy Branch, Eastern Experimental Station, Region VIII.
[4] Chief, Ore Dressing Section, Eastern Experimental Station, Region VIII.
[5] Consulting ceramic engineer.
[6] Engineering and Mining Journal, Reserve Mining Co. Starts Taconite Plant at Babbitt: Vol. 153, No. 11, November 1952, pp. 72–79.

Columbia for open-circuit rod-mill crushing. The Tennessee Copper Co., Copperhill, Tenn., and the Kennecott Copper Corp., Hayden, Ariz., also used open-circuit rod mills for fine crushing ahead of ball mills. Advantages claimed were that the rod mills produce more finished product per ton of feed, lower costs, and permit easier operation without dust nuisances, screens, elevators, etc. Anaconda Copper Mining Co., Yerington, Nev., and Butte, Mont., planned to install open-end rod mills for fine crushing; at Butte the mills replace roll crushers, screens, elevators, etc.

Larger ball mills operating at higher speeds were installed in some plants to reduce the installed cost per horsepower for grinding. The new mill under construction for the White Pine Copper Co., in Michigan was equipped with 12½- by 13-foot low-pulp-level ball mills driven by 1,500-hp. synchronous motors and are probably the world's largest to date.[7] Some Canadian gold mills converted their ball mills to grinding with pebbles, claiming substantial savings in grinding costs, although at some sacrifice in capacity.

Dry crushing and grinding found favor for handling some materials. It was found that impact crushing produced a minimum of fines when crushing perlite.[8] The Aerofall mill, a dry, combined crushing-grinding unit employing air classification to remove the ground material from the mill, won favor in Canada, where it was used on asbestos ore with a resulting increase in the yield of Premium-grade long-fiber asbestos.

Along with the larger crushing and grinding units installed in new mills in 1952, record-size classifiers and sizing equipment were also constructed. The largest simplex spiral classifiers built to date were the 84-inch-diameter spirals scheduled for use at the West Hill mine, Western Mining Co., near Colerain, Minn. Larger heavy-duty vibrating grizzlies and screens were in use in 1952 and both electric and hot-air-heated screens were widely used, particularly on sticky materials.

The Dutch State Mines cyclone, variously known as the Driessen cone, Dorrclone, and hydrocyclone was used as a classifier and gave promise of being an important device to close grinding circuits, deslime ores before concentration, dewater tailings for mine fill, and deslime waste or return water.

Great Lakes iron-ore-beneficiation developments continued at a rapid pace, and the size of the "pilot plants" was astounding. Not since the days of active development of copper concentration after World War I were such large units used as pilot plants, and the iron plants dwarfed the copper plants. Magnetic separation was the primary concentrating method employed in the magnetic taconite plants, but flotation and gravity-separation processes also were involved. Magnetic roasting for nonmagnetic ores was being thoroughly investigated by all major iron-ore producers. Magnetic-separation studies employed both dry and wet separators, but because most of the ores require extremely fine grinding for liberation the drum-type wet machines found most favor. Humphreys-spiral concentrators were found to be useful in concentrating fine nonmagnetic iron ores

---

[7] Ramsey, R. H., White Pine Copper: Eng. and Min. Jour., vol 154, No. 1, January 1953, pp. 72–87.

[8] West, W. W., Impact Crushing for Reduction of Hard Abrasive Ores: Min. Eng., vol. 4, No. 6, June 1952, pp. 563–564.

as well as other minerals. Dense-medium separators, including the Dutch State Mines cyclone, were an important part of the iron-ore-beneficiation program. The M. A. Hanna Co. operated a Dutch State Mines cyclone plant on fine iron ore in 1952 and a 50-ton-per-hour pilot plant was also operated by the Mesaba-Cliffs Mining Co. at the Holman Cliffs mine. A number of such plants were being designed or actually constructed for operation in 1953.

The work with the Dutch State Mines cyclone on iron ore sufficiently indicated the potentialities of this new process so that it seems evident that the cyclone separation with a dense medium will be applied to the treatment of base-metal and other heavy-mineral-bearing ores.

The trend in dense-medium separation plants for coarse metallic ores was to employ drum-type separators, although where the difference in specific gravity between the sink-and-float products is slight the older cone-type separator was still preferred. Most plants were using ferrosilicon as the dense medium, but the new plant of the St. Joseph Lead Co., at Hayden Creek, Mo., employed a galena medium.

Improvements at the mills of the Utah Copper Division of the Kennecott Copper Corp. included installation of new and larger flotation machines,[9] and the flowsheets at the Arthur and Magna mills in Utah were modified to recover molybdenum from the copper-plant tailings instead of from a concentrate produced in the copper section of the mills. The Bagdad Copper Co. in Arizona also expanded its flotation plant and included recovery of molybdenite in its flowsheet.[10]

The International Minerals & Chemical Corp. announced the development of a new dry-concentration process for potash, phosphate, and other ores. The method, called the Lebaron-Lawver process, was not described in detail, but enough information was available to indicate that it was essentially an electrostatic separation process. The two great ilmenite plants at Starke and Jacksonville, Fla., continued to be the main installations of electrostatic separation, but much research testing was underway. In nearly all cases, electrostatic separation as a primary step is not economic, but the values in mixed concentrates are frequently great enough to permit the cost of drying for electrostatic separation.

The greatest interest in thickening centered around the cyclone classifier or thickener, particularly for thickening mill tailings for mine backfill. Numerous applications for the hydrocyclone were found, but the most important used in 1952 were for thickening and classifying. Centrifugal filters continued to attract attention by their high capacities and wide range of applications. New vacuum filters, including horizontal and panel types, were installed in some milling plants where special conditions warranted their use.

The number of milling plants using infrared lamps for drying concentrates increased during the year, particularly among the tungsten producers. Larger plants using the lamps included the Getchell mill at Red House, Nev., and the Tungsten Mining Co. plant at Henderson, N. C.

---

[9] Corfield, R. J., and Johnson, A. G., Electrical and Metallurgical Improvements at Kennecott's Utah Copper Division Mills: Min. Eng., vol 5, No. 3, March 1953, pp. 274-276.

[10] Bagdad Copper Co., Bagdad Expands Copper Mill—Recovers By-Product Molybdenite—Ups Copper Recovery by pH Control: Min. World, vol. 14, March 1952, pp. 30-33.

Methods for agglomerating fine concentrates received a large amount of attention, and many large companies set up special testing units for sintering, nodulizing, pelletizing, etc. Much of the work was concerned with methods for agglomerating fine iron-ore concentrates being produced in the large pilot plants treating taconite ores in Minnesota. Rotary kilns and sintering machines were the preferred equipment for agglomerating the magnetic iron concentrates.

EXTRACTIVE METALLURGY

One of the most important metallurgical developments of the year was the disclosure of its autoclaving process by Chemical Construction Corp. in several technical articles [11] covering the technique for extracting and recovering various metals from their ores as fine metal powders. The use of a chemical method to produce metal powders without the necessity of using ore concentrates and smelting-recovery procedures has some far-reaching potentialities.

The process has been considered applicable for recovering nickel, cobalt, copper, and manganese from their low-grade ores in the form of fine metal powders, except for manganese, which would be as a hydrous oxide. All metals above zinc in the electromotive series are alleged to be recoverable in the elemental form, but cobalt, nickel, and copper are the most important.

The process comprises leaching cobalt-nickel-copper ores or copper and brass scrap in acid or alkaline solutions under pressure. Sulfide ore is treated in a water slurry by passing air, oxygen, or sulfur dioxide or their mixtures through the heated mixture; ammonia is used on scrap copper or brass. The metals are precipitated from the filtered solutions by reducing with hydrogen and recovered as fine powders of high purity. Selective precipitation is attained successively by careful pH control during reduction. Commercial exploitation of the process has been begun by the Sherritt-Gordon Mines, Ltd., Edmonton, Canada; by the National Lead Co., at Fredericktown, Mo., and by Howe Sound Mining Co., near Salt Lake City, Utah. Details of the process are further disclosed in a series of United States patents (2,647,819 and 2,647,825 and 2,647,827–2,647,832) issued August 4, 1953, and assigned to the Chemical Construction Co. of New York and in Patent 2,647,820 assigned to Sherritt-Gordon Mines, Ltd., Canada. Other developments in the recovery of cobalt, nickel, and copper from grosses have been reported,[12] and details of developments on electrolytic extraction of manganese, chromium and cobalt have been published.[13] The major nickel producers were very active on research and development of recovery methods, and a patent was issued for the recovery of nickel from its oxide ores.[14]

Important advances have been made in the technology of aluminum in an industry accustomed to keeping its operating techniques

[11] O'Connor, Joe. Chemical Refining of Metals: Chem. Eng., vol. 59, No. 6, June 1952, pp. 164–168, 368, 370, 372–374, 376.
Mining Engineering, New Chemical Method Recovers Nickel, Cobalt, Copper Metal: Vol. 4, No. 6, June 1952, pp. 565–567; Jour. Metals, vol 4, No. 6, June 1952, pp. 589–591; Eng. and Min. Jour., vol. 153, No. 6, June 1952, pp. 84–87, 176.

[12] Sherman, A. H., and Pesses, Marvin, Alnico Recovery Process Salvages Valuable Nickel, Cobalt: Iron Age, vol. 170, No. 1, July 3, 1952, pp. 115–119.

[13] Cuthbertson, J. W., Recent Advances in Electrolytic Extraction of Manganese, Chromium, and Cobalt: Chem. and Ind. (London), No. 48, Nov. 29, 1952, pp. 1165–1170.

[14] Forward, F. A. (assigned to Sherritt-Gordon Mines Ltd.), Treatment of Nickeliferous Oxide Concentrates for Recovery of Nickel Values Therefrom: U. S. Patent 2,616,781, Nov. 4, 1952.

unpublicized. Progress has been made in metal production and fabrication, electrodeposition on other metals, and production of metallurgical alumina from ores difficult to process. An electrolytic furnace with alleged advantages, including better power economy, was announced.[15] A new process being developed by the British Columbia Aluminum Co., at a small plant at Westminster near Vancouver, British Columbia, is reported to effect 30 percent economy in power consumption. Power in "square waves" at 8 volts and 1,600 amperes is used on the furnace.[16]

The direct reduction of aluminous material, such as clays, low-grade bauxites, pyrophyllite, and similar materials, has been investigated by the Bureau of Mines at its Albany, Oreg., station in cooperation with the Apex Smelting Co., of Chicago, Ill. As a result of the research Apex is constructing a small plant in Lane County, Oreg., to produce aluminum-silicon alloys. These alloys can be used as master alloys for producing other alloys or for subsequent treatment by molten zinc or mercury for extracting the aluminum by a simulated Sohxlet extraction with final removal of the solvent metal by distillation. Rough separation by filtration of crystals from liquid metal slightly above its melting point is also contemplated.

Intensive research on the electrodeposition of aluminum on steel and certain base metals has opened up some interesting possibilities for acquiring a corrosion-resistant coating over a metal having greater strength and other more desirable physical properties.[17] Another development pertaining to the electrolytic coating of light metals was discussed by O'Keefe.[18]

Exploitation of the Jamaican bauxite deposits made progress in 1952, when the Jamaica Bauxites, Ltd., a subsidiary of Aluminium, Ltd., of Canada constructed an alumina plant at Mandeville in Manchester Parish.[19]

The Jamaica bauxites are lower in alumina than the Guiana ores and require extraction with alkali solutions similar to a modified European Bayer procedure rather than the conventional American Bayer process. Two other American producers, Reynolds Metals Co. and the Kaiser Aluminum & Chemical Corp., through their respective subsidiary mining companies, by their construction of new plants and expansion of existing facilities have advanced the production of alumina from these ores.[20] [21]

The recovery of manganese from low-grade ores and waste products received special attention in 1952. Early in the year details of the Dean ammonium carbamate process were published,[22] and its exploitation by K. M. Leute was reported. The Manganese Chemical

[15] Ferrand, M. L., Large Modern Electrolytic Furnace for Manufacture of Aluminum: Private Prospectus Presented to National Inventors Council, U. S. Department of Commerce, March 1952.

[16] Steel, New Aluminum Process Disclosed: Vol. 130, No. 8, Feb. 25, 1952, p. 51.

[17] Collins, F. R., Aluminum Electroplated on Steel from a Fused-Salt Bath: Iron Age, vol. 169, No. 2, Jan. 17, 1952, pp. 100–101.

[18] O'Keefe, Philip, Electroplated Coatings on Light Metals: Materials and Methods, vol. 35, No. 6, June 1952, pp. 119–130.

[19] Engineering and Mining Journal, New Alumina Plant Will Treat Jamaica Bauxite: Vol. 153, No. 3, March 1952, pp. 94–96.

[20] Knoerr, A. W., Reynolds Jamaica Bauxite Project Ships First Load of Ore to U. S.: Eng. and Min. Jour., vol. 153, No. 9, September 1952, pp. 108–113.

[21] Lee, J. A., Corpus Christi: From Bauxite to Alumina to Pig Metal: Eng. and Min. Jour., vol. 153, No. 12, December 1952, pp. 80–82.

[22] Dean, R. S., Manganese Extraction by Carbamate Solutions and the Chemistry of New Manganese-Ammonia Complexes: Min. Eng., vol. 4, No. 1, January 1952, pp. 55–60. Aqueous Solutions Containing Manganese in a Complex Ion and Processes of Making the Same and Making Manganese Compounds Therefrom: U. S. Patent 2,608,463, Aug. 26, 1952.

Co., organized to develop the process, was awarded a Defense Production Authority contract for $1.5 million to erect a plant near Riverton, Minn., to process 200 tons per day of the Cuyuna low-grade manganiferous iron ores.[23] On December 31, 1952, the Defense Materials Procurement Agency announced signing of a contract with Mangaslag, Inc., to construct and operate a plant at Coxton, Luzerne County, Pa., to determine the feasibility of the process developed at the Central Experiment Station of the Bureau of Mines at Pittsburgh, Pa., for recovering ferromanganese from open-hearth slags. Anthracite will be substituted as much as possible for coke as a blast-furnace fuel and reducing agent, however. Production of approximately 1,000 long tons of ferromanganese is planned during demonstration runs. Essential steps of the process comprise low shaft blast-furnace smelting of the slag to produce a high-phosphorus spiegeleisen and subsequent selective oxidation of the spiegel in a special converter to leave a high-phosphorus pig iron and produce a high-manganese slag meeting the requirements of ore for making standard ferromanganese. Blast-furnace operations were planned for late 1953.

Important developments resulted in 1952 in the advancing exploitation of the deposits of taconite in the Great Lakes iron-mining region. The operations, although considered to be pilot scale for the iron and steel industry, would rate as commercial installations in less extensive industries. Three major operations dominate the field. The status of the Reserve Mining Co. operation was reported [24] late in the year. The Reserve Mining Co. is owned by Armco Corp. and the Republic Steel Corp. The Oliver Iron Mining Division of the U. S. Steel Corp. was operating its agglomeration plant on nontaconite concentrates and fine ores while its new Pilotac plant at Mountain Iron, Minn., was nearing completion. The Erie Mining Co., owned jointly by Bethlehem Steel Corp., Youngstown Sheet & Tube Co., Interlake Iron Corp., and Pickands, Mather & Co., also announced the proposed construction of a $300 million plant to produce 10.5 million tons of taconite pellets per year.[25]

Based upon an old principle, some outstanding applications of ion exchange were made during the year.[26]

Another innovation with far-reaching possibilities is conversion of the regular downdraft sintering machine to operate with an updraft.[27] This modified machine was announced by the Broken Hill Associated Smelters Pty., Ltd., South Australia, and it is believed that plans for constructing commercial machines of this type are being effectuated by American manufacturers. Several important advantages are being claimed for the innovation. The installation of multiple windboxes or gas collectors above the grate makes it practical to produce high-SO_2 gases and recycle the gases low in SO_2 to enrich them. Plans are to construct a 10- by 77-foot machine. In a similar operation, the first Dorrco FluoSolids reactor was installed

---

[23] Engineering and Mining Journal, To Process Low-Grade Manganese Ore-Deposits: Vol. 4, No. 11, November 1952, p. 1023.

[24] Engineering and Mining Journal, Reserve Mining Co. Starts Taconite Plant at Babbitt: Vol. 153, No. 11, November 1952, pp. 72–79.

[25] Mining World, Huge Taconite Plant Proposed for Minnesota: Vol. 14, No. 4, April 1952, p. 85.

[26] Engineering and Mining Journal, Ion Exchange: Does it Have a Role in the Mineral Industry: Vol. 153, No. 11, November 1952, pp. 80–85.

[27] Burrow, W. R., Continuous Updraft Sintering Recovers More SO_2 for Smelter: Eng. and Min. Jour., vol. 153, No. 11, November 1952, pp. 90–94.

for producing rich SO_2 by roasting pyrrhotite at the Berlin, N. H., plant of the Brown Co., manufacturers of paper.[28] The SO_2 gas is used to make sulfuric acid. Other new applications of the FluoSolids reactor have been described.[29] Oxygen flash smelting of copper concentrates, in which all smelting heat requirements are met by reacting the concentrates with oxygen, was carried out on a commercial basis at Copper Cliff, Canada. Large-scale production of liquid sulfur dioxide, obtained as a byproduct, was initiated in 1952. The process was described in a recent publication.[30]

Another outstanding application of the FluoSolids reactor is reported by the Aluminum Co. of Canada, Ltd., which has constructed a plant to process 150 tons per day of zinc sulfide concentrates at its Arvida aluminum plant 150 miles north of Quebec City, Quebec, Canada.[30a]

This installation is the first successful commercial-scale roasting in North America of zinc sulfide flotation concentrates in a FluoSolids reactor to produce a zinc oxide calcine for electrolytic leaching and at the same time to produce sulfuric dioxide gas for a contact sulfuric acid plant. The operation is also a "first" in respect to size (22 feet i. d. by 22 feet high), as the reactor has almost two and one-half times the hearth area of any previously built for use on other ores. Attention is called particularly to design problems brought about by the close thermodynamic balance of the reactions and the lack of commercial experience with this type of operation. Enough operating data have been included to illustrate typical results obtained by the plant as a whole.

Improvements in the recovery of copper by an acid-leaching process is reported by Schlechten.[31] After preliminary laboratory testing, a plant was constructed to treat 2,000 long tons per day of minus-½-inch raw Mavrovouni ore with 4-percent sulfuric acid containing 2 grams per liter of ferric iron. After the slime and sand fractions are treated in separate countercurrent-decantation washing thickeners, the solids are reclaimed and sent to the flotation plant and the pregnant liquor is treated by iron cementation. Overall recoveries are increased 10 percent. Another hydrometallurgical process for copper recovery following preroasting in a Dorrco FluoSolids reactor is reported on ores from the mine of the Kilembe Mines, Ltd.[32] The copper in the leachate obtained from the roasted ores is recovered by electrodeposition.

The electric smelting process to produce a high-titania slag and a special type of iron from the Allard Lake ilmenite ores of Canada, as under development by the Quebec Iron & Titanium Corp., gained considerable impetus early in 1952. The development corporation is owned jointly by Kennecott Copper Co. and New Jersey Zinc Co., with the electric smelter situated on the St. Lawrence River at Sorel, Quebec. Details of the operation, which will produce a titanium slag

---

[28] Chemical Week, A Captive Source of Sulfur Insurance: Vol. 72, No. 10, Mar. 7, 1953, pp. 57–58.

[29] Copeland, G. G., New FluoSolids Experience: Min. Cong. Jour., vol. 38, No. 3, March 1953, pp. 42–44, 54.

[30] Mining Magazine, Sulphur Recovery at Copper Cliff: Vol. 86, No. 5, May 1952, pp. 315–316.

[30a] Anderson, T. T. and Bolduc, Raymond, Fluosolids Roasting of Zinc Concentrates for Contact Acid: Chem. Eng. Progress, vol. 49, No. 10, October 1953, pp. 527–530.

[31] Schlechten, A. W., and Bruce, J. A., A New Acid-Leaching Section Raises Cyprus Copper Recovery by 10%: Eng. and Min. Jour., vol. 153, No. 12, December 1952, pp. 88–91.

[32] Mining World, Production at Kilembe Copper-Cobalt Mine to Start in 1955: Vol. 14, No. 12, November 1952, p. 60.

suitable for producing pigment-grade titanium oxide, have been discussed in a recent article.[33] The deposits were discovered over 10 years before, and the mining program and development of the smelting technique have proceeded over the past several years. However, important progress was made on the smelting operation in 1952. A special grade of this slag is also being tested for making titanium tetrachloride suitable for extraction of titanium metal. Although not entirely a 1952 development, the Sterling Electric Furnace developed by the New Jersey Zinc Co. for smelting zinc ores was described during the year.[34] Numerous advantages of the process are cited. The process as used is covered by United States patents 2,598,741–2,598,744, assigned to the New Jersey Zinc Co.

The use of nitric acid to replace sulfuric acid, in short supply in 1952, to process superphosphate is an innovation in the American phosphate industry. The use of nitric acid adds nitrogen, one of the "big three" essential fertilizer ingredients, to the superphosphate. Two commercial plants are planning to exploit the process. One plant is to be at Sheffield, Ala., and the other will be constructed by the Allied Chemical & Dye Corp. at South Point, Ohio. Other technologic advances in phosphatic fertilizers during the year are discussed by Waggaman.[35]

The synthesis of strategic minerals, such as mica and particularly radiograde quartz crystals, received much attention, and considerable progress was made by the Brush Development Co., Cleveland, Ohio, and the Bell Telephone Laboratories, Inc., Murray Hills, N. J.[36] The hydrothermal synthesis of quartz crystals, although conducted on a pilot-plant scale, resulted in the production of substantial quantities of material. The successful development of the process has extremely important significance from the viewpoint of national defense. Research of a fundamental nature pertaining to crystal growth is being extensively pursued at several of United States universities and in other countries. Although still in the laboratory stage and not yet entirely ready for expansion to a commercial scale, the synthesis of phlogopite mica by hydrothermal techniques is meeting with much success at the Bureau of Mines Electrotechnical Experiment Station, Norris, Tenn.

A new process for treating the carnotite ores of Colorado, to recover the strategic uranium and vanadium compounds, has been reported.[37] Likewise, some details of the conversion of zirconium oxide to its chloride by a special chlorination technique is disclosed in a recent article.[38]

A new development of special importance was initiated by the Foote Mineral Co. at Sunbright, Va., where a plant is being constructed to apply lime sintering of spodumene ore in a rotary kiln to

---

33 Knoerr, A. W., World's Major Titanium Mine and Smelter Swing Into Full-Scale Production: Eng. and Min. Jour., vol. 153, No. 3, March 1952, pp. 72–79.

34 Engineering and Mining Journal, Sterling Furnace Smelts Zinc With Electric Arc: Vol. 153, No. 7, July 1952, pp. 76–78.

35 Waggaman, W. H., Phosphoric Acids, Phosphates and Phosphatic Fertilizers: Am. Chem. Soc. Mon. 34, Reinhold Publishing Co., 1952, p. 683.

36 Hale, D. R. The Properites of Synthetic Quartz Crystals and Their Growing Technique: Brush Strokes, Brush Development Co., Cleveland, Ohio, December 1952, pp. 1–6.

37 Mining Engineering, U. S. Vanadium's Uravan, Colo., Mill Doubles Output: Vol. 4, No. 11, November 1952, pp. 1025–1026.

38 Stephens, W. M., and Gilbert, H. L., Chlorination of Zirconium Oxide: Trans. Am. Inst. Min. and Met. Eng., Jour. Metals, vol. 4, No. 7, July 1952, pp. 733–737.

solubilize the lithium content. Operation of the plant is expected to begin in late 1953. Another new development is that of the Carborundum Co. at its Niagara Falls, N. Y., plant, where the product "Fiberfrax", a cottonlike mineral fiber, is produced essentially from equal proportions of alumina and silica by high-temperature fusion in an electric furnace followed by blowing of the molten mixture.[39] The product can withstand temperatures up to 2,300° F. and can be made into brick, board, or paper and other forms.

Considerable progress was made on the development and production of cermets during the year. Cermets are a combination of ceramic and metallic materials in useful shapes for high-temperature applications. Research on cermets by private industry, research organizations, universities, and Government agencies in the last few years has been to a large extent exploratory; but, as results become available, it is evident that a broad, new field of great promise is being uncovered. The need for new and unusual materials originates largely from developments in the fields of nuclear energy, high-temperature applications in rockets and jet engines, and in electrical and magnetic applications.

The objective is in most cases a combination of useful properties of the components, sometimes also conservation of scarce materials. In some instances the modifying properties of the components on each other are very striking, such as is the case with the well-known tungsten carbide-cobalt combination for cutting tools where solubility and good wetting by the metal develop enough toughness for high-speed cutting.

In metals, the refractoriness, high-temperature strength, and oxidation resistance are usually poor but are good in some groups of ceramic materials. Outstanding in metals is their tensile strength and thermal-shock resistance, which are poor in ceramics. Similarly opposed properties are found in thermal and electrical conductivity. Cermets usually receive from their ceramic components a certain brittleness but also a good compressive strength.

The ceramic raw materials for cermets include, among the more important groups of compounds, the oxides, carbides, borides, nitrides, and silicides. Favored among the metals are those of the iron group, iron, cobalt, and nickel, further silicon, and more recently chromium and molybdenum. These materials represent a very broad area of diverse properties and opportunities of research for new applications.[40]

The cermets so far successfully developed include cobalt-bonded tungsten carbide, chrom-alumina and iron-alumina bodies, nickel-bonded titanium carbide, and silicon-bonded silicon carbide. In 1952 nickel-bonded titanium carbide was announced with small additions of tantalum and columbium carbide for increased oxidation resistance and 20 to 30 percent nickel as the binder. This material is said to resist satisfactorily temperatures of 2,200° F. and is being tested for gas-turbine-wheel construction. Similar results were obtained in Europe with up to 40 percent chrom-nickel and chrom-cobalt bonds. Titanium carbide cermets may offer possibilities of increasing the gas turbine temperatures.[41]

---

[39] Chemical Engineering, Ceramic Fiber Resists 2,300° F.: Vol. 59, No. 9, September 1952, p. 198.
[40] Westbrook, J. H., Metal-Ceramic Composites, I: Am. Ceram. Soc. Bull. 31, 1952, pp. 205–208.
[41] Harwood, J. J., Powder Metallurgy Parts in High-Temperature Applications: Materials and Methods, vol. 36, No. 2, August 1952, pp. 87–91.

The last few years have witnessed a tremendous growth in the production and use of ferrites as components in electronic equipment. The rather slow progress in developing these technically useful materials up to this point can be explained, at least partly, by the relatively small number of investigators in the field. In view of the critical need for high-frequency magnetic materials brought about by the rapid advance of the electronic age, it seems strange that a suggestion for utilizing ferrites in this respect made 40 years ago by S. Hilpert [42] went unheeded for so long. It remained for Snoek [43] to arouse the first technical interest in magnetic ferrites in 1946 by announcing the development of mixed ferrites having exceptionally high permeability values. By 1952, interest has grown to such an extent that, with increasing development of materials and applications, no electronic-minded concern can afford to avoid the ferrite field.

Chemically, the magnetic ferrites, sometimes termed "ferrospinels," are a modern derivation of magnetite, the oldest magnetic material known. They are achieved when certain iron atoms in the cubic crystal of magnetite (ferrous ferrite) are replaced by other metal atoms, such as nickel and zinc, to form, in this case, nickel-zinc ferrite. They are prepared using conventional ceramic techniques. Constituent oxides are mixed, pressed into shapes, and fired to high temperatures (1,000°–1,400° C.), where the ferrite is formed by solid phase reaction.

Ferrites have distinct advantages over conventional magnetic materials above the power-frequency range. Their high volume resistivity reduces eddy current losses to values negligible when compared to the finest silicon-steel laminated materials. This property eliminates the necessity for laminating or powdering.

Ferrites have been used extensively by the television and radio industries. Classic examples are sweep-circuit transformer cores and antenna cores. Other applications include magnetostrictive component, induction heating cores, and computer and memory systems. In the microwave frequency range, the properties of Faraday rotation, phase shifting, absorption, and nonreciprocity have allowed many vital commercial and Armed Service applications to be realized.

In view of the foregoing, it is obvious that one particular ferrite material could not be optimum for all applications. Considerable research is now in progress to develop materials with desirable properties characteristic to specific specialized applications. At the same time many commercial concerns, universities, and Government agencies are conducting fundamental research in an effort to correlate the magnetic properties to the atomic and crystalline structures. In so doing, the possibility of preparing ferrites with special characteristics will be more closely approached.

Complete information on the latest developments in ferrites is not readily available. This is due to the highly competitive nature in the commercial field and the fact that most of the government research is conducted on a classified basis.

---

[42] Hilpert, S., Genetische und konstitutive Zusammenhange in den magnetischen Eigenschaften bei Ferriten und Eisenoxyden: Ber. deut. chem. Gesell., vol. 42, 1909, p. 2248.

[43] Snoek, J. L., Nonmetallic Magnetic Materials for High Frequencies: Phillips Tech. Rev., vol. 8, 1946, pp. 353-360.

PHYSICAL METALLURGY

Many advances in physical metallurgy were made during 1952.

Steels containing boron progressed beyond the experimental stage, as approximately 5 percent of engineering alloy steels now contain it. When boron is added to steel the increased hardenability permits lower alloy content; hence, scarce alloying elements can be conserved.[44] In addition to this advantage, it is claimed that boron-treated steels are softer than many alloy steels in the annealed condition and hence more easily worked and machined; the scale formed on them is loose and flaky, simplifying hot-forming problems; and lower annealing temperatures and shorter annealing times are possible with these steels.[45]

The necessity for conserving nickel has led to development of new stainless steel alloys, with manganese replacing the nickel content. A steel proved to be a good alternate for 18–8 (Cr 18 percent –Ni:8 percent) developed by the Allegheny-Ludlum Steel Co., contains 16 percent manganese, 16 percent chromium, and less than 1 percent nickel.[46] Acceptance of this steel has placed greater demands on the fast-growing process for electrolytic manganese. As electrolytic manganese has a purity of at least 99.9 percent and is virtually free from carbon, it is highly desirable for the manufacture of manganese-containing stainless steels, as well as low-carbon steels, where increased ductility results.[47]

In the aluminum industry, one of the most spectacular developments was the design and initiation of construction of huge presses for the Air Force, both for forging and for extrusion. The status of this program at the end of 1952 is listed; extrusion presses begin at 8,000 tons, and forging presses go to a maximum capacity of 50,000 tons.[48] There are several trends in aircraft design that forecast the production of large forgings. Weight and labor savings are realized because of the reduction in the number of small pieces and in the number of fasteners required. There are also structural advantages to be gained in using large continuous forgings and extrusions.[49] The first of the large extrusion presses on which installation was begun in 1952, at Alcoa's Lafayette, Ind., works, was scheduled to go into operation about the middle of 1953. With a load capacity of 13,200 tons—2½ times greater than any other equipment now in production—this press is expected to extrude solid shapes up to a maximum size of 90 feet long, 23 inches in diameter, with a weight of 2,300 pounds.[50]

Advances in the technique of impact extruding of aluminum were made in 1952. High-strength aluminum alloys can be worked into a variety of shapes by this method. High pressures are required

---

[44] Panel on Substitution of Alloying Elements in Engineering Steels, Recommended Research Projects on Boron Steels: Rept. MMAB-11-M, Minerals and Metals Advisory Board, National Research Council, National Academy of Sciences, Washington, D. C., Mar. 12, 1953, 6 pp.

[45] Gertsman, S. L., Substitution for Strategic Metals in Steel Production: Canada Dept. Mines and Tech. Surveys, Ottawa, Canada, Feb. 1, 1952, pp. 9–11.

[46] Hatschek, R. L., New Austentic Steel Good Alternate for 18–8: Iron Age, vol. 171, No. 11, Mar. 12, 1953, pp. 135–138.

[47] Mantell, C. L., Electrolytic Manganese Acceptance Grows: Iron Age, vol. 70, No. 12, Sept. 18, 1952, pp. 168–172.

[48] Materials and Methods, Heavy Press Program Pushed for Forged Aircraft Parts: Vol. 37, No. 1, January 1953, pp. 7–8.

[49] Large Forgings Will Slash Fabrication Costs: Iron Age, vol. 170, No. 13, Sept. 25, 1952, pp. 128–130.

[50] McCormick, T. F., Techniques and Problems in Large Extrusion Production: Iron Age, vol. 170, No. 24, Dec. 11, 1952, pp. 158–161.

because of the high tensile strength of the metal, but heat generation during the process aids extrusion. Raw-material savings often run as high as 85 percent, and the resultant product is lighter than a comparable forging.[51]

Use of ultrasonic vibrations while soldering aluminum serves to break up the tenacious oxide and allows the soldering to occur without flux. Development of this method came to fruition in 1952.[52] Perfected also was the new process for hard-coating aluminum and its alloys. These anodic coatings, produced from acid electrolytes at low temperature and high current density, provide for better resistance to wear and abrasion than ever before possible with aluminum. Replacement of coated aluminum alloys in aircraft for heavier materials in such applications as gears, pistons, and slides is now possible.[53]

Several years research on the development of magnesium casting alloys containing zirconium resulted in the production in 1952 of large 16-foot aircraft wing sections, cast from a zirconium-bearing magnesium alloy. Zirconium was found to be primarily useful because of its grain-refining quality, which through small additions not only made it possible to cast otherwise difficult alloys but also improved the ductility and toughness of these alloys.[54] Investigations were also continued in the improvement of magnesium-thorium alloys for improved creep strength above 400° F. One such alloy showed such promise that development work was begun in adapting it to castings in the newer jet engines.[55]

As would be expected, the technology of titanium and its alloys grew by leaps and bounds during the year. Rem-Cru Titanium, Inc., produced the largest titanium ingot to date; weighing 2 tons, it was easily adaptable to continuous rolling techniques in a mill used normally on stainless steels.[56] Lowering of fabrication costs will result from this. The same company introduced a new titanium alloy containing 2½ percent tin and 4 percent aluminum, purported to be ductile after welding, a property not usually associated with alloy titanium.[57] A titanium alloy containing 36 percent aluminum proved superior for high-temperature performance and presaged the day when titanium alloys will be developed for use at temperatures over 1,000° F.[58]

Many applications of titanium came into being during the year. Titanium was adopted as standard material for the 81-mm. mortar base plate, approved by Army Ordnance for use in Korea. As it weighs only 23 pounds compared to 45 for its steel counterpart, the mortar crew could be cut from 3 to 2 men. Douglas Aircraft began using 1,000 pounds of titanium per ship in its new DC–7, in the form

[51] Meinel, M. P., High-Strength Aluminum Impact Extrusions: Materials and Methods, vol. 36, No. 5, November 1952, pp. 110–113.

[52] Neppiras, E. A., Ultrasonic Soldering: Metal Ind., vol. 81, No. 6, Aug. 8, 1952, pp. 103–106.

[53] VandenBerg, R. V., Hard Aluminum Finishes Resist Wear and Abrasion: Iron Age, vol. 170, No. 18, Oct. 30, 1952, pp. 81–83.

[54] Stricter, F. P., Magnesium Casting Alloys Containing Zirconium: Metal Prog., vol. 63, No. 3, March 1953, pp. 75–82.

[55] McDonald, J. C., Rare-Earth Metals Improve Elevated-Temperature Properties of Magnesium Castings: Materials and Methods, vol. 36, No. 1, July 1952, pp. 162–165.

[56] Iron Age, Metal Show Documents Technical Progress: Vol. 170, No. 19, Nov. 6, 1952, pp. 170–173.

[57] Finlay, W. L., Parcel, R. W., and Durstein, R. C., Initial Experience With a New-Type Titanium Alloy, the All-Alpha: Talk at annual fall meeting, Inst. Metals Div., Am. Inst. Min. and Met. Eng., Cleveland, Ohio, October 1952, to be pub. in Jour. Metals.

[58] McAndrew, J. B., and Kessler, H. D., Investigation of the Metallurgical Characteristics of the 36% Aluminum Titanium-Base Alloy: Wright Air Development Center, Quart. Rept. 1, submitted by Armour Research Inst., Project 90-1233B.

of sheets with thicknesses of 0.016 to 0.051 inch. The sheets are to be used in engine nacelles. These are but two of the many new applications for this metal. The same article that describes these applications also touches on advances made in titanium technology, in fabrication, forging, welding, machining, and melting.[59]

A new process for producing titanium sponge by electrolysis of titanium dioxide was developed by United International Research, Inc., Long Island City, N. Y. Savings of $3 a pound of sponge are claimed by the process as compared with the Kroll process, and titanium of a high degree of purity is produced. The company initiated the building of a pilot plant for this process in 1952.[60] Research in levitation melting at Westinghouse may result in the development of a method [61] of melting for reactive metals such as titanium, zirconium, vanadium, and tantalum.

In levitation melting, the molten metal is suspended in a vacuum or in an inert gas without touching anything; proper size, shape, and number of inductive coils hold the material in suspension and also provide the heat for melting. Limitations of melt size are yet to be determined. The purpose of the method, of course, is to allow melting of reactive metals without contamination with refractories or gases.

The metal germanium came into its own in 1952, when the junction transistor was developed. Germanium, an integral part of the transistor, has the property of semiconduction necessary to operation of the transistor, which can replace vacuum tubes in many electronic applications. The Bell Telephone Co., improved its long distance dialing facilities at Englewood, N. J., by the use of transistors, and a pilot plant was reported under construction by Western Electric Co. to manufacture 240,000 germanium transistors per year.[62] [63] [64]

A process forgotten for half a century was revived in 1952 with promising results. This is vapor deposition, formation of a coating by chemical reaction at a heated surface. The coatings are obtained from gaseous compounds, usually halides, and hence can be deposited at temperatures below the melting point of the resultant coating material. Besides metals, refractory coatings such as carbides, borides, silicides, and oxides can be formed. Possible applications include nitride and boride superconductors for use in sensitive heat elements, thermocouple resistor thermometers, and corrosion-resistant chemical ware. Tubes and sheets composed of deposited material are produced by coating core material, which can be removed later.[65]

Alloys of indium with lead, tin, cadmium, and bismuth were perfected for such applications as bearings, solders, and for glass welding. In aircraft bearings indium is sprayed and diffused on a steel-backed bearing previously sprayed with layers of silver and lead; the indium-

[59] Brown, D. I., Titanium, Our No. 1 Problem Metal; part 1: Iron Age, vol. 170, No. 15, Oct. 9, 1952, pp. 260–279.
[60] Modern Metals, New Process for Titanium Production: Vol. 9, No. 7, August 1953, p. 79.
[61] O'Kress, E. K., and Wroughton, D. U., Metals Melted Without Crucibles: Iron Age, vol. 170, No. 5, July 31, 1952, pp. 83–86.
[62] Sparks, Morgan, The Junction Transistor: Sci. American, vol. 187, No. 1, July 1952, pp. 29–32.
[63] American Telephone & Telegraph Co., Annual Report for 1952: P. 9; Jour. Metals, vol. 4, No. 12, December 1952, p. 1261.
[64] American Metal Market, Germanium—the Stranger Metal: Vol. 59, No. 93, May 14, 1952, p. 2.
[65] Campbell, I. E., and Powell, C. F., Vapor Deposition May Solve Today's Coating Problems: Iron Age, vol. 169, April 10, 1952, pp. 113–117.

lead layer serves the primary purpose of improving the corrosion resistance of the bearing in acid lubricating oils. When indium is added to lead-tin solders, improvements in strength and in corrosion resistance to alkalis are realized. An alloy containing equivalent quantities of tin and indium is used for making glass-to-glass or glass-to-metal seals.[66]

There were some interesting developments in powder metallurgy during 1952. Production of iron powder spurted as industry realized its potentialities for parts competing with screw machine products, castings, and stampings. In powder parts machining is reduced or eliminated. Ordnance uses of iron powder also increased, with such applications as rotating bands for hypervelocity projectiles, 50 caliber steel cartridge cases drawn from sintered cups, and ball ammunition.[67] Improvement of the ductility of iron powder parts gave impetus to this program. Chrysler Corp. reported that parts made of steel powder now have the ductility and strength of low-carbon steel. Such material is being used in parts for industrial machinery, home appliances, textile machinery, and automotive applications.[68] Developments in chrome carbide assured this material a place where resistance to corrosion, erosion, and abrasion is paramount, such as in gage blocks, bushings, and wear slides. Made by the same powder-metallurgy process as tungsten carbide, chrome carbide is lightweight, nonmagnetic, and wear resistant and has high resistance to high-temperature oxidation.[69] Increased interest in high-density alloys for such uses as static and dynamic balancing, rotating inertia members, and radioactive shielding led P. R. Mallory Co. to develop a new method for producing parts from these alloys. Called contour pressing, the method provides for production of parts of uniform density, even though many are of unusual or unsymmetrical shape. Distortion and cracking are eliminated, but the tooling is expensive, requiring large production runs.

[66] Jaffee, R. I., and Weiss, S. M., Indium Alloys Finding Important Commercial Uses: Materials and Methods, vol. 36, No. 3, September 1952, pp. 113–115.
[67] Iron Age, Iron Powder Use Grows, Output Spurts: Vol. 170, No. 14, Oct. 2, 1952, pp. 37–38.
[68] Patton, W. S., Ductility of Metal-Powder Parts Increased: Iron Age, vol. 171, No. 11, Mar. 12, 1953, pp. 140–141.
[69] Iron Age, Chrome Carbide Has Unusual Properties: Vol. 170, No. 7, Aug. 14, 1952, p. 129.

Review of Mining Technology

By E. D. Gardner[1]

DURING 1952 all branches of the mining industry made continued efforts to improve techniques, so that the tons produced per man-shift could be increased. Mining practices were also improved to conserve timber and effect other economies. Although no notable innovations were introduced during the year, there was progress all along the line; the trend toward increased mechanization was pronounced.

The outstanding development in mining practice during the year appeared to be widespread adoption of rock bolting in underground metal mines. The practice has proved satisfactory in some situations where previously it was not thought applicable.

The year 1952, like 1951, was marked by high labor costs, labor shortages, and high costs of materials in the mineral industries. These disadvantages were offset, in part, by full production and by relatively high prices received for most mineral products. In the metals field, however, gold mining was far from being prosperous. The price of lead and zinc suddenly declined in the early part of the year, and at the year's end many lead and zinc mines were in distress. A prolonged strike, which plagued the iron industry during the year, also affected consumption of the ferrous alloy metals.

An active search for new mines, especially by established mining companies, continued during the year. Added production was provided for at a relatively large number of mines; exploration of undeveloped mineral deposits continued at a high rate.

The diamond drill remains the most common tool for sampling mineral deposits. It has the field to itself for drilling inclined holes and sampling buried hard deposits; churn drills, however, remain in the competition for sampling deep deposits that will not core.

A diamond-drill hole was completed to a depth of 6,010 feet during the year; a separate high-speed hoist was provided, and the standard driving mechanism was rearranged. This is reported to be the deepest diamond-drill hole drilled in North America.[2]

The use of circulating mud instead of clear water, especially through overburden, increased during the year. A new device for cementing diamond-drill holes was reported.[3] Experiments with the reverse circulation of water and sludge in diamond drilling were continued.

A considerable number of diamond bits cast-set with the stones oriented to take advantage of their greatest resistance to wear, according to crystal planes, were undergoing tests at the end of the year. The bits were cast in commercial shops. Experimental work by the Bureau of Mines at its Mount Weather, Va., station has shown that such setting is feasible and that it increases drilling speeds and prolongs the life of the bits.[4]

[1] Chief mining engineer, Bureau of Mines.

[2] Longyear, R. J., Trends in Diamond Drilling in the United States: Jour. Chem., Met., and Min. Soc. South Africa, April 1952.

[3] Ross, A. E., Cementing in Deep Diamond-Drill Holes: Min. Eng., vol. 4, No. 11, November 1952, pp. 1061–1064.

[4] Long, A. E., and Slawson, C. B., Diamond Orientation in Diamond Bits: Bureau of Mines Rept. of Investigations 4853, 1952, 6 pp.

Procedures were improved for collecting drill cuttings from sample holes put down by wagon drills. With improved techniques and equipment available, auger drills found increased favor during the year for sampling surface deposits in ground susceptible to this type of drilling.

At a Canadian mine, the ore bodies were completely indicated by diamond drilling, and a complete mining plan was projected from the results of the drilling before the shaft was sunk.[5] After 3 years of operation and after mining 500,000 tons of ore, it is reported (1) the ground is competent as foreseen, and no timbering is necessary; (2) the walls of the ore bodies are not quite as regular as anticipated; (3) the mine is dry, as expected, with only 50 gallons of water per minute; (4) the plan of stoping with long-hole blasting has proved successful (with 12 tons per man-shift underground); (5) concentration of operations permits the entire daily tonnage (2,000 tons) to come from a single level, as foreseen; (6) there has been virtually no unnecessary drifting, crosscutting, or raising; (7) mill recovery has been 80 percent, compared to an estimated 80 to 83 percent; (8) the grade of ore has been 8 percent below the estimate before dilution allowance; (9) operating costs are below the 1946 estimate if corrected for the 50-percent increase for labor and supplies; and (10) capital costs were higher than estimates because of the large increase in the cost of construction labor and supplies.

The trend continued during the year of using more track-mounted drill carriages or jumbos for driving mine drifts and crosscuts. The increased adoption of tungsten carbide bits, which permit completion of a long hole with a single bit, encouraged the practice of mounting development drills on long feed carriages, permitting faster drilling of drift rounds. Alloy drill steel was tested and employed more widely in underground mines. There was more extensive use of tractor-mounted jumbos and loading machines and diesel trucks or shuttle cars to extend large development headings.

Shaft mucking machines for driving both inclined and vertical shafts were improved. It was demonstrated that roof-bolting the hanging wall when sinking inclined shafts permits safe working conditions farther ahead of the regular shaft support, with resulting economies. Successful shaft sinking through quicksands, using the freezing method, was completed in the Carlsbad, N. Mex., district during the year.[6] Grouting was successfully used in sinking shafts at a Nevada copper mine, a New Jersey lead-zinc mine, and a New Mexico potash mine.

Gold dredging, like lode-gold mining, was relatively quiet during the year. Dredge mining of monazite-bearing placer deposits in Idaho has gone far to make the United States self-sufficient in monazite; it has also brought about some technical development in dredging.

Open-pit mining has a common interest with the construction industry so far as earth- and rock-moving equipment is concerned. The construction industry is highly competitive and provides a ready market for new or improved equipment that promises to reduce costs. The result has been the introduction of much new or improved equipment into open-pit mining. More construction firms actively entered

[5] Lipsey, G. C., The Development of a Mining Operation From Diamond-Drill Data: Min. Eng., vol. 4, No. 8, August 1952, pp. 784–788.
[6] Latz, J. E., Freezing Method Solves Problem in Carlsbad, N. Mex., Shaft: Min. Eng., vol. 4, No. 10, October 1952, pp. 942–947.

into the mining field during the year. Underground mining does not have the advantage of an allied industry to help the development of new machines for underground use, but there was a continued trend during the year to introduce quarry equipment and procedures underground where conditions were favorable.

Opencut mining practices have been changed over the years principally to permit taking full advantage of improved types of equipment. An innovation in general procedure was introduced during the year at an Arizona copper mine. The fringe ore of a deposit that previously had been exploited by block caving was being mined by opencuts. An efficient haulage system was intact in the underground mine. Ore mined at the surface was dumped over the immediate draw points of a block-caving stope and thence hauled to the mine shaft. The system worked so well that a block-caving stope was developed in virgin ground and after being pulled received the surface ore from a surrounding area.

No brand-new underground mining methods have been developed for many years; improvements of existing methods, however, have been constant, and important advances were made in 1952.

Top slicing is being partly replaced with other mining methods in underground iron mines. There also was a trend to replace sublevel caving and sublevel stoping by block caving where feasible.

Block caving at a new Canadian asbestos mine is featured by concreted draw points and slusher drifts, with the slushers discharging directly into mine cars on the main haulage level; there are no transfer raises. Blast holes for undercutting the 200- by 200-foot blocks are drilled with diamond drills. The mine is planned for an ultimate daily capacity of 12,000 tons.[7] This is in marked contrast to a new block-caving copper mine in Montana, where the conventional transfer raises are used. The mine also is planned for 12,000 tons a day.

Machines developed for continuous mining of coal were successfully introduced in a potash mine in New Mexico. Pillars are being successfully removed from a mine, also in this field, without causing breaks in the overlying salt.

The trend continued of adapting quarry practices underground for mining flat-bedded deposits where conditions are favorable. A new zinc mine in Tennessee is entered through a 1,100-foot minus-11½-percent entry.[8] A 1,700-foot minus-10-percent haulage entry at a Wisconsin zinc mine has proved very successful.[9] The haulage cost for 1.1 miles in 1952 was $0.22 per ton. At this mine the advance heading is taken at the bottom of the ore body, which ranges up to 70 feet in thickness. Incline slices are then developed by drilling in the back. The broken ore is leveled with a bulldozer, and a tractor-mounted jumbo travels on the broken ore to drill the next slice. In effect, the method is shrinkage stoping.

An innovation in extracting sulfur from the ground by the Frasch process was made in the Gulf Coast area.[10] Large quantities of heated water are required in the process. Some of the new sulfur deposits

---

[7] Lindell, K. V., World's Largest Asbestos Producer: Min. Eng., vol. 4, No. 3, March 1952, pp. 265–271.

[8] Langley, M. J., Development and Diesel Haulage at the New North Friends Station, Slope Mine of American Zinc Co. of Tennessee: Paper pres. at meeting of Southeastern Section, Am. Inst. Min. and Met. Eng., Chattanooga, Tenn., June 1952.

[9] Allen, V. C., Use of Diesel Equipment in a Zinc-Lead Mine: Paper pres. at Am. Min. Cong., Metal and Nonmettalic Mining Convention, Denver, Colo., September 1952.

[10] Bartlett, Z. W., Lee, C. O., and Feierabend, R. H., Development and Operation of Sulfur Deposits in the Louisiana Marshes: Min. Eng., vol. 4, No. 8, August 1952, pp. 775–783.

being developed are far from a fresh-water supply. The first installation to use untreated sea water has been completed 65 miles southwest of New Orleans. Another unusual feature of this operation is transportation of the molten sulfur in insulated barges to a storage site on dry land.

The hard-rock miner has been called upon to help solve some storage problems of the petroleum industry. Large quantities of liquefied petroleum gas have been pumped back underground in salt domes, but storage space is needed nearer the points of consumption. Some companies have built or were in the process of building underground reservoirs. The problems of design, excavation, and sealing of the chambers apparently are being met.

Rotary drills have replaced churn drills at a number of places for drilling blast holes in surface work. A new rotary drill using a Tricone bit was showing much promise in open-pit mining.[11]

The use of auger drills with carbide cutters increased for surface-drilling blast holes in ground suitable to this kind of drilling.

A new mobile drill unit was put under test in mid-1951 at a large copper mine in Utah; it appears to be an innovation at surface mines.[12] The unit comprises a 4-inch drill on a 12-foot slide and an air compressor mounted on a tractor; it relaces standard wagon drills and tripod drills. Flat toe holes as well as vertical holes can be drilled. During a 119-day run, the drill averaged 343 feet per 8-hour shift, compared to 112 for the wagon and tripod drills in the same kind of rock; 19 feet was drilled per man-shift at a cost of $0.09 per foot, compared to 6 at $0.30 for the standard drills.

As in 1951, considerable attention was paid during 1952 to drill supports, drill bits, and drill steel in underground mines. The use of jumbos is increasing in stopes as well as in development headings. To go with trackless haulage, jumbos mounted on tractors or rubber-tired vehicles have nearly replaced track-mounted jumbos for mining flat deposits; improved models came on the market during the year. Jumbos and jacklegs have largely replaced the old-fashioned columns for supporting drills.

Airleg-mounted drills have been tried at most metal mines and widely but not universally adopted. The trend is toward jumbos in stopes where they are feasible, but otherwise jacklegs are largely replacing the columns. Airleg drilling with jackhammers and carbide-tipped steel or carbide detachable bits continues to grow in favor. The advantages are numerous: Drilling is faster; less time is spent in setting up drills; the drills are easier to handle; and a better drill pattern can be made, resulting in more tons per man-shift and lower costs. American companies brought out a number of models to compete with the Swedish jackleg during the year.

It was found at an iron mine in Michigan that bit life in hard ore was increased 50 percent, with no loss of speed of penetration by reducing the diameter of holes to 1¼ to 1⅜ inches and using lighter machines than were formerly employed for the larger diameter holes drilled. The trend toward drilling smaller diameter blast holes in stopes, however, appears to have halted.

[11] Putman, G. E., Blast-Hole Rotary Drilling in Open-Pit Mining: Paper pres. at Am. Min. Cong. Metal and Nonmetallic Mineral Mining Convention, Denver, September 1952.
Mining World, Rotary Blast-Hole Drilling Now Feasible in Igneous Rocks: Vol. 14, No. 10, September 1952, pp. 42-43.

[12] Pett, L. F., and Snow, L. E., The Mobile Drill Unit in Use at the Utah Copper Pit: Min. Eng., vol. 4, No. 8, August 1952, pp. 799-803.

Percussion drills using jointed rods and carbide bits continued to replace diamond drills during the year for drilling long blast holes up to about 60 feet.

Millisecond delays for blasting stope rounds continued to gain during the year. A mine in British Columbia modified its blasting practice in stopes where long-hole ring drilling was used. Each ring was primed with Primacord, and millisecond delays were used for detonating each ring or part of a ring in the proper sequence. This practice eliminated the complicated hookup required when millisecond delays were used in all holes.

Some new models of relatively small capacity special-duty loading machines designed for surface work became available during the year. A continuous loader first developed for mining coal was used in more rock mines during the year. Improved models of other underground loading machines also became available. Track-mounted loaders still have a place in narrow workings but have been largely replaced by more mobile types where room for the larger machines is available. Conventional shovels continue to be preferred in flat stopes where working room is available. A diesel-powered loader works under a height of 12 feet in the Tri-State district. Standard types of shovels, however, require greater working heights.

The trend toward putting crushers underground at shaft mines continues. Where the ore tends to break into large fragments, growing practice was to load the ore mechanically into the haulage units from mill holes at the haulage level, eliminating grizzlies and chute gates. At some underground mines trucks loaded directly by shovels in the stopes dump into a crusher at the hoisting shaft.

Rock bolting made outstanding gains in underground metal mines during 1951 and 1952; further expansion is expected. From roof bolting of the backs of open stopes and other wide openings, the technique has spread to both top and side support in development workings and cut-and-fill, shrinkage, and other stopes. Wood pins instead of steel bolts are used in an Idaho mine in both shrinkage and cut-and-fill stopes to support both the walls and the ore.

The use of rock bolts has effected savings in the use of timber and afforded other economies in metal mining. The practice has made it possible in some instances to use shrinkage stopes by rock-bolting the walls, where otherwise a more expensive stoping method would be required. Rock bolting of walls in long-hole stoping before rings of holes are blasted has increased safety at a Canadian mine. Roof bolting instead of timbering in flat deposits has permitted more efficient operation of mechanical equipment, as in coal mines. Roof bolting instead of timber offers advantages in ventilation circuits.

Roof bolting in one instance indicates that the practice may offer protection from rock bursts. A severe rock burst occurred in a crosscut on the 3,840 level in an Idaho mine in July 1952; it knocked down a large quantity of rock, but in a 100-foot section that had been rock-bolted no fall of rock occurred, and no roof bolts loosened.[13]

Although it has many uses, experimental studies have demonstrated that the roof bolting cannot supplant timber or other roof supports everywhere.

---

[13] Foster, W. B., Rock-Bolting Program at the Sunshine Mine, Kellogg, Idaho: Paper pres. at the Am. Min. Cong., Metal and Nonmetallic Mineral Mining Convention, Denver, Colo., September 1952.

The use of sand from mill tailings for filling stopes increased during the year. At an Idaho mine a successful technique was worked out for using unclassified mill tailings for filling in cut-and-fill stopes.[14]

The tendency in surface mines is toward larger hauling units for off-highway work. New models of 50-ton diesel trucks came on the market during the year. Truck haulage, rather than rail, is being selected for most new opencut mining. Added importance was given to truck maintenance and road maintenance during the year.

Diesel power is supplanting gasoline engines, especially in large trucks. A new 40-ton haulage unit, however, with a radical departure in construction and powered with a butane engine, is an innovation in the mine haulage field.

Where quarry practices have been taken underground, diesel trucks are preferred for transportation if the working height is 12 feet or over. Usually the largest size truck is used that underground conditions permit, especially for hauls over about ½ mile. Where the working height is insufficient for trucks, more diesel and electric shuttle cars came into use in noncoal mines during the year.

Diesel locomotives also were placed in operation in more metal mines during the year. In new mines with track haulage, the trend was to larger mine cars; a number of mines use 10-ton cars, and cars with 15-ton capacity are in use. Mine cars and dumping arrangements also were improved during the year.

Belt conveyors for mainline haulage underground held their own. A new installation was put in a potash mine in New Mexico, which has an hourly capacity of 500 to 600 tons. The potash ore is crushed before going on the belt. Belt haulage was planned for a new iron mine in Canada and a new copper mine in Michigan. A Mesabi operator installed a complete conveyor system for mining an ore body ranging from 6 to 38 feet in height. Belt haulage in an inclined shaft, instead of hoisting, was installed at a Washington zinc mine; the hoisting cost was $0.06 per ton.[15] The system includes 1,500 feet of 17° incline and 12,000 feet of 10° incline.

The use of deep-well pumping for mine drainage increased during the year. The life of a small mine pump in a Michigan mine was increased greatly by lining it with liquid Neoprene.

Plastic pipe is being used in some metal mines both for air and water lines.

Radiotelephone service between working units, office, and supervisors' automobiles has proved its worth in operating opencut mines. Improvements in communications systems in hoisting and haulage underground were made during the year. Line-carrier-type telephone systems were installed in a number of metal mines, serving not only to control haulage but for general underground communications. The units of the systems take power from a d. c. trolley line or a storage battery locomotive. The telephones are installed on locomotives and at strategic points in the mine.

Recognition of the importance of mining research is evidenced by the increasing number of large operating mining companies that maintain research facilities and the growing interest of the mining industry

[14] Toepfer, P. H., Filling With Unclassified Tailings in Modified Cut-and-fill Stopes, Dayrock Mine, Wallace, Idaho: Bureau of Mines Rept. of Investigations 7649, 1952, pp. 14.

[15] Rayner, N. H., Pend Oreille's Inclined Conveyor Reduces Ore-Hoisting Costs: Eng. and Min. Jour., Vol. 153, No. 7, July 1952, pp. 90–93.

in this subject in recent years. Most experiments pertain to breaking ground and improving details of mining practices, but the field of interest is consistently broadening.

Pipeline transportation of solids has been used in the phosphate fields of Florida for several years. A coal-mining company conducted experimental work in Ohio to determine the economics of transporting coal on the surface in competition with rail haulage.

An experimental installation for hydraulic hoisting was continued into 1952 at a zinc mine in Wisconsin, with encouraging results. Addition of a second pipe column converted the system to a U-tube, with some of the water circulating down to augment the hoisting capacity. Operating as a U-tube in balance, the power requirement was reported to be about one-third of that with a comparable balanced skip hoist. With 2,500 g. p. m. rising in the 10-inch pipe, hoisting capacity per hour was reported to be 240 tons of ore.

Ground subsidence and rock bursts are becoming more of a problem as many mines reach greater depths or where large cavities exist resulting from stoping. The Bureau of Mines is cooperating with a number of companies in active studies looking toward solution of such problems.

Active research was continued by the Bureau of Mines during the year on the physical characteristics of rocks as related to design of mine structure and to mining problems. The studies also included the mechanics involved in rock movements resulting from stoping. Techniques have been developed for testing rocks in uniform deposits to ascertain safe spans ahead of mining. Studies were in progress regarding safe spans in open stopes where the time element is involved.

Statistical Summary of Metal and Nonmetal Production

By Kathleen J. D'Amico [1]

PRESENTATION of the mineral statistics in this chapter represents a departure from the procedure followed in earlier years to permit publication of the Minerals Yearbook in three volumes. This chapter gives a detailed summary of metals and nonmetals

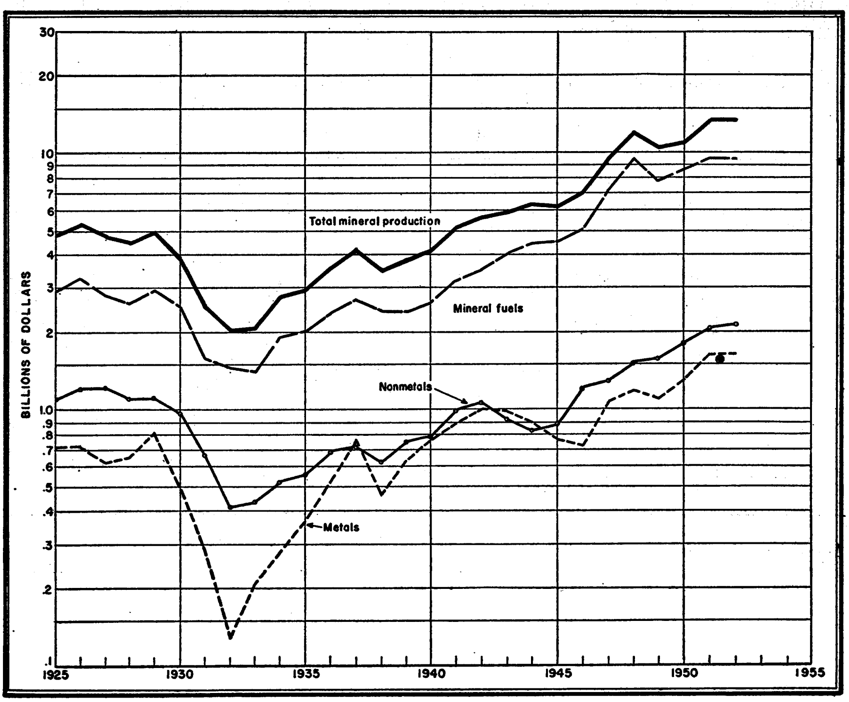

FIGURE 1.—Value of mineral production in continental United States, 1925–52.

(except fuels). A summary chapter for mineral-fuels statistics is included in volume II, and a detailed summary chapter for all minerals will be found in volume III of this series.

[1] Publications editor.

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

Because of inadequacies in the statistics available, some series deviate from the foregoing definition. In particular, the limestone, cement rock, and clay that are processed into cement are reflected in the series on cement rather than being included in their originally extracted form; similarly, limestone used for lime is reflected in the series on lime rather than that on stone. The quantities of gold, silver, copper, lead, zinc, and tin are recorded on a mine basis—that is, as the recoverable content of ore sold or treated; the values assigned to these quantities, however, are based on the average selling price of refined metal, not the mine value. Mercury is measured in the form of recovered metal and valued at the average New York price for metal.

The weight or volume units shown are those customary in the particular industries producing the respective commodities. No adjustment has been made in the dollar values for changes in the purchasing power of the dollar.

TABLE 1.—Value of mineral production in continental United States, 1925–52, by mineral groups [1]

[Millions of dollars]

Year	Mineral fuels [2]	Nonmetallic minerals (except fuels)	Metals	Total	Year	Mineral fuels [2]	Nonmetallic minerals (except fuels)	Metals	Total
1925	2,910	1,187	715	4,812	1939	2,423	754	631	3,808
1926	3,371	1,219	721	5,311	1940	2,662	784	752	4,198
1927	2,875	1,201	622	4,698	1941	3,228	989	890	5,107
1928	2,666	1,163	655	4,484	1942	3,568	1,056	999	5,623
1929	2,940	1,166	802	4,908	1943	4,028	916	987	5,931
1930	2,500	973	507	3,980	1944	4,574	836	900	6,310
1931	1,620	671	287	2,578	1945	4,569	888	774	6,231
1932	1,460	412	128	2,000	1946	5,090	1,243	729	7,062
1933	1,413	432	205	2,050	1947	7,188	1,338	1,084	9,610
1934	1,947	520	277	2,744	1948	9,502	1,552	1,219	12,273
1935	2,013	564	365	2,942	1949	7,920	1,559	1,101	10,580
1936	2,405	685	516	3,606	1950	8,689	1,815	1,351	11,855
1937	2,798	711	756	4,265	1951	9,779	2,075	1,670	13,524
1938	2,436	622	460	3,518	1952	9,615	2,156	1,611	13,382

[1] Data for 1925–46 are not strictly comparable with those for subsequent years, since for the earlier years the value of heavy-clay products has not been replaced by the value of raw clays used in such products.

[2] Beginning with this volume asphalt, carbon dioxide, helium, and peat are included with mineral fuels.

TABLE 2.—Mineral production in continental United States, 1949–52, by individual minerals [1] [2]

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
METALS								
Antimony ore and concentrate____gross weight__	5, 186	$1, 134, 417	6, 888	$1, 443, 227	9, 100	(3)	4, 434	(3)
Bauxite____long tons, dried equivalent__	1, 148, 792	6, 778, 181	1, 334, 527	7, 692, 809	1, 848, 676	$12, 477, 516	1, 667, 047	$10, 776, 254
Beryllium concentrate____gross weight__	475	152, 485	559	170, 550	484	161, 361	515	233, 757
Chromite____do____	433	11, 662	404	(3)	7, 056	510, 741	21, 304	1, 776, 981
Cobalt (content of ore)____pounds__	673, 773	(3)	660, 025	(3)	755, 631	(3)	836, 372	(3)
Columbium-tantalum concentrate__pounds, gross weight__	1, 020	1, 785	1, 000	2, 150	925	1, 528	5, 385	16, 723
Copper (recoverable content of ores, etc.)____	752, 746	296, 581. 924	909, 337	378, 284, 192	928, 329	449, 311, 235	925, 377	447, 882, 468
Gold (recoverable content of ores, etc.)____troy ounces__	1, 762, 367	61, 682, 845	2, 104, 959	73, 673, 565	1, 741, 026	60, 935, 910	1, 652, 704	57, 844, 640
Iron ore, usable (excluding byproduct iron sinter) long tons, gross weight__	84, 174, 399	377, 637, 131	97, 150, 704	483, 358, 130	115, 621, 556	629, 837, 139	97, 236, 397	590, 346, 970
Lead (recoverable content of ores, etc.)____	409, 857	129, 514, 812	430, 678	116, 283. 060	388, 143	134, 297, 478	390, 161	125, 631, 842
Manganese ore (35 percent or more Mn)____gross weight__	126, 135	5, 178, 564	134, 451	6, 229, 985	105. 007	6, 045, 452	115, 379	8, 251, 774
Manganiferous ore (5 to 35 percent Mn)____do____	1, 078. 395	4, 040, 155	1, 087, 597	4, 609, 432	1, 223, 964	5, 385, 986	1, 009, 018	5, 116, 985
Manganiferous residuum____do____	158, 902	(3)	183, 842	(3)	267, 751	(3)	215, 255	(3)
Mercury____76-pound flasks__	9, 830	781, 092	4, 535	368, 514	7, 293	1, 532. 478	12, 519	2, 492, 533
Molybdenum (content of ore and concentrate)____pounds__	23, 280, 000	19. 332, 000	44, 544, 000	37, 729, 000	37, 954, 544	36, 176, 900	42, 717, 443	40, 844, 575
Silver (recoverable content of ores, etc.)____troy ounces__	34, 638, 896	31, 349, 949	42, 406, 376	38, 379, 912	39, 733, 909	35, 961, 195	39, 419, 344	35, 676, 497
Tin (content of ore and concentrate)____long tons__	17	37, 410	15	31, 165	19	55, 757	17	45, 324
Titanium concentrate:								
Ilmenite____gross weight__	389, 234	6, 212, 348	452, 370	5, 607, 584	510, 840	7, 689, 272	522, 514	8, 022, 752
Rutile____do____	10, 559	489, 798	(3)	(3)	(3)	(3)	(3)	(3)
Tungsten concentrate____60-percent WO_3 basis__	2, 765	4, 377, 066	4, 807	8, 156, 758	6, 265	22, 936, 638	7, 603	28, 943, 162
Zinc (recoverable content of ores, etc.)____	593, 201	148, 912, 878	623, 369	178, 667, 197	681, 188	249, 330, 389	666, 001	222, 981, 864
Undistributed: Magnesium chloride for magnesium metal, platinum-group metals (crude), vanadium, zirconium concentrate, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)____	____	6, 670, 946	____	10, 215, 783	____	17, 755, 280	____	23, 581, 606
Total metals____	____	1, 101, 000, 000	____	1, 351, 000, 000	____	1, 670, 000, 000	____	1, 611, 000, 000

For footnotes, see end of table.

TABLE 2.—Mineral production in continental United States, 1949–52, by individual minerals [1] [2]—Continued

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
NONMETALLIC MINERALS (EXCEPT FUELS)								
Abrasive stone: [4]								
Grindstones and pulpstones	4, 507	$246, 679	4, 468	$232, 562	5, 571	$315, 871	3, 974	$247, 434
Millstones	(5)	9, 400	(5)	11, 300	(5)	6, 000	(5)	9, 285
Pebbles (grinding)	2, 374	64, 038	1, 923	53, 007	3, 062	84, 306	4, 140	96, 537
Tube-mill liners (natural)	1, 166	47, 093	1, 523	62, 535	1, 408	77, 027	1, 083	66, 218
Asbestos	43, 387	2, 614, 416	42, 434	2, 925, 050	51, 645	3, 912, 500	53, 864	4, 713, 032
Barite (crude)	717, 313	5, 642, 226	695, 414	6, 193, 906	860, 669	7, 968, 023	941, 825	8, 797, 944
Boron minerals	467, 592	11, 511, 893	647, 735	15, 890, 000	862, 797	20, 030, 000	583, 828	14, 105, 000
Bromine ... pounds	88, 725, 709	16, 267, 908	98, 502, 300	18, 794, 978	129, 563, 073	26, 179, 556	156, 201, 577	30, 639, 292
Calcium-magnesium chloride ... 75-percent (Ca, Mg) Cl_2 basis	255, 797	3, 260, 675	299, 821	3, 801, 508	328, 042	4, 756, 242	(6)	(6)
Cement ... 376-pound barrels	207, 142, 364	475, 074, 352	228, 787, 765	537, 651, 523	240, 331, 112	611, 751, 089	250, 821, 410	637, 746, 171
Clays (including fuller's earth) [7]	28, 473, 844	74, 618, 654	32, 301, 425	89, 675, 599	[8] 35, 612, 343	[8] 120, 569, 827	33, 847, 609	122, 385, 736
Emery	4, 909	60, 917	5, 949	75, 308	11, 634	160, 212	10, 352	141, 911
Feldspar (crude) ... long tons	369, 378	2, 278, 441	407, 925	2, 558, 390	400, 439	2, 815, 587	420, 831	3, 696, 018
Fluorspar	236, 704	8, 266, 754	301, 510	10, 619, 717	347, 024	14, 369, 521	331, 273	15, 353, 634
Garnet (abrasive)	6, 578	505, 231	9, 304	793, 558	14, 050	1, 246, 947	11, 390	981, 841
Gem stones (estimated)	(5)	450, 000	(5)	450, 000	(5)	450, 000	(5)	490, 000
Graphite	5, 213	475, 264	5, 605	427, 908	6, 808	771, 434	5, 081	594, 618
Gypsum (crude)	6, 608, 118	18, 318, 553	8, 192, 625	22, 734, 568	8, 665, 534	24, 024, 101	8, 415, 300	22, 896, 051
Kyanite	12, 115	403, 169	(6)	(6)	(6)	(6)	(6)	(6)
Lime (open-market)	6, 302, 551	68, 907, 830	7, 462, 109	82, 847, 301	8, 236, 422	96, 507, 144	8, 055, 609	94, 795, 435
Lithium minerals	4, 838	345, 970	9, 306	579, 922	12, 897	896, 000	15, 611	1, 052, 000
Magnesite (crude)	287, 315	1, 950, 153	429, 392	3, 091, 135	670, 167	4, 506, 712	510, 750	2, 871, 548
Magnesium compounds from sea water and brines (except for metal) ... MgO equivalent	63, 000	5, 033, 000	89, 300	7, 283, 000	106, 414	8, 996, 198	143, 795	12, 229, 234
Marl:								
Calcareous (except for cement)	166, 800	231, 975	347, 843	246, 451	269, 955	233, 787	260, 213	187, 148
Greensand	6, 128	276, 564	3, 935	304, 321	5, 067	263, 944	4, 600	177, 847
Mica:								
Scrap	32, 856	795, 782	69, 360	1, 742, 616	71, 871	1, 884, 087	75, 236	1, 954, 286
Sheet ... pounds	513, 994	132, 097	578, 818	125, 928	594, 884	160, 322	697, 989	908, 135
Olivine	3, 528	56, 850	4, 103	59, 402	(6)	(6)	(6)	(6)
Perlite (crude)	71, 203	510, 646	101, 536	649, 162	[8] 153, 502	[8] 858, 099	164, 845	1, 002, 920
Phosphate rock ... long tons	8, 986, 933	51, 415, 027	10, 253, 552	59, 027, 848	11, 095, 204	66, 158, 078	11, 324, 158	68, 120, 918
Potassium salts ... K_2O equivalent	1, 120, 653	35, 105, 799	1, 276, 164	39, 774, 447	1, 408, 408	44, 788, 880	1, 598, 354	53, 754, 316
Pumice and pumicite	716, 742	2, 369, 082	719, 356	2, 661, 052	749, 192	2, 739, 907	597, 044	2, 266, 981
Pyrites ... long tons	888, 388	3, 904, 000	931, 163	4, 059, 000	1, 017, 769	4, 656, 000	994, 342	4, 947, 000
Quartz from pegmatites and quartzite	107, 552	475, 491	160, 508	706, 724	281, 047	1, 165, 370	246, 604	1, 013, 637
Salt (common)	15, 559, 551	53, 548, 916	16, 616, 264	59, 774, 118	20, 196, 565	69, 615, 662	19, 532, 276	70, 870, 767
Sand and gravel	315, 895, 407	245, 660, 928	367, 304, 408	292, 559, 011	[8] 393, 644, 618	[8] 329, 870, 466	424, 605, 508	344, 568, 531

Sand and sandstone (ground)	610, 789	5, 258, 464	750, 673	6, 462, 503	818, 479	7, 163, 343	792, 802	6, 922, 586
Slate	740, 260	12, 164, 276	930, 370	15, 047, 481	[8] 819, 360	[8] 14, 534, 327	739, 640	12, 706, 651
Sodium carbonate (natural)	[9] 200, 496	[9] 4, 163, 714	351, 075	7, 543, 769	350, 688	8, 368, 037	323, 479	7, 828, 033
Sodium sulfate (natural)	186, 223	2, 733, 853	186, 537	2, 199, 336	(6)	(6)	236, 825	3, 217, 000
Stone [10]	222, 548, 750	339, 442, 316	250, 844, 240	387, 910, 538	[8] 284, 155, 499	[8] 433, 924, 525	299, 005, 371	461, 064, 048
Sulfur:								
Ore for direct agricultural use ... long tons	5, 392	101, 991	3, 247	60, 115	3, 945	75, 609	4, 686	91, 310
Frasch-process ... do	4, 789, 311	86, 208, 000	5, 504, 714	104, 000, 000	4, 988, 101	107, 300, 000	5, 141, 392	110, 925, 000
Talc, pyrophyllite, and soapstone (ground)	461, 896	7, 523, 478	620, 750	10, 620, 743	636, 068	11, 322, 830	593, 147	11, 347, 317
Tripoli	25, 525	690, 564	43, 720	1, 173, 647	37, 476	1, 105, 135	35, 459	1, 043, 124
Vermiculite	168, 819	1, 686, 419	208, 096	2, 122, 427	209, 008	2, 093, 953	208, 906	2, 081, 993
Wollastonite	500	7, 000	800	16, 200	(6)	(6)	(6)	(6)
Undistributed: Andalusite (1949), aplite, brucite, diatomite, dumortierite (1949), epsom salt from epsomite (1949–51), iodine, quartz crystal (1950), sharpening stones, sodium carbonate (Wyoming 1949), topaz (1949), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 6)	------------	8, 104, 563	------------	9, 824, 259	------------	16, 026, 333	------------	15, 104, 190
Total nonmetallic minerals	------------	1, 559, 000, 000	------------	1, 815, 000, 000	------------	2, 075, 000, 000	------------	2, 156, 000, 000
MINERAL FUELS								
Asphalt and related bitumens (native):								
Bituminous limestone and sandstone	1, 150, 931	4, 264, 989	1, 184, 676	3, 522, 308	1, 378, 434	4, 159, 259	1, 570, 698	4, 687, 512
Gilsonite	51, 462	1, 303, 584	66, 186	1, 774, 330	65, 521	1, 895, 374	60, 740	1, 779, 815
Carbon dioxide, natural (estimated) ... thousand cubic feet	489, 000	376, 000	472, 334	369, 000	547, 436	161, 000	737, 000	226, 250
Coal:								
Bituminous [11]	434, 342, 373	2, 126, 225, 715	512, 528, 632	2, 489, 228, 604	529, 879, 295	2, 614, 219, 188	463, 137, 264	2, 276, 189, 066
Lignite	3, 092, 130	7, 335, 553	3, 369, 966	8, 111, 730	3, 291, 104	8, 043, 962	3, 017, 300	7, 211, 912
Pennsylvania anthracite	42, 701, 724	358, 008, 451	44, 076, 703	392, 398, 006	42, 669, 997	405, 817, 963	40, 582, 558	379, 714, 076
Helium (shipments) ... cubic feet	51, 501, 421	688, 795	80, 888, 990	1, 027, 913	108, 970, 000	1, 387, 000	145, 492, 000	1, 891, 000
Natural gas ... thousand cubic feet	5, 419, 736, 000	344, 034, 063	6, 282, 060, 000	408, 521, 516	7, 457, 359, 000	542, 964, 400	8, 013, 457, 000	623, 649, 460
Natural-gas liquids:								
Natural gasoline and cycle products ... 42-gallon barrels	99, 217, 000	303, 136, 000	109, 679, 000	321, 832, 000	118, 377, 000	369, 718, 000	121, 482, 000	371, 468, 000
LP-gases ... do	57, 869, 000	99, 054, 000	72, 282, 000	97, 773, 000	86, 377, 000	138, 443, 000	102, 033, 000	161, 692, 000
Peat	129, 532	1, 020, 014	130, 723	1, 142, 566	194, 416	1, 489, 225	210, 582	1, 729, 511
Petroleum (crude) ... 42-gallon barrels	1, 841, 940, 000	4, 674, 770, 000	1, 973, 574, 000	4, 963, 380, 000	2, 247, 711, 000	5, 690, 410, 000	[12] 2,289,836, 000	[12] 5,785,230,000
Total mineral fuels	------------	7, 920, 000, 000	------------	8, 689, 000, 000	------------	9, 779, 000, 000	------------	9, 615, 000, 000
Grand total mineral production	------------	10, 580, 000, 000	------------	11, 855, 000, 000	------------	13, 524, 000, 000	------------	13, 382, 000, 000

[1] Production as measured by mine shipments or mine sales (including consumption by producers), except that fuels and the following additional minerals are strictly production: Gypsum, iodine, magnesite, pyrites, bauxite, and mercury. Excludes uranium ores and monazite.

[2] Beginning with this volume asphalt and related bitumens, carbon dioxide, helium and peat are included with mineral fuels.

[3] Value included with "Metals, undistributed."

[4] Excludes sharpening stones, value for which is included with "Nonmetallic minerals, undistributed."

[5] Weight not recorded.

[6] Value included with "Nonmetallic minerals, undistributed."

[7] Excludes clays sold or used for cement as follows: 1949—6,676,000 short tons, $4,573,000; 1950—7,080,000 tons, $5,574,000; 1951—7,804,000 tons, $8,052,000; 1952—8,439,000 tons, $8,646,000.

[8] Revised figure.

[9] Excludes production from Wyoming, value for which is included with "Nonmetallic minerals, undistributed."

[10] Excludes abrasive stone, bituminous limestone, bituminous sandstone, and ground soapstone, all included elsewhere in table. Also excludes limestone for cement and lime.

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

Final figure. Supersedes preliminary figure given in commodity chapter.

TABLE 3.—Metals and nonmetals (except fuels) produced in continental United States and principal producing States in 1952

Rank in value	Mineral	Principal producing States: In order of quantity	Principal producing States: In order of value
	Abrasive stone:		
60	Grindstones and pulpstones	Ohio, West Virginia, Washington	Rank same as for quantity.
75	Millstones	Not available	North Carolina.
66	Pebbles (grinding)	Minnesota, North Carolina, Wisconsin, Texas	Minnesota, Wisconsin, North Carolina, Texas.
71	Sharpening stones	Arkansas, New Hampshire, Indiana	Rank same as for quantity.
69	Tube-mill liners (natural)	Minnesota, North Carolina, Wisconsin	Do.
55	Antimony ore and concentrate	Idaho, Nevada, Washington, California	Do.
59	Aplite	Virginia	Do.
36	Asbestos	Vermont, Arizona, Georgia	Do.
27	Barite (crude)	Arkansas, Missouri, Georgia, Nevada	Do.
26	Bauxite	Arkansas, Alabama, Georgia	Do.
61	Beryllium concentrate	South Dakota, New Mexico, Colorado, New Hampshire	Do.
21	Boron minerals	California	Do.
17	Bromine	Texas, Michigan, California, West Virginia	Michigan, Texas, California, West Virginia.
68	Brucite	Nevada	Rank same as for quantity.
35	Calcium-magnesium chloride	Michigan, California, West Virginia, Ohio	Do.
1	Cement	Pennsylvania, California, Texas, New York	Do.
45	Chromite	California, Oregon	Do.
8	Clays	Ohio, Pennsylvania, Georgia, Missouri	Georgia, Ohio, Pennsylvania, Missouri.
57	Cobalt (content of ore)	Pennsylvania, Idaho	Rank same as for quantity.
72	Columbium-tantalum concentrate	North Carolina, Colorado, South Dakota	Do.
4	Copper (in ores, etc.)	Arizona, Utah, New Mexico, Montana	Do.
31	Diatomite	California, Nevada, Oregon, Washington	Do.
65	Emery	New York	Do.
37	Feldspar (crude)	North Carolina, South Dakota, Colorado, New Hampshire.	North Carolina, New Hampshire, Colorado, South Dakota.
20	Fluorspar	Illinois, Kentucky, Colorado, Utah	Illinois, Kentucky, Colorado, New Mexico.
53	Garnet (abrasive)	New York, Idaho, Florida	Rank same as for quantity.
58	Gem stones	Not available	California, Oregon, Texas, Nevada.
13	Gold (in ores, etc.)	South Dakota, Utah, California, Colorado	Rank same as for quantity.
55	Graphite:		
	Amorphous	Rhode Island	Do.
	Crystalline	Texas, Alabama	Do.
19	Gypsum (crude)	Michigan, California, New York, Iowa	Michigan, New York, Iowa, California.
46	Iodine	California	Rank same as for quantity.
2	Iron ore (usable)	Minnesota, Michigan, Alabama, Utah	Minnesota, Michigan, Alabama, New York.
49	Kyanite	Virginia, South Carolina	Rank same as for quantity.
7	Lead (in ores, etc.)	Missouri, Idaho, Utah, Colorado	Do.
10	Lime (open-market)	Ohio, Pennsylvania, Missouri, Illinois	Do.
47	Lithium minerals	South Dakota, North Carolina, California	Do.
39	Magnesite (crude)	Washington, Nevada, California	Do.
22	Magnesium chloride (for magnesium metal)	Texas	Do.

24	Magnesium compounds from sea water and brines (except for metal).	Michigan, California, New Jersey	Do.
28	Manganese ore	Montana, California, New Mexico, Arkansas	Montana, California, Nevada, Arkansas.
33	Manganiferous ore	*Minnesota, New Mexico, Michigan, Montana*	Rank same as for quantity.
44	Manganiferous residuum	New Jersey	Do.
	Marl:		
63	Calcareous	Michigan, Virginia, Wisconsin, Indiana	Michigan, Virginia, Nevada, Indiana.
64	Greensand	New Jersey	Rank same as for quantity.
41	Mercury	California, Nevada, Idaho, Oregon	Do.
40	Mica	North Carolina, Georgia, Arizona, Colorado	North Carolina, Georgia, Idaho, Arizona.
	Scrap	do	North Carolina, Georgia, Arizona, Pennsylvania.
	Sheet	North Carolina, New Hampshire, Idaho, Connecticut	North Carolina, Idaho, New Hampshire, South Dakota.
15	Molybdenum (content of ore and concentrate)	Colorado, Utah, Arizona, New Mexico	Rank same as for quantity.
62	Olivine	North Carolina, Washington	Do.
52	Perlite (crude)	New Mexico, Nevada, California, Colorado	Nevada, New Mexico, California, Colorado.
12	Phosphate rock	Florida, Tennessee, Idaho, Montana	Florida, Tennessee, Montana, Idaho.
73	Platinum-group metals (crude)	California	Rank same as for quantity.
14	Potassium salts	New Mexico, *California, Utah, Michigan*	Do.
42	Pumice and pumicite	New Mexico, California, Idaho, Colorado	California, New Mexico, Oregon, Idaho.
34	Pyrites	Tennessee, California, Virginia, Montana	Rank same as for quantity.
50	Quartz from pegmatites and quartzite	Washington, California, North Carolina, Connecticut	Do.
11	Salt (common)	Michigan, New York, Ohio, Texas	Michigan, New York, Louisiana, Kansas.
5	Sand and gravel	California, Michigan, Wisconsin, Ohio	California, Ohio, Michigan, Pennsylvania.
32	Sand and sandstone (ground)	Illinois, New Jersey, West Virginia, Ohio	Illinois, West Virginia, New Jersey, Ohio.
16	Silver (in ores, etc.)	Idaho, Utah, Montana, Arizona	Rank same as for quantity.
23	Slate	Pennsylvania, Vermont, New York, Georgia	Pennsylvania, Vermont, New York, Virginia.
30	Sodium carbonate (natural)	*California, Wyoming*	Rank same as for quantity.
38	Sodium sulfate (natural)	California, Texas, Wyoming	Do.
3	Stone	Pennsylvania, Ohio, Illinois, Michigan	Pennsylvania, Ohio, Illinois, New York.
9	Sulfur (Frasch-process)	Texas, Louisiana	Rank same as for quantity.
67	Sulfur ore for direct agricultural use	Nevada, California, Wyoming	Do.
25	Talc, pyrophyllite, and soapstone (ground)	New York, California, *North Carolina*, Vermont	Do.
70	Tin (content of ore and concentrate)	Colorado, North Carolina	Do.
	Titanium concentrate:		
29	Ilmenite	New York, Florida, Virginia, North Carolina	Do.
54	Rutile	Florida	Do.
48	Tripoli	Illinois, Missouri, Pennsylvania	Missouri, Illinois, Pennsylvania.
18	Tungsten concentrate	California, Nevada, North Carolina, Colorado	Rank same as for quantity.
43	Vermiculite	Montana, South Carolina, Wyoming, North Carolina	Do.
72	Wollastonite	New York, California	Do.
6	Zinc (in ores, etc.)	Montana, Idaho, New Jersey, *Oklahoma*	Do.
51	Zirconium concentrate	Florida	Do.

TABLE 4.—Value of metals and nonmetals (except fuels) produced in continental United States, 1949–52, by States, in thousands of dollars and principal minerals produced in 1952

State	1949	1950	1951	1952			
				Value	Rank	Percent of U. S. total	Principal minerals, in order of value
Alabama	63,211	68,606	79,197	84,623	15	2.25	Iron ore, cement, stone, lime.
Arizona	181,070	207,379	243,856	231,669	3	6.15	Copper, zinc, lead, silver.
Arkansas	20,145	26,424	28,468	28,682	33	.76	Bauxite, sand and gravel, barite, stone.
California	171,197	201,682	[1] 247,311	244,508	2	6.49	Cement, sand and gravel, stone, boron minerals.
Colorado	54,774	72,472	85,848	87,588	14	2.32	Molybdenum, zinc, lead, cement.
Connecticut	4,854	5,640	[1] 6,213	7,063	43	.19	Stone, sand and gravel, lime, clays.
Delaware	335	522	[1] 584	677	48	.02	Sand and gravel, stone, clays.
District of Columbia	63	60	82	7	49	([2])	Clays.
Florida	54,257	66,745	77,285	79,080	16	2.10	Phosphate rock, stone, cement, sand and gravel.
Georgia	35,353	44,016	[1] 47,509	52,200	25	1.39	Clays, stone, cement, sand and gravel.
Idaho	64,267	79,077	82,795	77,060	17	2.05	Zinc, lead, silver, sand and gravel.
Illinois	70,411	80,320	93,225	97,606	12	2.59	Stone, cement, sand and gravel, fluorspar.
Indiana	47,123	57,714	65,135	63,719	20	1.69	Cement, stone, sand and gravel, clays.
Iowa	30,529	34,777	41,488	47,074	29	1.25	Cement, stone, sand and gravel, gypsum.
Kansas	44,528	52,221	54,508	56,423	23	1.50	Cement, stone, zinc, salt.
Kentucky	18,950	20,422	23,249	25,151	35	.67	Stone, clays, cement, sand and gravel.
Louisiana	37,226	42,464	47,279	56,811	22	1.51	Sulfur, cement, salt, sand and gravel.
Maine	6,663	7,399	8,479	8,923	42	.25	Cement, sand and gravel, stone, slate.
Maryland	16,956	19,516	[1] 22,683	23,692	36	.63	Sand and gravel, stone, cement, clays.
Massachusetts	12,442	16,006	16,946	17,715	39	.47	Stone, sand and gravel, lime, clays.
Michigan	153,166	185,275	217,920	217,450	5	5.77	Iron ore, cement, sand and gravel, salt.
Minnesota	257,486	331,554	433,096	397,441	1	10.55	Iron ore, sand and gravel, stone, manganiferous ore.
Mississippi	3,276	4,285	6,698	6,902	44	.18	Clays, cement, sand and gravel, stone.
Missouri	96,190	100,672	121,712	128,825	10	3.42	Lead, cement, stone, lime.
Montana	65,636	74,221	94,998	91,663	13	2.43	Copper, zinc, manganese ore, lead.
Nebraska	9,372	10,720	11,678	12,853	41	.34	Cement, sand and gravel, stone, clays.
Nevada	37,372	48,499	[1] 57,674	64,231	19	1.70	Copper, tungsten, zinc, gold.
New Hampshire	1,390	1,711	1,295	1,941	45	.05	Sand and gravel, stone, feldspar, mica.
New Jersey	38,403	46,205	58,809	57,117	21	1.52	Zinc, stone, sand and gravel, iron ore.
New Mexico	62,138	73,904	97,497	107,384	11	2.85	Potassium salts, copper, zinc, lead.
New York	121,835	140,032	[1] 169,993	161,716	8	4.29	Cement, iron ore, stone, sand and gravel.
North Carolina	19,650	26,156	29,474	34,713	30	.92	Stone, sand and gravel, tungsten, feldspar.
North Dakota	1,787	1,825	2,389	1,866	46	.05	Sand and gravel, clays, stone.
Ohio	99,223	111,506	137,839	137,448	9	3.65	Stone, cement, lime, sand and gravel.
Oklahoma	31,169	35,450	44,422	47,288	28	1.26	Zinc, cement, stone, lead.

Oregon	21,795	21,483	28,374	26,637	34	.71	Stone, sand and gravel, cement, diatomite.
Pennsylvania	168,103	195,204	226,567	213,243	6	5.66	Cement, stone, sand and gravel, lime.
Rhode Island	929	1,425	1,278	1,250	47	.03	Stone, sand and gravel, graphite.
South Carolina	9,026	11,394	11,286	14,531	40	.39	Stone, clays, cement, sand and gravel.
South Dakota	26,653	32,593	[1] 29,553	30,455	31	.81	Gold, stone, cement, clays.
Tennessee	55,390	62,295	72,855	74,908	18	1.99	Cement, stone, zinc, phosphate rock.
Texas	142,536	169,947	188,487	198,368	7	5.27	Sulfur, cement, sand and gravel, bromine.
Utah	145,237	193,049	219,395	227,256	4	6.03	Copper, lead, gold, iron ore.
Vermont	17,384	18,563	[1] 18,516	17,891	37	.47	Stone, asbestos, slate, copper.
Virginia	33,905	40,774	45,224	49,509	27	1.31	Stone, cement, sand and gravel, zinc.
Washington	34,779	43,176	48,396	50,003	26	1.33	Cement, sand and gravel, zinc, stone.
West Virginia	23,820	26,893	33,001	29,743	32	.79	Sand and gravel, stone, cement, lime.
Wisconsin	35,868	41,683	48,345	55,706	24	1.48	Sand and gravel, stone, iron ore, zinc.
Wyoming	11,926	12,368	16,192	17,873	38	.47	Clays, cement, sand and gravel, stone.
Total	2,660,000	3,166,000	3,745,000	3,767,000	--------	100.00	Cement, iron ore, stone, copper.

[1] Revised figure.
[2] Less than 0.005 percent.

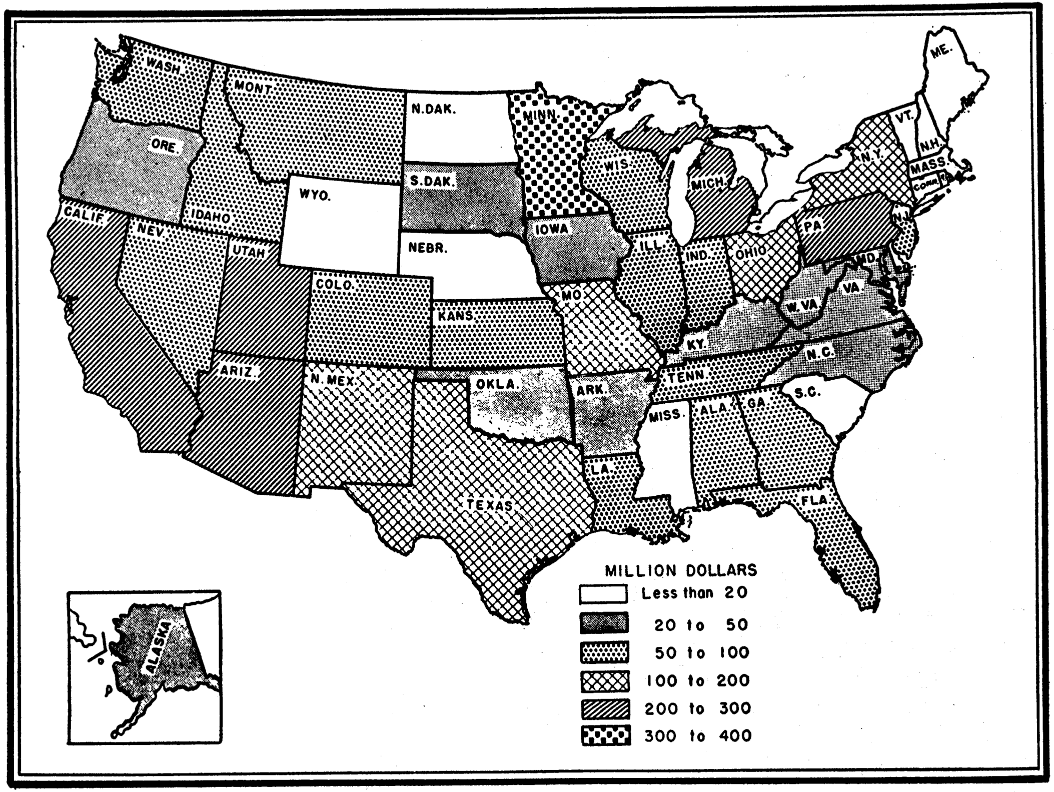

FIGURE 2.—Value of metals and nonmetals (except fuels), produced in continental United States and Alaska, 1952, by States.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]

ALABAMA

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Cement [2] ....376-pound barrels..	9,394,348	$20,320,658	10,574,955	$23,175,772	10,586,825	$24,523,073	10,642,409	$25,084,379
Clays (except for cement)	856,719	934,262	992,836	1,045,217	918,598	1,367,545	921,588	1,560,858
Iron ore (usable)............long tons, gross weight..	7,314,204	27,553,175	7,402,208	28,932,801	8,181,737	34,799,951	7,243,214	37,940,412
Lime (open-market)	359,446	3,203,564	389,071	3,577,850	455,953	4,395,922	424,028	4,458,604
Manganese ore (35 percent or more Mn)............gross weight..	------	------	138	(3)	------	------	------	------
Sand and gravel	3,296,582	2,268,013	3,616,363	2,463,722	3,535,871	2,806,540	3,722,555	2,955,630
Stone (except for cement and lime)	2,636,930	6,039,867	2,587,500	6,038,220	2,818,421	7,254,671	3,052,150	7,948,410
Undistributed: Bauxite, puzzolan cement, graphite, mica (1952), salt (1952), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	------	2,891,380	------	3,372,980	------	4,048,936	------	4,674,458
Total	------	63,211,000	------	68,606,000	------	79,197,000	------	84,623,000
Total mineral fuels	------	80,694,000	------	90,369,000	------	85,083,000	------	73,759,000
Total Alabama	------	143,905,000	------	158,975,000	------	164,280,000	------	158,382,000

ARIZONA

Mineral	1949 Short tons	1949 Value	1950 Short tons	1950 Value	1951 Short tons	1951 Value	1952 Short tons	1952 Value
Clays	189,854	$432,813	223,586	$512,025	226,672	$471,973	247,329	$579,175
Copper (recoverable content of ores, etc.)	359,010	141,449,940	403,301	167,773,216	415,870	201,281,080	395,719	191,527,996
Fluorspar	846	(3)	952	(3)	1,623	(3)	434	(3)
Gold (recoverable content of ores, etc.)............troy ounces..	108,993	3,814,755	118,313	4,140,955	116,093	4,063,255	112,355	3,932,425
Gypsum (crude)	(3)	(3)	(3)	(3)	(3)	(3)	11,314	28,285
Lead (recoverable content of ores, etc.)	33,568	10,607,488	26,383	7,123,410	17,394	6,018,324	16,520	5,319,440
Lime (open-market)	43,529	607,709	51,530	717,885	54,023	772,899	53,019	757,390
Manganese ore (35 percent or more Mn)............gross weight..	223	(3)	222	(3)	173	(3)	203	(3)
Manganiferous ore (5 to 35 percent Mn)............do....	------	------	------	------	224	(3)	------	------
Mica (scrap)	(3)	(3)	(3)	(3)	1,763	50,030	(3)	(3)
Molybdenum (content of ore and concentrate)............pounds..	(3)	(3)	(3)	(3)	1,172,740	1,101,641	2,022,832	1,987,418
Perlite (crude)	519	2,670	1,923	10,487	(3)	(3)	(3)	(3)
Sand and gravel	1,511,953	970,813	2,498,777	1,590,001	2,691,100	2,203,345	1,824,330	1,635,903
Silver (recoverable content of ores, etc.)............troy ounces..	4,970,736	4,498,767	5,325,441	4,819,793	5,120,985	4,634,750	4,701,330	4,254,941
Stone (except limestone for cement and lime)	356,050	203,295	228,490	139,810	308,881	353,872	235,020	355,709
Tungsten concentrate............60-percent WO_3 basis..	(4)	(3)	1	(3)	11	36,663	71	251,136

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

ARIZONA—Continued

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Zinc (recoverable content of ores, etc.)	70,658	$17,523,184	60,480	$17,176,320	52,999	$19,291,636	47,143	$15,651,476
Undistributed: Asbestos, barite, beryllium concentrate (1949–51), cement, feldspar, gem stones, lithium (1951), mercury (1951), pumice (1949, 1951–52), quartz, vanadium, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		958,882		3,374,993		[6] 3,577,171		5,388,080
Total		181,070,000		207,379,000		243,856,000		231,669,000
Total mineral fuels		24,000		27,000		30,000		33,000
Total Arizona		181,094,000		207,406,000		243,886,000		231,702,000

ARKANSAS

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Barite (crude)	363,382	$2,907,056	343,168	$3,088,512	407,085	$3,765,536	428,522	[6] $3,963,828
Bauxite ... long tons, dried equivalent	1,094,924	6,433,964	1,307,335	7,531,535	1,815,274	12,259,742	1,603,833	10,235,254
Clays (except for cement)	433,909	1,067,033	460,826	996,253	483,059	1,198,458	546,334	1,507,692
Gem stones and industrial diamonds ... carats	[7] 246	[7] 1,000						
Iron ore (usable) ... long tons, gross weight			1,444	(3)	1,343	(3)	115	(3)
Lead (recoverable content of ores, etc.)	1	316	9	2,430	33	11,418	4	1,288
Manganese ore (35 percent or more Mn) ... gross weight	2,851	(3)	1,224	(3)	3,718	(3)	2,246	(3)
Manganiferous ore (5 to 35 percent Mn) ... do	5,555	(3)	6,359	(3)	1,429	(3)	896	(3)
Sand and gravel	2,507,244	2,128,474	4,118,080	3,446,578	3,868,940	3,569,114	5,011,095	4,977,219
Slate	(3)	(3)	(3)	(3)	27,080	174,329	(3)	(3)
Stone (except limestone for cement and lime)	[8] 1,279,250	[8] 2,247,236	3,952,720	7,419,110	2,535,746	3,216,426	[8] 2,967,479	[8] 3,346,201
Zinc (recoverable content of ores, etc.)	1	248	8	2,272	50	18,200	26	8,632
Undistributed: Abrasive stones, cement, gypsum, lime, sand and gravel (1949), stone (unclassified 1949, dimension miscellaneous 1952), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		5,359,172		3,936,998		4,254,895		4,641,801
Total		20,145,000		26,424,000		28,468,000		28,682,000
Total mineral fuels		89,378,000		92,218,000		90,226,000		87,653,000
Total Arkansas		109,523,000		118,642,000		118,694,000		116,335,000

CALIFORNIA

Antimony ore and concentrate ... gross weight	-----	-----	-----	-----	-----	-----	9	(3)
Boron minerals	467, 592	$11, 511, 893	647, 735	$15, 890, 000	862, 797	$20, 030, 000	583, 828	$14, 105, 000
Calcium-magnesium chloride ... 75-percent (Ca, Mg) Cl_2 basis	11, 166	204, 024	(3)	(3)	(3)	(3)	(3)	(3)
Cement ... 376-pound barrels	23, 201, 982	57, 464, 213	26, 685, 004	65, 258, 675	28, 956, 470	77, 753, 697	29, 786, 245	79, 457, 745
Chromite ... gross weight	433	11, 662	404	(3)	6, 302	[5] 447, 769	14, 713	[6] 1, 269, 000
Clays (including fuller's earth) [9]	1, 391, 088	2, 744, 069	1, 454, 846	2, 904, 750	1, 615, 241	3, 757, 325	1, 886, 649	3, 993, 052
Copper (recoverable content of ores, etc.)	649	255, 706	646	268, 736	921	445, 764	800	387, 200
Gem stones (estimated)	(10)	(3)	(10)	(3)	(10)	(3)	(10)	100, 000
Gold (recoverable content of ores, etc.) ... troy ounces	417, 231	14, 603, 085	412, 118	14, 424, 130	339, 732	11, 890, 620	258, 176	9, 036, 160
Gypsum (crude)	753, 581	1, 852, 452	962, 373	2, 462, 604	1, 092, 883	2, 602, 758	1, 236, 430	2, 721, 134
Iron ore (usable) ... long tons, gross weight	584, 109	(3)	849, 489	(3)	1, 182, 799	(3)	1, 463, 239	(3)
Lead (recoverable content of ores, etc.)	10, 318	3, 260, 488	15, 831	4, 274, 370	13, 967	4, 832, 582	11, 199	3, 606, 078
Lime (open-market)	153, 483	2, 516, 262	171, 440	2, 722, 835	203, 344	3, 366, 959	238, 957	3, 752, 738
Magnesium compounds from sea water and bitterns (partly estimated) MgO equivalent	27, 600	1, 770, 000	43, 300	2, 730, 000	53, 900	3, 564, 500	50, 204	3, 529, 362
Manganese ore (35 percent or more Mn) ... gross weight	280	(3)	37	(3)	-----	-----	8, 081	(3)
Manganiferous ore (5 to 35 percent Mn) ... do	386	(3)	640	5, 766	-----	-----	56	(3)
Mercury ... 76-pound flasks	4, 493	357, 014	3, 850	312, 851	4, 282	899, 777	7, 241	1, 441, 683
Perlite (crude)	4, 043	27, 158	(3)	(3)	(3)	(3)	(3)	(3)
Pumice and pumicite	149, 878	799, 602	157, 497	970, 826	264, 411	1, 228, 569	129, 780	793, 716
Salt (common)	964, 807	4, 110, 271	868, 496	3, 816, 655	1, 275, 574	5, 261, 780	1, 148, 693	4, 880, 392
Sand and gravel	36, 279, 816	30, 198, 924	41, 894, 039	35, 547, 558	46, 927, 452	41, 279, 835	53, 051, 260	43, 633, 125
Silver (recoverable content of ores, etc.) ... troy ounces	783, 880	709, 451	1, 071, 917	970, 139	1, 145, 219	1, 036, 481	1, 099, 658	995, 246
Sodium carbonate (natural)	200, 496	4, 163, 714	(3)	(3)	(3)	(3)	(3)	(3)
Stone (except limestone for cement and lime)	11, 373, 700	12, 594, 048	11, 764, 630	13, 998, 432	12, 537, 344	14, 714, 524	14, 374, 930	17, 697, 085
Sulfur ore for direct agricultural use ... long tons	1, 302	26, 444	1, 463	27, 797	(3)	(3)	(3)	(3)
Talc, pyrophyllite, and soapstone, (ground)	83, 359	1, 434, 046	109, 747	2, 069, 211	126, 784	2, 269, 771	120, 574	2, 868, 255
Tungsten concentrate ... 60-percent WO_3 basis	952	(3)	2, 025	3, 392, 244	3, 007	11, 557, 325	2, 980	11, 360, 569
Zinc (recoverable content of ores, etc.)	7, 209	1, 787, 832	7, 551	2, 144, 484	9, 602	3, 495, 128	9, 419	3, 127, 108
Undistributed: Abrasive stones (1949), asbestos (1949–51), barite, bromine, diatomite, feldspar, iodine, lithium minerals, magnesite, mica (1952), molybdenum, platinum-group metals (crude), potassium salts, pyrites, quartz, ground sand and sandstone, slate, sodium sulfate, titanium concentrate (1949), wollastonite (1952), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	-----	18, 794, 011	-----	27, 489, 446	-----	36, 875, 670	-----	35, 753, 673
Total	-----	171, 197, 000	-----	201, 682, 000	-----	[5] 247, 311, 000	-----	244, 508, 000
Total mineral fuels	-----	904, 415, 000	-----	854, 365, 000	-----	962, 070, 000	-----	969, 777, 000
Total California	-----	1, 075, 612, 000	-----	1, 056, 047, 000	-----	[5] 1,209,381,000	-----	1, 214, 285, 000

For footnotes, see end of table.

342070—55——5

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

COLORADO

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Beryllium concentrate ---- gross weight	144	$43,200	97	$30,500	97	$32,339	54	$24,588
Clays (except for cement)	254,691	499,294	310,130	618,814	443,403	958,115	413,386	931,810
Copper (recoverable content of ores, etc.)	2,403	946,782	3,141	1,306,656	3,212	1,554,608	3,606	1,745,304
Feldspar (crude) ---- long tons	60,966	341,049	59,457	329,120	50,451	283,153	38,268	224,385
Fluorspar	22,324	763,296	18,489	654,089	20,661	820,322	29,185	1,505,968
Gold (recoverable content of ores, etc.) ---- troy ounces	102,618	3,591,630	130,390	4,563,650	116,503	4,077,605	124,594	4,360,790
Gypsum (crude)	(3)	(3)	62,150	183,976	(3)	(3)	(3)	(3)
Lead (recoverable content of ores, etc.)	26,853	8,485,548	27,007	7,291,890	30,336	10,496,256	30,066	9,681,252
Manganiferous ore (5 to 35 percent Mn) ---- gross weight							76	(3)
Mica (scrap)	4,168	60,072	1,467	27,068	1,882	32,901	(3)	(3)
Molybdenum (content of ore and concentrate) ---- pounds	10,482,600	(3)	24,090,200	(3)	22,911,949	(3)	24,557,149	(3)
Perlite (crude)	12,729	89,105	13,691	95,842	(3)	(3)	(3)	(3)
Pyrites ---- long tons	13,877	50,498	(3)	(3)	(3)	(3)	(3)	(3)
Sand and gravel	4,751,431	2,964,588	5,154,287	3,940,439	6,916,631	4,452,489	8,461,039	6,268,367
Silver (recoverable content of ores, etc.) ---- troy ounces	2,894,886	2,620,018	3,492,278	3,160,688	2,787,882	2,523,174	2,813,643	2,546,489
Stone (except limestone for cement and lime)	[8] 1,816,790	[8] 2,803,538	[8] 1,679,960	[8] 2,776,331	1,470,123	2,334,376	1,708,872	2,566,401
Tin (content of ore and concentrate) ---- long tons	17	37,410	15	31,165	18	54,033	13	33,723
Tungsten concentrate ---- 60-percent WO_3 basis	222	(3)	196	302,248	336	1,092,780	625	2,354,664
Zinc (recoverable content of ores, etc.)	47,703	11,830,344	45,776	13,000,384	55,714	20,279,896	53,203	17,663,396
Undistributed: Cement, columbium-tantalum concentrate, gem stones, lime (1949), pumice and pumicite (1950–52), stone (dimension, unclassified 1949–50), sulfur ore (1949–50), vanadium, vermiculite (1949–50), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		19,647,411		34,159,514		36,856,248		37,680,235
Total		54,774,000		72,472,000		85,848,000		87,588,000
Total mineral fuels		85,099,000		82,426,000		93,587,000		100,001,000
Total Colorado		139,873,000		154,898,000		179,435,000		187,589,000

CONNECTICUT

Clays	289,090	$216,829	292,367	$236,317	275,900	$252,725	157,500	$157,500
Feldspar (crude) long tons	12,659	95,044	13,580	101,851	13,811	107,083	10,929	87,432
Quartz from pegmatites and quartzite	16,225	97,350	27,560	166,810	29,273	175,638	(3)	(3)
Sand and gravel	2,648,343	1,587,446	2,998,424	1,861,741	[5] 2,321,715	[5] 1,708,910	2,581,247	1,933,214
Stone (except limestone for lime)	1,695,650	2,460,547	[8] 1,860,700	[8] 2,789,532	2,278,466	3,360,378	2,837,045	4,101,060
Undistributed: Nonmetallic minerals, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		396,810		483,981		608,407		783,691
Total		4,854,000		5,640,000		[5] 6,213,000		7,063,000
Total mineral fuels		33,000		35,000		34,000		62,000
Total Connecticut		4,887,000		5,675,000		[5] 6,247,000		7,125,000

DELAWARE

Clays	33,212	$46,293	41,000	$40,375	35,950	$35,450	(3)	(3)
Sand and gravel	233,977	196,451	367,524	291,715	[5] 454,563	[5] 303,643	515,399	$382,484
Stone	37,240	92,100	77,050	190,113	99,201	245,002	94,911	251,759
Undistributed: Nonmetallic minerals, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)								42,805
Total Delaware		335,000		522,000		[5] 584,000		677,000

FLORIDA

Clays (including fuller's earth) [9]	95,516	$1,446,544	126,852	$1,954,641	132,563	$2,288,855	112,113	$1,985,587
Phosphate rock long tons	6,815,989	37,857,983	8,085,870	45,377,842	8,496,831	50,262,562	8,781,125	51,541,799
Sand and gravel	2,243,898	1,879,733	2,793,865	2,806,431	4,418,573	4,300,682	4,154,613	3,848,077
Stone (except limestone for cement and lime)	4,215,090	4,748,253	5,313,400	6,885,394	8,032,966	9,419,682	7,836,634	9,577,541
Undistributed: Cement, abrasive garnet (1951–52), lime, calcareous marl (1949), titanium concentrate, and zirconium concentrate		8,324,380		9,720,532		11,013,358		12,126,587
Total		54,257,000		66,745,000		77,285,000		79,080,000
Total mineral fuels		761,000		972,000		1,263,000		1,255,000
Total Florida		55,018,000		67,717,000		78,548,000		80,335,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

GEORGIA

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Barite (crude)	50, 267	$465, 325	(3)	(3)	(3)	(3)	(3)	(3)
Clays (including fuller's earth) [9]	1, 983, 001	16, 653, 426	2, 325, 292	$20, 937, 991	2, 528, 599	$23, 090, 280	2, 490, 167	$23, 033, 977
Gold (recoverable content of ores, etc.) troy ounces	18	630			3	105		
Iron ore (usable) long tons, gross weight	228, 689	692, 649	202, 427	677, 248	357, 754	1, 339, 248	319, 959	1, 439, 251
Lime (open-market)	7, 028	67, 252	11, 998	121, 556	10, 616	104, 626	7, 854	87, 587
Mica (sheet) pounds	(3)	(3)	(3)	(3)	(3)	(3)	13, 010	18, 852
Sand and gravel	[11] 984, 488	[11] 757, 680	[11] 1, 211, 782	[11] 936, 726	1, 226, 231	1, 041, 561	2, 133, 970	2, 029, 367
Sand and sandstone (ground)	771	7, 712	1, 176	11, 760	1, 874	18, 740	1, 765	17, 650
Stone (except limestone for cement and lime)	[8] 4, 156, 226	[8] 8, 427, 627	[8] 6, 144, 980	[8] 11, 917, 482	[5] 5, 234, 131	[5] 14, 813, 413	7, 141, 923	18, 114, 604
Talc and soapstone (ground)	49, 338	580, 405	70, 749	774, 148	77, 895	823, 133	56, 491	653, 144
Undistributed: Asbestos, bauxite, beryllium concentrate (1952), cement, feldspar (1949–51) kyanite (1949), scrap mica, sand and gravel (noncommercial, 1949–50), slate, stone (marble and dimension unclassified, 1949–50), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		7, 700, 505		8, 639, 256		6, 277, 955		6, 805, 259
Total		35, 353, 000		44, 016, 000		[5] 47, 509, 000		52, 200, 000
Total mineral fuels		155, 000		141, 000		46, 000		198, 000
Total Georgia		35, 508, 000		44, 157, 000		[5] 47, 555, 000		52, 398, 000

IDAHO

Mineral	1949 Short tons	1949 Value	1950 Short tons	1950 Value	1951 Short tons	1951 Value	1952 Short tons	1952 Value
Antimony ore and concentrate gross weight	4, 838	$1, 053, 177	6, 868	(3)	8, 805	(3)	4, 173	(3)
Clays (except for cement)	24, 850	30, 780	25, 858	$30, 811	28, 281	$42, 545	23, 533	$24, 683
Cobalt (content of ore) pounds							196, 516	(3)
Copper (recoverable content of ores, etc.)	1, 438	566, 572	2, 107	876, 512	2, 160	1, 045, 440	3, 213	1, 555, 092
Gold (recoverable content of ores, etc.) troy ounces	77, 829	2, 724, 015	79, 652	2, 787, 820	45, 064	1, 577, 240	32, 997	1, 154, 895
Gypsum (crude)					65	293	400	1, 200
Lead (recoverable content of ores, etc.)	79, 299	25, 058, 484	100, 025	27, 006, 750	76, 713	26, 542, 698	73, 719	23, 737, 518
Mercury 76-pound flasks					357	75, 016	887	176, 602
Mica:								
Scrap							170	5, 100
Sheet pounds							20, 020	115, 572
Phosphate rock long tons	(3)	(3)	(3)	(3)	694, 446	1, 748, 074	(3)	(3)

Pumice and pumicite	71, 373	105, 360	93, 990	121, 044	83, 528	133, 192	88, 085	141, 253
Sand and gravel	3, 271, 362	2, 286, 609	4, 281, 908	3, 043, 905	4, 057, 391	2, 971, 264	3, 925, 863	2, 745, 201
Sand and sandstone (ground)			3, 700	29, 600	11, 968	107, 738	9, 500	80, 000
Silver (recoverable content of ores, etc.) troy ounces	10, 049, 257	9, 095, 085	16, 095, 019	14, 566, 805	14, 753, 023	13, 352, 231	14, 923, 165	13, 506, 218
Stone (except limestone for cement)	1, 440, 680	1, 878, 801	[8] 644, 020	[8] 861, 290	1, 457, 182	1, 811, 422	[8] 1, 630, 034	[8] 2, 441, 236
Tungsten concentrate 60-percent WO_3 basis	66	(3)	222	(3)	377	1, 402, 866	333	1, 245, 499
Zinc (recoverable content of ores, etc.)	76, 555	18, 985, 640	87, 890	24, 960, 760	78, 121	28, 436, 044	74, 317	24, 673, 244
Undistributed: Barite, cement, abrasive garnet, fluorospar (1951–52), stone (crushed sandstone and limestone, 1950, crushed limestone, 1952), titanium concentrate (1951), vanadium, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		2, 482, 678		4, 791, 655		3, 548, 945		5, 456, 623
Total		64, 267, 000		79, 077, 000		82, 795, 000		77, 060, 000
Total mineral fuels		25, 000						
Total Idaho		64, 292, 000		79, 077, 000		82, 795, 000		77, 060, 000

ILLINOIS

Cement 376-pound barrels	7, 976, 972	$16, 645, 730	7, 857, 969	$16, 920, 234	8, 377, 387	$19, 853, 132	8, 710, 621	$20, 600, 347
Clays (including fuller's earth) [9]	1, 956, 639	2, 706, 777	2, 302, 330	3, 242, 577	2, 399, 787	3, 836, 617	2, 156, 071	3, 690, 099
Fluorspar	120, 881	4, 621, 733	154, 623	6, 110, 765	204, 328	9, 294, 703	188, 293	9, 481, 223
Lead (recoverable content of ores, etc.)	3, 824	1, 208, 384	2, 729	736, 830	3, 160	1, 093, 360	4, 262	1, 372, 364
Lime (open-market)	276, 161	3, 197, 890	367, 485	4, 465, 413	462, 690	5, 878, 289	460, 775	5, 917, 038
Sand and gravel	17, 128, 144	14, 780, 487	18, 695, 433	16, 531, 797	20, 130, 567	19, 146, 502	19, 584, 308	19, 214, 195
Sand and sandstone (ground)	217, 577	1, 887, 144	263, 122	2, 278, 237	262, 488	2, 300, 102	267, 180	2, 342, 549
Silver (recoverable content of ores, etc.) troy ounces	3, 128	2, 831	2, 001	1, 811	3, 465	3, 136	3, 781	3, 422
Stone (except limestone for cement and lime)	17, 054, 110	20, 682, 162	17, 911, 480	21, 970, 537	19, 298, 968	23, 474, 516	22, 334, 887	28, 326, 060
Zinc (recoverable content of ores, etc.)	18, 157	4, 502, 936	26, 982	7, 662, 888	21, 776	7, 926, 464	18, 816	6, 246, 912
Undistributed: Nonmetallic minerals		175, 000		398, 558		418, 561		411, 940
Total		70, 411, 000		80, 320, 000		93, 225, 000		97, 606, 000
Total mineral fuels		379, 482, 000		407, 824, 000		396, 709, 000		362, 399, 000
Total Illinois		449, 893, 000		488, 144, 000		489, 934, 000		460, 005, 000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

INDIANA

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Clays (except for cement)	1,022,699	$1,197,982	1,159,257	$1,395,662	1,267,159	$1,656,885	1,020,840	$1,389,751
Marl, calcareous (except for cement)	44,026	49,543	20,380	13,977	12,960	18,129	16,414	9,021
Pyrites .... long tons	559	1,873	(3)	(3)	(3)	(3)	(3)	(3)
Sand and gravel	8,887,231	6,695,426	9,723,033	7,516,509	11,030,814	8,763,936	11,546,014	9,279,908
Stone (except limestone for cement and lime)	[8] 6,332,360	[8] 15,227,818	6,994,670	20,686,160	[8] 8,641,670	[8] 23,729,433	9,126,837	21,965,454
Undistributed: Abrasive stones, cement, lime, stone (sandstone, 1949; dimension sandstone, 1951), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		23,950,991		28,101,638		30,966,381		31,074,713
Total		47,123,000		57,714,000		65,135,000		63,719,000
Total mineral fuels		93,902,000		108,918,000		109,253,000		98,206,000
Total Indiana		141,025,000		166,632,000		174,388,000		161,925,000

IOWA

Mineral	1949 Short tons	1949 Value	1950 Short tons	1950 Value	1951 Short tons	1951 Value	1952 Short tons	1952 Value
Cement .... 376-pound barrels	6,655,208	$14,602,554	7,231,807	$16,157,979	8,024,492	$19,800,084	9,336,727	$22,849,597
Clays (except for cement)	571,505	628,674	579,423	645,057	576,955	719,785	519,918	2,332,283
Gypsum (crude)	858,464	2,188,002	981,647	2,507,651	1,127,705	2,881,150	1,122,409	2,797,704
Sand and gravel	7,978,229	4,446,661	8,994,822	4,795,835	9,943,372	5,916,950	10,796,979	6,032,898
Stone (except limestone for cement)	6,831,190	8,663,201	[8] 8,425,490	[8] 10,668,427	9,261,317	12,170,082	9,899,404	13,036,726
Undistributed				2,151				24,750
Total		30,529,000		34,777,000		41,488,000		47,074,000
Total mineral fuels		6,929,000		6,996,000		6,218,000		5,407,000
Total Iowa		37,458,000		41,773,000		47,706,000		52,481,000

KANSAS

Mineral	1949 Short tons	1949 Value	1950 Short tons	1950 Value	1951 Short tons	1951 Value	1952 Short tons	1952 Value
Cement [12] .... 376-pound barrels	7,640,540	$16,880,156	8,759,103	$19,400,068	8,163,916	$19,413,144	8,811,762	$20,956,886
Clays (except for cement)	302,208	260,318	351,756	320,869	373,365	370,326	349,418	473,129
Lead (recoverable content of ores, etc.)	9,772	3,087,952	9,487	2,561,490	8,947	3,095,662	5,916	1,904,952

Salt (common)	832, 442	5, 217, 844	846, 374	5, 914, 514	900, 917	6, 639, 343	911, 744	6, 850, 027
Sand and gravel	6, 186, 719	3, 327, 920	9, 781, 123	6, 782, 285	7, 676, 888	4, 747, 544	8, 380, 065	5, 023, 593
Stone (except limestone for cement)	[8] 5, 978, 420	[8] 7, 951, 490	7, 630, 300	8, 920, 207	7, 191, 483	9, 058, 512	8, 830, 871	12, 051, 740
Zinc (recoverable content of ores, etc.)	29, 433	7, 299, 384	27, 176	7, 717, 984	28, 904	10, 521, 056	25, 482	8, 460, 024
Undistributed: Natural cement, gypsum, pumicite, and stone (dimension sandstone, 1949)	------------	502, 347	------------	603, 624	------------	662, 541	------------	703, 011
Total	------------	44, 528, 000	------------	52, 221, 000	------------	54, 508, 000	------------	56, 423, 000
Total mineral fuels	------------	292, 634, 000	------------	316, 393, 000	------------	345, 579, 000	------------	346, 947, 000
Total Kansas	------------	337, 162, 000	------------	368, 614, 000	------------	400, 087, 000	------------	403, 370, 000
KENTUCKY								
Clays (except for cement)	571, 427	$2, 902, 661	660, 550	$3, 552, 718	816, 585	$5, 210, 630	782, 099	$5, 002, 491
Fluorspar	63, 438	2, 018, 209	80, 137	2, 554, 668	68, 635	2, 334, 485	48, 308	1, 863, 262
Lead (recoverable content of ores, etc.)	187	59, 092	66	17, 820	107	37, 022	60	19, 320
Sand and gravel	2, 375, 906	2, 168, 626	2, 382, 672	2, 262, 964	2, 801, 639	2, 434, 799	3, 334, 261	2, 656, 053
Stone (except limestone for cement)	7, 100, 160	8, 586, 402	[8] 7, 417, 200	[8] 8, 865, 913	7, 048, 771	8, 609, 609	[8] 8, 817, 859	[8] 10, 816, 707
Zinc (recoverable content of ores, etc.)	935	231, 880	731	207, 604	3, 457	1, 258, 348	3, 280	1, 088, 960
Undistributed: Cement and stone (crushed sandstone, 1950, and dimension sandstone, 1952)	------------	2, 982, 571	------------	2, 960, 768	------------	3, 364, 116	------------	3, 704, 433
Total	------------	18, 950, 000	------------	20, 422, 000	------------	23, 249, 000	------------	25, 151, 000
Total mineral fuels	------------	353, 279, 000	------------	439, 534, 000	------------	419, 015, 000	------------	373, 295, 000
Total Kentucky	------------	372, 229, 000	------------	459, 956, 000	------------	442, 264, 000	------------	398, 446, 000
LOUISIANA								
Clays (except for cement)	134, 366	$106, 841	209, 433	$184, 890	152, 906	$152, 906	157, 025	$200, 697
Salt (common)	2, 030, 076	5, 837, 714	2, 278, 811	6, 902, 502	2, 737, 149	7, 662, 179	2, 553, 448	7, 807, 693
Sand and gravel	[11] 5, 050, 148	[11] 6, 107, 311	5, 505, 362	6, 310, 425	6, 384, 328	7, 419, 570	6, 005, 119	6, 736, 524
Sulfur (Frasch-process) long tons	1, 111, 115	20, 000, 000	1, 256, 026	23, 700, 000	1, 152, 821	25, 400, 000	1, 449, 668	32, 015, 000
Undistributed: Cement, gypsum (1950–52), noncommercial sand and gravel (1949), and stone (except limestone for cement, 1949–50, 1952)	------------	5, 173, 868	------------	5, 365, 814	------------	6, 644, 231	------------	10, 051, 053
Total	------------	37, 226, 000	------------	42, 464, 000	------------	47, 279, 000	------------	56, 811, 000
Total mineral fuels	------------	594, 587, 000	------------	651, 143, 000	------------	740, 399, 000	------------	791, 448, 000
Total Louisiana	------------	631, 813, 000	------------	693, 607, 000	------------	787, 678, 000	------------	848, 259, 000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

MAINE

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Cement ... 376-pound barrels	1,057,413	$2,526,182	1,127,220	$2,705,034	1,236,299	$3,182,918	1,457,250	$3,750,483
Clays (except for cement)	27,918	24,568	31,917	26,561	21,885	21,885	26,050	26,050
Feldspar (crude) ... long tons	18,286	130,275	17,487	124,821	19,273	154,695	18,644	147,371
Mica, scrap	45	1,087	23	592	(3)	(3)	(3)	(3)
Sand and gravel	4,605,172	1,393,676	4,897,143	1,726,217	5,366,694	1,817,317	7,078,078	2,187,531
Stone (except limestone for cement and lime)	258,810	2,025,870	[8] 309,740	[8] 2,214,164	644,594	2,582,541	[8] 316,874	[8] 1,795,768
Undistributed: Beryllium concentrate, columbium-tantalum concentrate (1951), gem stones (1949–51), lime, lithium minerals (1950), mica (sheet, 1950–52), quartz from pegmatites or quartzite (1950–52), slate, stone (crushed sandstone, 1950, and crushed limestone 1952), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	------	561,208	------	601,873	------	[5] 720,095	------	1,015,827
Total	------	6,663,000	------	7,399,000	------	8,479,000	------	8,923,000
Total mineral fuels	------	79,000	------	62,000	------	37,000	------	58,000
Total Maine	------	6,742,000	------	7,461,000	------	8,516,000	------	8,981,000

MARYLAND

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Clays (except for cement)	586,453	$922,822	675,749	$1,158,031	697,528	$1,354,883	709,248	$1,363,882
Gold (recoverable content of ores, etc.) ... troy ounces	------	------	20	700	1	35	------	------
Lime (open-market)	64,299	617,696	64,687	691,843	67,684	722,011	72,885	746,893
Sand and gravel	[11] 4,776,815	[11] 6,028,791	5,864,472	7,789,764	7,054,488	8,170,851	6,956,640	8,136,697
Stone (except limestone for cement and lime)	[8] 1,789,830	[8] 3,036,410	1,975,690	3,459,605	3,181,434	5,983,380	[8] 3,391,679	[8] 6,330,443
Undistributed: Cement, potassium salts, quartz (1949 and 1952), noncommercial sand and gravel (1949–50), slate, stone (dimension granite, 1949, and dimension limestone and crushed marble, 1952), talc and ground soapstone	------	6,350,471	------	6,416,645	------	[5] 6,451,707	------	7,113,819
Total	------	16,956,000	------	19,516,000	------	[5] 22,683,000	------	23,692,000
Total mineral fuels	------	3,505,000	------	3,209,000	------	3,465,000	------	3,155,000
Total Maryland	------	20,461,000	------	22,725,000	------	[5] 26,148,000	------	26,847,000

MASSACHUSETTS

Clays	156,017	$135,813	155,279	$139,060	150,370	$167,646	140,148	$160,371
Lime (open-market)	107,931	1,360,328	139,357	1,830,625	143,316	1,930,225	132,135	1,999,545
Quartz from pegmatites and quartzite	577	4,265	2,145	23,646	2,186	17,489	(3)	(3)
Sand and gravel	5,504,841	4,379,030	7,111,067	5,430,790	7,232,088	5,592,640	7,645,728	6,128,744
Sand and sandstone (ground)	1,514	9,650	1,829	9,882	(3)	(3)	(3)	(3)
Stone (except limestone for lime)	2,290,940	6,552,935	[8] 3,284,470	[8] 8,484,999	[8] 3,225,839	[8] 9,172,425	[8] 3,355,819	[8] 9,331,871
Undistributed	-----------	-----------	-----------	87,230	-----------	65,761	-----------	93,935
Total	-----------	12,442,000	-----------	16,006,000	-----------	16,946,000	-----------	17,715,000
Total mineral fuels	-----------	7,000	-----------	8,000	-----------	5,000	-----------	4,000
Total Massachusetts	-----------	12,449,000	-----------	16,014,000	-----------	16,951,000	-----------	17,719,000

MICHIGAN

Bromine ... pounds	28,034,765	$7,023,211	(3)	(3)	(3)	(3)	(3)	(3)
Cement ... 376-pound barrels	12,747,791	28,823,055	12,854,423	$29,619,766	14,112,639	$35,121,324	14,760,783	$36,819,042
Clays (except for cement)	368,578	333,249	416,023	380,511	391,134	461,862	436,939	471,938
Copper (recoverable content of ore, etc.)	19,506	7,685,364	25,608	10,652,928	24,979	12,089,836	21,699	10,502,316
Gypsum (crude)	1,264,511	3,470,294	1,474,210	4,090,777	1,566,276	4,402,725	1,487,642	4,200,418
Iron ore (usable) ... long tons, gross weight	10,993,239	55,237,126	12,821,344	72,358,822	13,611,621	81,765,748	11,779,366	76,088,935
Magnesium compounds from well brines (partly estimated) MgO equivalent	23,700	2,719,000	34,000	3,871,000	45,692	5,010,674	(3)	(3)
Manganiferous ore (5 to 35 percent Mn) ... gross weight	-----------	-----------	117,619	(3)	-----------	-----------	22,095	(3)
Marl, calcareous (except for cement)	1,500	1,500	218,429	122,212	178,010	96,639	164,519	86,529
Salt (common)	4,064,106	16,109,117	4,446,667	18,178,765	5,137,639	21,221,330	4,778,347	21,446,382
Sand and gravel	20,475,996	13,992,903	24,556,911	16,699,203	27,540,921	20,976,632	29,193,763	22,400,879
Stone (except limestone for cement and lime)	16,546,670	13,387,334	19,095,540	15,391,366	20,851,733	17,514,720	17,973,685	15,770,816
Undistributed: Calcium-magnesium chloride, lime, potassium salts, ground sand and sandstone (1951–52), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	-----------	4,383,892	-----------	13,909,808	-----------	19,258,326	-----------	29,663,153
Total	-----------	153,166,000	-----------	185,275,000	-----------	217,920,000	-----------	217,450,000
Total mineral fuels	-----------	48,094,000	-----------	44,667,000	-----------	40,017,000	-----------	37,082,000
Total Michigan	-----------	201,260,000	-----------	229,942,000	-----------	257,937,000	-----------	254,532,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

MINNESOTA

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Clays	133, 565	$153, 446	129, 220	$151, 074	129, 942	$187, 605	113, 492	$160, 408
Gem stones (estimated)	(10)	5, 000						
Iron ore (usable) long tons, gross weight	55, 943, 714	239, 858, 902	64, 538, 759	311, 716, 341	78, 164, 527	411, 468, 895	63, 906, 069	375, 765, 251
Manganiferous ore (5 to 35 percent Mn) gross weight	990, 202	(3)	869, 838	(3)	1, 132, 250	(3)	912, 118	(3)
Marl, calcareous (except for cement)	8, 840	7, 244	19, 375	7, 600	2, 925	1, 549	1, 449	722
Sand and gravel	12, 935, 392	4, 903, 908	15, 472, 815	5, 903, 025	17, 229, 526	6, 008, 994	19, 825, 157	6, 808, 763
Stone (except limestone for cement and lime)	1, 878, 910	5, 278, 716	[8] 1, 953, 450	[8] 5, 334, 028	[8] 1, 906, 407	[8] 5, 613, 157	[8] 2, 394, 178	[8] 5, 498, 177
Undistributed: Abrasive stones, cement, lime, stone (crushed sandstone, 1950–51, and crushed basalt, 1952), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		7, 278, 961		8, 442, 083		9, 815, 600		9, 207, 947
Total		257, 486, 000		331, 554, 000		433, 096, 000		397, 441, 000
Total mineral fuels		54, 000		13, 000				
Total Minnesota		257, 540, 000		331, 567, 000		433, 096, 000		397, 441, 000

MISSISSIPPI

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Clays (including fuller's earth) [9]	508, 425	$1, 653, 473	561, 951	$2, 184, 429	673, 062	$4, 250, 237	504, 799	$2, 677, 263
Sand and gravel	[11] 1, 942, 941	[11] 1, 330, 413	2, 764, 444	1, 985, 908	3, 012, 152	2, 279, 034	2, 296, 577	1, 833, 306
Stone	(3)	(3)	100, 000	115, 000	171, 131	168, 933	90, 000	103, 500
Undistributed		292, 186						2, 287, 612
Total		3, 276, 000		4, 285, 000		6, 698, 000		6, 902, 000
Total mineral fuels		100, 435, 000		98, 660, 000		96, 332, 000		94, 973, 000
Total Mississippi		103, 711, 000		102, 945, 000		103, 030, 000		101, 875, 000

MISSOURI

Barite (crude)	186,891	$1,497,985	212,736	$1,924,520	281,895	$2,697,200	304,080	$2,919,795
Cement — 376-pound barrels	8,518,636	19,347,814	9,779,657	22,751,226	10,217,421	25,760,473	10,086,850	25,523,038
Clays (except for cement)	1,468,516	3,962,674	1,532,685	4,329,456	1,904,015	10,098,711	2,159,010	11,226,794
Copper (recoverable content of ores, etc.)	3,670	1,445,980	2,982	1,240,512	2,422	1,172,248	2,576	1,246,784
Iron ore (usable) — long tons, gross weight	144,549	[3]	194,138	[3]	172,466	[3]	268,218	[3]
Lead (recoverable content of ores, etc.)	127,522	40,296,952	134,626	36,349,020	123,702	42,800,892	129,245	41,616,890
Lime (open-market)	878,561	8,035,117	1,035,176	9,447,669	1,122,299	11,285,877	1,130,970	11,326,941
Sand and gravel	5,193,672	4,346,681	6,232,411	5,267,939	6,809,857	5,969,849	6,790,422	6,122,195
Silver (recoverable content of ores, etc.) — troy ounces	123,413	111,695	236,273	213,839	184,424	166,913	517,432	468,302
Stone (except limestone for cement and lime)	9,562,720	13,969,008	10,300,400	14,406,627	11,294,227	15,255,427	15,106,544	20,676,958
Tripoli	15,888	505,851	[3]	[3]	[3]	[3]	[3]	[3]
Tungsten concentrate — 60-percent WO_3 basis	2	[3]	[4]	[3]	----------	----------	----------	----------
Zinc (recoverable content of ores, etc.)	5,911	1,465,928	8,189	2,325,676	11,476	4,177,264	13,986	4,643,352
Undistributed: Ground sand and sandstone, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	----------	1,204,543	----------	2,415,964	----------	2,326,981	----------	3,053,839
Total	----------	96,190,000	----------	100,672,000	----------	121,712,000	----------	128,825,000
Total mineral fuels	----------	15,103,000	----------	12,519,000	----------	13,537,000	----------	12,152,000
Total Missouri	----------	111,293,000	----------	113,191,000	----------	135,249,000	----------	140,977,000

MONTANA

Antimony ore and concentrate — gross weight	----------	----------	----------	----------	29	[3]	----------	----------
Clays	53,914	$124,314	37,617	$37,617	39,231	$41,631	51,304	$73,601
Copper (recoverable content of ores, etc.)	56,611	22,304,734	54,478	22,662,848	57,406	27,784,504	61,948	29,982,832
Fluorspar	422	[3]	41	[3]	----------	----------	16,160	[3]
Gold (recoverable content of ores, etc.) — troy ounces	52,724	1,845,340	51,764	1,811,740	30,502	1,067,570	24,161	845,635
Lead (recoverable content of ores, etc.)	17,996	5,686,736	19,617	5,296,590	21,302	7,370,492	21,279	6,851,838
Manganese ore (35 percent or more Mn) — gross weight	122,382	5,068,425	131,201	[3]	100,562	[3]	100,070	[3]
Manganiferous ore (5 to 35 percent Mn) — do	5,517	[3]	6,810	[3]	7,598	[3]	9,357	[3]
Phosphate rock — long tons	355,169	2,574,330	210,165	1,496,537	304,507	2,353,381	332,299	2,620,764
Sand and gravel	6,682,144	3,365,472	9,044,125	5,140,207	9,582,843	6,201,888	6,765,955	3,579,932
Silver (recoverable content of ores, etc.) — troy ounces	6,327,025	5,726,277	6,590,747	5,964,959	6,393,768	5,786,683	6,138,185	5,555,367
Stone (except limestone for cement and lime)	[8] 602,890	[8] 563,465	919,090	949,545	871,508	986,327	[8] 690,081	[8] 792,897
Tungsten concentrate — 60-percent WO_3 basis	9	[3]	----------	----------	1	2,832	----------	----------
Zinc (recoverable content of ores, etc.)	54,195	13,440,360	67,678	19,220,552	85,551	31,140,564	82,185	27,285,420
Undistributed: Barite (1951–52), cement, gem stones (1949–51), gypsum, lime, pumice and pumicite (1950–51) pyrites, sodium sulfate (1951) stone (basalt and unclassified, 1949, and dimension granite, 1952), talc, vermiculite, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	----------	4,936,368	----------	11,640,301	----------	12,261,998	----------	14,074,692
Total	----------	65,636,000	----------	74,221,000	----------	94,998,000	----------	91,663,000
Total mineral fuels	----------	32,434,000	----------	29,168,000	----------	31,168,000	----------	29,737,000
Total Montana	----------	98,070,000	----------	103,389,000	----------	126,166,000	----------	121,400,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

NEBRASKA

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Clays (except for cement)	86,593	$85,347	100,299	$109,294	86,186	$86,686	90,245	$90,720
Pumice and pumicite	4,622	40,000	(3)	(3)	(3)	(3)	(3)	(3)
Sand and gravel	5,114,766	2,911,734	5,077,792	3,167,659	4,969,243	3,477,409	5,436,540	3,874,106
Stone (except limestone for cement)	[8] 504,870	[8] 840,758	[8] 736,660	[8] 1,042,035	942,967	1,437,899	1,245,106	1,946,448
Undistributed: Cement, stone (sandstone, 1949–50), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		5,493,674		6,400,618		6,676,419		6,941,871
Total		9,372,000		10,720,000		11,678,000		12,853,000
Total mineral fuels		730,000		3,302,000		6,791,000		7,744,000
Total Nebraska		10,102,000		14,022,000		18,469,000		20,597,000

NEVADA

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Antimony ore and concentrate ...gross weight	280	$76,964	20	(3)	156	(3)	152	(3)
Barite (crude)	70,576	416,416	47,608	$268,874	63,201	$387,026	68,062	$391,242
Clays (including fuller's earth)	(3)	(3)	(3)	(3)	3,220	33,420	3,958	36,278
Copper (recoverable content of ores, etc.)	38,058	14,994,852	52,569	21,868,704	56,474	27,333,416	57,537	27,847,908
Fluorspar	5,847	(3)	7,577	(3)	(3)	(3)	(3)	(3)
Gold (recoverable content of ores, etc) ...troy ounces	130,399	4,563,965	178,447	6,245,645	121,036	4,236,260	117,203	4,102,105
Gypsum (crude)	495,229	1,347,666	604,604	1,614,107	643,637	1,811,757	608,284	1,666,938
Iron ore (usable) ...long tons, gross weight	3,094	(3)	5,465	(3)	299,010	898,306	911,657	3,991,970
Lead (recoverable content of ores, etc.)	10,626	3,357,816	9,408	2,540,160	7,148	2,473,208	6,790	2,186,380
Manganese ore (35 percent or more Mn) ...gross weight	----	----	----	----	328	(3)	695	(3)
Manganiferous ore (5 to 35 percent Mn) ...do	4,964	52,990	8,942	102,348	1,250	(3)	7,947	(3)
Mercury ...76-pound flasks	4,170	331,348	680	55,257	1,400	294,182	3,523	701,429
Sand and gravel	1,346,608	1,212,166	2,617,052	2,253,258	2,616,629	2,657,654	2,098,211	2,380,419
Silver (recoverable content of ores, etc.) ...troy ounces	1,800,209	1,629,280	1,537,217	1,391,259	981,669	888,460	941,195	851,829
Stone (except limestone for lime)	518,510	668,960	[8] 274,460	[8] 269,478	834,807	959,815	830,712	1,158,608
Sulfur ore for direct agricultural use ...long tons	860	15,050	867	15,173	(3)	(3)	(3)	(3)
Talc and soapstone (ground)	8,837	147,148	8,581	170,736	6,919	152,878	7,580	180,328
Tungsten concentrate ...60-percent WO_3 basis	740	(3)	1,123	(3)	1,482	4,780,237	2,329	8,820,598
Zinc (recoverable content of ores, etc.)	20,443	5,069,864	21,606	6,136,104	17,443	6,349,252	15,357	5,098,524
Undistributed: Andalusite (1949), brucite, diatomite, dumortierite (1949), gem stones (1949 and 1952), lime, magnesite, calcareous marl, molybdenum, perlite, pumice and pumicite, salt, stone (crushed limestone, 1950), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		3,487,138		5,567,815		[5] 4,418,333		4,816,659
Total Nevada		37,372,000		48,499,000		[5] 57,674,000		64,231,000

NEW HAMPSHIRE

Beryllium concentrate	(3)	(3)	106	$40,310	50	$16,670	(3)	(3)
Clays	26,392	$19,795	22,719	17,115	28,501	28,501	30,135	$30,135
Sand and gravel	[13] 2,000,842	[13] 236,895	[13] 1,713,284	[13] 226,424	2,260,410	517,927	3,200,232	1,001,591
Stone	6,910	381,141	15,760	[8] 383,667	[8] 62,355	[8] 349,606	69,850	546,177
Undistributed: Abrasive stones, feldspar, mica, sand and gravel (commercial, 1949-50), stone (crushed unclassified, 1950, and crushed granite, 1951), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	----------	751,699	----------	1,043,718	----------	382,691	----------	362,214
Total New Hampshire	----------	1,390,000	----------	1,711,000	----------	1,295,000	----------	1,941,000

NEW JERSEY

Clays	537,480	$1,314,186	602,369	$1,277,860	683,439	$2,106,628	598,775	$1,962,599
Iron ore (usable) long tons, gross weight	448,489	4,468,575	588,199	5,651,563	657,930	7,810,776	685,466	6,760,467
Manganiferous residuum gross weight	158,902	(3)	183,842	(3)	267,751	(3)	215,255	(3)
Marl (greensand)	6,128	276,564	3,935	304,321	5,067	263,944	4,600	177,847
Sand and gravel	[11] 5,555,121	[11] 6,981,862	[11] 7,620,422	[11] 8,636,141	6,652,383	9,106,052	7,060,074	9,473,428
Sand and sandstone (ground)	107,946	755,215	131,744	936,817	144,098	1,053,991	138,434	1,011,844
Stone (except limestone for lime)	4,070,790	7,896,619	[8] 4,672,050	[8] 9,119,251	6,457,248	10,987,705	6,102,324	12,307,480
Zinc (recoverable content of ores, etc.) [14]	50,984	14,443,062	55,029	17,258,637	62,917	24,279,745	59,190	21,520,612
Undistributed: Lime, magnesium compounds, noncommercial sand and gravel (1949-50), stone (unclassified, 1950), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	----------	2,266,802	----------	3,020,515	----------	3,200,574	----------	3,902,859
Total	----------	38,403,000	----------	46,205,000	----------	58,809,000	----------	57,117,000
Total mineral fuels	----------	181,000	----------	186,000	----------	214,000	----------	192,000
Total New Jersey	----------	38,584,000	----------	46,391,000	----------	59,023,000	----------	57,309,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

NEW MEXICO

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Beryllium concentrate ..... gross weight	8	(3)	(3)	(3)	141	$47,008	101	$29,185
Clays	97,751	$69,002	63,337	$77,582	75,653	148,876	57,668	107,633
Copper (recoverable content of ores, etc.)	55,388	21,822,872	66,300	27,580,800	73,558	35,602,072	76,112	36,838,208
Fluorspar	12,844	446,086	20,036	742,408	24,402	1,163,098	16,443	823,320
Gold (recoverable content of ores, etc.) ..... troy ounces	3,249	113,715	3,414	119,490	3,959	138,565	2,949	103,215
Iron ore (usable) ..... long tons, gross weight	-----------	-----------	14,284	(3)	32,210	(3)	7,793	(3)
Lead (recoverable content of ores, etc.)	4,652	1,470,032	4,150	1,120,500	5,846	2,022,716	7,021	2,260,762
Manganese ore (35 percent or more Mn) ..... gross weight	-----------	-----------	1,320	(3)	226	(3)	2,360	(3)
Manganiferous ore (5 to 35 percent Mn) ..... do	65,511	(3)	74,348	(3)	79,844	(3)	52,934	(3)
Potassium salts ..... K_2O equivalent	932,497	27,950,111	1,072,772	31,944,365	1,217,617	37,209,740	1,411,125	46,385,452
Pumice and pumicite	351,368	1,026,479	351,642	1,109,883	245,564	884,311	217,482	755,139
Sand and gravel	883,223	610,839	937,653	923,270	1,080,256	1,087,857	496,921	499,589
Silver (recoverable content of ores, etc.) ..... troy ounces	380,855	344,693	338,581	306,433	443,267	401,179	479,318	433,807
Stone	138,290	106,135	364,930	243,841	1,022,901	592,179	[8] 317,894	[8] 191,642
Zinc (recoverable content of ores, etc.)	29,346	7,277,808	29,263	8,310,692	45,419	16,532,516	50,975	16,923,700
Undistributed: Barite, gem stones, gypsum (1949), lithium minerals (1950), mica (1950), molybdenum, perlite, salt, stone (crushed miscellaneous, 1952), vanadium (1950–52), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	-----------	900,497	-----------	1,424,492	-----------	1,666,948	-----------	2,031,749
Total	-----------	62,138,000	-----------	73,904,000	-----------	97,497,000	-----------	107,384,000
Total mineral fuels	-----------	136,687,000	-----------	136,390,000	-----------	158,805,000	-----------	181,116,000
Total New Mexico	-----------	198,825,000	-----------	210,294,000	-----------	256,302,000	-----------	288,500,000

NEW YORK

Cement [12] ... 376-pound barrels	12,679,906	$28,483,681	13,271,469	$30,895,295	13,862,522	$34,687,090	14,624,274	$36,679,379
Clays (except for cement)	976,751	769,290	1,153,909	938,740	1,224,229	1,297,635	872,577	945,463
Emery	4,909	60,917	5,949	75,308	11,634	160,212	10,352	141,911
Gypsum (crude)	916,117	2,805,154	1,280,100	3,876,176	1,259,484	4,010,766	1,143,920	3,816,148
Iron ore (usable) ... long tons, gross weight	2,344,518	22,184,757	2,917,257	27,914,818	3,649,531	39,819,368	2,896,531	34,514,879
Lead (recoverable content of ores, etc.)	1,317	416,172	1,484	400,680	1,500	519,000	1,120	360,640
Marl, calcareous (except for cement)	550	3,000	(3)	(3)	(3)	(3)	(3)	(3)
Salt (common)	2,951,750	12,709,819	2,806,927	14,405,362	3,518,715	16,552,890	3,417,443	16,746,462
Sand and gravel	18,543,071	15,116,820	21,778,089	18,075,237	21,008,701	19,285,299	20,270,058	18,287,623
Silver (recoverable content of ores, etc.) ... troy ounces	18,378	16,633	32,628	29,530	47,568	43,051	38,895	35,202
Slate	122,180	1,617,097	151,160	2,054,725	[5] 126,070	[5] 2,000,106	125,930	1,810,865
Stone (except limestone for cement and lime)	13,022,070	18,160,387	13,121,850	19,728,957	15,559,372	24,326,118	16,234,549	25,244,245
Talc	115,636	2,658,774	163,974	4,039,973	152,652	4,170,987	149,837	4,069,771
Wollastonite	500	7,000	800	16,200	(3)	(3)	(3)	(3)
Zinc (recoverable content of ores, etc.)	37,973	9,417,304	38,321	10,883,164	40,051	14,578,564	32,636	10,835,152
Undistributed: Natural cement, feldspar (1949), abrasive garnet, lime, sheet mica (1950), pyrites, titanium concentrate, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	-----------	7,408,070	-----------	6,698,272	-----------	8,542,154	-----------	8,227,647
Total	-----------	121,835,000	-----------	140,032,000	-----------	[5] 169,993,000	-----------	161,716,000
Total mineral fuels	-----------	16,658,000	-----------	16,497,000	-----------	18,797,000	-----------	19,025,000
Total New York	-----------	138,493,000	-----------	156,529,000	-----------	[5] 188,790,000	-----------	180,741,000

NORTH CAROLINA

Abrasive stone: Millstones	(10)	$8,000	(10)	$9,500	(10)	$6,000	(10)	$9,285
Clays	1,181,047	1,335,954	1,437,202	1,766,785	1,462,030	2,177,515	1,357,700	2,080,172
Feldspar (crude) ... long tons	160,916	973,431	183,027	1,107,061	166,361	1,230,404	240,364	2,416,031
Gold (recoverable content of ores, etc.) ... troy ounces	13	455	-----------	-----------	-----------	-----------	-----------	-----------
Mica:								
Scrap	24,801	640,374	48,193	1,281,584	52,550	1,441,886	58,576	1,551,071
Sheet ... pounds	470,072	121,270	483,736	102,179	464,949	127,204	595,331	664,075
Olivine	2,458	(3)	4,063	(3)	(3)	(3)	(3)	(3)
Sand and gravel	5,092,929	3,553,180	8,352,475	5,465,067	7,656,370	4,435,702	8,724,748	5,665,169
Stone	6,225,290	10,077,976	7,711,580	11,894,745	[8] 8,612,967	[8] 13,292,690	[8] 9,647,513	[8] 14,694,698
Talc, pyrophyllite and soapstone (ground)	86,208	1,344,767	116,895	1,855,163	113,950	1,982,927	115,481	1,771,518
Tin (content of ore and concentrate) ... long tons	-----------	-----------	-----------	-----------	1	1,724	4	11,601
Titanium concentrate (ilmenite)	31,714	(3)	25,842	(3)	(3)	(3)	(3)	(3)
Tungsten concentrate ... 60-percent WO_3 basis	770	(3)	1,240	(3)	1,041	(3)	1,254	(3)
Vermiculite	(3)	(3)	2,366	66,627	(3)	(3)	(3)	(3)
Undistributed: Abrasive stones (grinding pebbles and tube-mill liners), asbestos (1950–51), beryllium concentrate (1949 and 1951), columbium-tantalum concentrate (1952), lithium minerals (1951–52, quartz, ground sand and sandstone (1950), stone (dimension marble, 1951–52, and crushed marble, 1952), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	-----------	1,594,981	-----------	2,607,072	-----------	4,777,634	-----------	5,849,314
Total	-----------	19,650,000	-----------	26,156,000	-----------	29,474,000	-----------	34,713,000
Total mineral fuels	-----------	105,000	-----------	182,000	-----------	173,000	-----------	13,000
Total North Carolina	-----------	19,755,000	-----------	26,338,000	-----------	29,647,000	-----------	34,726,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

NORTH DAKOTA

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Clays	(3)	(3)	(3)	(3)	18,250	$35,250	(3)	(3)
Sand and gravel	4,370,521	$1,638,293	4,270,838	$1,660,371	4,573,341	2,140,466	6,557,069	$1,841,216
Stone	(3)	(3)	193,250	135,698	281,219	213,061	67,064	4,968
Undistributed: Nonmetallic minerals, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		149,181		28,800				19,900
Total		1,787,000		1,825,000		2,389,000		1,866,000
Total mineral fuels		7,031,000		7,789,000		7,858,000		10,191,000
Total North Dakota		8,818,000		9,614,000		10,247,000		12,057,000

OHIO

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Cement ... 376-pound barrels	10,157,001	$22,388,726	10,512,004	$24,012,983	11,872,278	$29,498,956	11,377,806	$28,488,500
Clays (except for cement)	4,043,999	7,447,829	4,497,550	8,695,537	5,146,531	13,223,958	5,003,870	13,153,782
Lime (open-market)	1,712,248	20,321,387	2,142,344	26,273,098	2,289,473	29,046,196	2,205,432	28,393,260
Salt (common)	2,195,778	5,134,923	2,515,205	5,491,553	3,112,472	5,848,478	2,827,455	5,991,626
Sand and gravel	14,955,657	14,428,820	15,664,175	16,209,267	19,430,898	21,394,891	20,751,493	23,069,458
Stone (except limestone for cement and lime)	[8] 19,364,230	[8] 27,419,158	20,466,350	28,628,678	[8] 25,190,277	[8] 36,436,081	[8] 24,693,189	[8] 36,197,485
Undistributed: Abrasive stones, bromine (1950–51), calcium-magnesium chloride, gypsum, ground sand and sandstone, and stone (crushed, unclassified, 1949, 1951–52, and dimension, unclassified, 1952)		2,081,719		2,194,910		2,390,845		2,154,151
Total		99,223,000		111,506,000		137,839,000		137,448,000
Total mineral fuels		142,857,000		163,066,000		164,773,000		155,241,000
Total Ohio		242,080,000		274,572,000		302,612,000		292,689,000

342070—55——6

OKLAHOMA

Clays (except for cement)	244,104	$222,256	315,512	$313,360	345,566	$356,207	249,819	$307,189
Lead (recoverable content of ores, etc.)	19,858	6,275,128	20,724	5,595,480	16,575	5,734,950	15,137	4,874,114
Sand and gravel	2,921,157	1,525,415	3,286,834	2,356,853	3,183,251	2,321,653	3,769,663	2,911,845
Stone (except limestone for cement and lime)	4,341,930	4,027,409	5,021,660	4,848,223	6,966,676	6,917,548	[8] 9,636,475	[8] 8,974,334
Zinc (recoverable content of ores, etc.)	44,033	10,920,184	46,739	13,273,876	53,450	19,455,800	54,916	18,232,112
Undistributed: Cement, gypsum, lime, pumice and pumicite (1949–50 and 1952), salt, ground sand and sandstone, and stone (dimension limestone, 1952)		8,198,693		9,061,737		9,635,445		11,988,603
Total		31,169,000		35,450,000		44,422,000		47,288,000
Total mineral fuels		453,095,000		491,645,000		563,064,000		574,063,000
Total Oklahoma		484,264,000		527,095,000		607,486,000		621,351,000

OREGON

Antimony ore and concentrate ... gross weight	54	$2,851						
Chromite ... do					754	$62,972	6,591	$507,981
Clays (except for cement)	109,405	89,931	112,313	$90,906	94,963	105,285	213,711	506,607
Copper (recoverable content of ores, etc.)	20	7,880	19	7,904	11	5,324	1	484
Gold (recoverable content of ores, etc.) ... troy ounces	16,226	567,910	11,058	387,030	7,927	277,445	5,509	192,815
Lead (recoverable content of ores, etc.)	12	3,792	17	4,590	2	692	1	322
Mercury ... 76-pound flasks	1,167	92,730	5	406	1,177	247,323	868	172,819
Perlite (crude)	(3)	(3)	17,397	69,616	(3)	(3)	(3)	(3)
Pumice and pumicite	104,475	273,427	79,653	320,530	47,026	137,136	59,578	201,809
Sand and gravel	7,134,751	7,682,272	8,199,900	8,168,293	10,504,339	9,117,343	12,219,486	8,556,218
Silver (recoverable content of ores, etc.) ... troy ounces	12,195	11,037	13,565	12,277	6,218	5,628	4,037	3,654
Stone (except limestone for cement and lime)	[8] 4,397,390	[8] 6,479,164	[8] 3,836,550	[8] 5,559,010	8,721,799	10,831,483	6,250,849	8,893,368
Tungsten concentrate ... 60-percent WO_3 basis	3	(3)			1	2,795	4	15,960
Zinc (recoverable content of ores, etc.)	6	1,488	21	5,964	3	1,092	1	332
Undistributed: Asbestos (1949–51), cement, diatomite, gem stones, lime (1950–52), quartz, stone (dimension granite, 1949, and dimension and crushed granite, 1950), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		6,582,965		6,856,725		7,579,511		7,584,727
Total		21,795,000		21,483,000		28,374,000		26,637,000
Total mineral fuels		50,000		59,000		28,000		37,000
Total Oregon		21,845,000		21,542,000		28,402,000		26,674,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

PENNSYLVANIA

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Cement ... 376-pound barrels	36,905,254	$84,839,175	39,450,611	$94,604,230	41,560,431	$107,035,506	40,037,761	$103,388,586
Clays (except for cement)	3,154,680	7,527,012	3,300,859	8,478,579	3,992,403	13,663,764	3,528,161	12,308,828
Cobalt (content of ore) ... pounds	673,773	(3)	660,025	(3)	755,631	(3)	639,856	(3)
Gold (recoverable content of ores, etc.) ... troy ounces	1,645	57,575	1,764	61,740	2,179	76,265	1,500	52,500
Iron ore (usable) ... long tons, gross weight	952,762	9,324,197	1,116,338	11,626,216	1,215,033	(3)	992,110	(3)
Lime (open-market)	911,065	10,190,679	1,086,451	12,663,074	1,181,100	14,260,054	1,202,981	13,842,213
Sand and gravel	11,698,939	14,398,577	13,858,154	17,172,215	15,737,464	21,488,540	14,696,106	19,920,003
Silver (recoverable content of ores, etc.) ... troy ounces	10,827	9,799	10,563	9,560	13,575	12,286	9,247	8,369
Slate	228,170	4,578,644	285,120	5,546,014	268,830	5,688,870	214,860	4,487,648
Stone (except limestone for cement and lime)	21,226,480	34,855,664	25,493,230	42,205,691	[8] 27,399,564	[8] 46,668,590	[8] 25,609,812	[8] 44,676,456
Tripoli (rottenstone)	452	• 9,713	(3)	(3)	(3)	(3)	(3)	(3)
Undistributed: Copper, mica, potassium salts (1949), pyrites, ground sand and sandstone, stone (dimension unclassified, 1951, and dimension basalt, 1952), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		2,311,584		2,836,760		[5] 17,672,755		14,558,890
Total		168,103,000		195,204,000		226,567,000		213,243,000
Total mineral fuels		867,867,000		991,008,000		1,062,659,000		932,355,000
Total Pennsylvania		1,035,970,000		1,186,212,000		1,289,226,000		1,145,598,000

RHODE ISLAND

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Sand and gravel	398,487	$378,896	579,528	$580,322	534,785	$576,781	589,451	$557,396
Stone	[8] 74,670	[8] 451,029	239,400	798,186	239,248	651,931	168,993	654,782
Undistributed: Nonmetallic minerals		98,760		46,500		48,945		37,500
Total Rhode Island		929,000		1,425,000		1,278,000		1,250,000

SOUTH CAROLINA

Clays (except for cement)	664,333	$3,795,657	955,072	$4,995,971	902,603	$4,689,609	869,819	$4,597,802
Sand and gravel	[11] 287,108	[11] 145,142	348,060	166,710	320,195	139,258	1,048,099	892,312
Stone	[8] 2,440,540	[8] 3,628,596	[8] 2,557,510	[8] 3,836,056	[8] 2,828,868	[8] 3,690,114	[8] 2,914,839	[8] 3,881,178
Undistributed: Barite, cement, kyanite, sand and gravel (noncommercial, 1949), stone (crushed unclassified, 1949-50, and dimension granite, 1951-52), topaz (1949), and vermiculite		1,456,480		2,394,796		2,767,017		5,159,307
Total South Carolina		9,026,000		11,394,000		11,286,000		14,531,000

SOUTH DAKOTA

Beryllium concentrate ... gross weight	139	$39,772	96	$29,920	138	$46,007	334	$166,251
Clays (except for cement)	151,341	1,529,542	205,585	2,207,827	[5] 254,116	[5] 2,917,952	227,934	2,575,783
Feldspar (crude) ... long tons	32,272	156,548	43,875	249,176	48,559	290,520	40,163	220,954
Gold (recoverable content of ores, etc.) ... troy ounces	464,650	16,262,750	567,996	19,879,860	458,101	16,033,535	482,534	16,888,690
Lead (recoverable content of ores, etc.)	4	1,264			2	692	2	644
Mica:								
Scrap	1,125	31,285	1,902	24,989	2,292	42,714	915	24,148
Sheet ... pounds	8,367	3,388	13,018	1,684			4,308	32,034
Sand and gravel	5,456,742	2,315,430	5,392,247	2,750,847	5,037,384	2,502,340	5,846,140	2,478,314
Silver (recoverable content of ores, etc.) ... troy ounces	109,383	98,997	142,065	128,576	139,590	126,336	132,102	119,559
Stone (except limestone for cement and lime)	[8] 1,023,710	[8] 4,473,432	[8] 1,205,910	[8] 4,860,858	1,263,322	4,660,074	1,671,187	4,806,882
Tungsten concentrate ... 60-percent WO_3 basis							(4)	335
Undistributed: Cement, columbium-tantalum concentrate (1951-52), lime, lithium minerals, and stone (crushed granite, 1949; crushed unclassified, 1950)		1,741,194		2,459,716		2,932,392		3,141,115
Total		26,653,000		32,593,000		[5] 29,553,000		30,455,000
Total mineral fuels		92,000		123,000		99,000		
Total South Dakota		26,745,000		32,716,000		[5] 29,652,000		30,455,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

TENNESSEE

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Barite (crude)	13,376	$137,120	(3)	(3)	(3)	(3)	(3)	(3)
Cement ... 376-pound barrels	5,992,571	12,857,600	6,663,427	$14,682,487	7,162,841	$17,203,080	7,428,604	$17,834,060
Clays (including fuller's earth) [9]	623,774	2,399,337	787,403	3,093,526	820,835	2,956,759	702,393	3,179,297
Fluorspar	----	----	----	----	140	(3)	348	(3)
Gold (recoverable content of ores, etc.) ... troy ounces	171	5,985	160	5,600	108	3,780	241	8,435
Iron ore (usable) ... long tons, gross weight	----	----	----	----	35,908	142,447	(3)	(3)
Lead (recoverable content of ores, etc.)	257	81,212	113	30,510	14	4,844	18	5,796
Lime (open-market)	117,053	1,108,139	98,232	958,325	108,970	1,097,874	100,189	1,005,235
Manganese ore (35 percent or more Mn) ... gross weight	175	(3)	133	(3)	----	----	126	(3)
Phosphate rock ... long tons	1,342,252	9,065,588	1,384,473	10,028,404	1,419,892	10,604,638	1,452,508	10,874,760
Sand and gravel	4,056,398	4,054,463	4,152,684	4,411,105	4,645,041	5,186,617	5,173,401	5,303,321
Silver (recoverable content of ores, etc.) ... troy ounces	41,833	37,861	39,958	36,164	24,960	22,590	57,569	52,103
Stone (except limestone for cement and lime)	[8] 7,613,530	[8] 13,026,948	7,978,590	13,802,288	[8] 8,838,796	[8] 14,765,988	10,377,320	17,652,763
Zinc (recoverable content of ores, etc.)	29,788	7,387,424	35,326	10,032,584	38,639	14,064,596	38,020	12,622,640
Undistributed: Copper, pyrites, stone (crushed sandstone, 1949, and dimension sandstone, 1951), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	----	5,228,005	----	5,214,265	----	6,801,780	----	6,370,037
Total	----	55,390,000	----	62,295,000	----	72,855,000	----	74,908,000
Total mineral fuels	----	21,943,000	----	27,399,000	----	26,998,000	----	25,601,000
Total Tennessee	----	77,333,000	----	89,694,000	----	99,853,000	----	100,509,000

TEXAS

Abrasive stone: Pebbles, grinding	226	$2,900	343	$4,709	350	$4,710	510	$3,100
Cement ... 376-pound barrels	14,741,805	33,409,347	17,281,521	39,677,804	17,642,654	42,648,536	19,849,455	48,042,901
Clays (including fuller's earth) [9]	1,234,607	3,001,975	1,454,485	3,576,797	1,544,064	4,271,976	1,389,434	3,790,596
Copper (recoverable content of ores, etc.)	24	9,456	2	832	1	483	18	8,712
Feldspar (crude) ... long tons	(3)	(3)	(3)	(3)	(3)	(3)	2,600	31,200
Fluorspar	1,770	(3)	719	(3)	------------	------------	------------	------------
Gold (recoverable content of ores, etc.) ... troy ounces	40	1,400	49	1,715	32	1,120	39	1,365
Gypsum (crude)	843,292	2,178,569	1,076,251	2,771,812	1,136,824	2,987,890	1,021,161	2,682,019
Iron ore (usable) ... long tons, gross weight	568,722	(3)	1,189,415	(3)	1,053,131	(3)	787,193	(3)
Lead (recoverable content of ores, etc.)	132	41,712	129	34,830	43	14,878	56	18,032
Lime (open-market)	173,724	1,739,185	216,439	2,074,367	279,957	2,532,387	281,604	2,622,975
Manganese ore (35 percent or more Mn) ... gross weight	------------	------------	------------	------------	------------	------------	56	(3)
Salt (common)	1,641,171	2,419,963	1,852,138	2,846,789	2,401,063	4,000,100	2,640,209	4,402,032
Sand and gravel	14,997,506	13,467,849	17,972,105	15,707,724	18,488,463	15,651,531	18,661,403	17,275,255
Silver (recoverable content of ores, etc.) ... troy ounces	2,691	2,435	2,454	2,221	1,381	1,250	4,672	4,228
Stone (except limestone for cement and lime)	4,158,430	5,289,647	[8] 4,893,150	[8] 5,580,463	[8] 7,351,069	[8] 7,626,122	7,604,468	8,664,633
Sulfur (Frasch-process) ... long tons	3,678,196	66,208,000	4,248,688	80,300,000	3,835,280	81,900,000	3,691,724	78,910,000
Talc and soapstone, (ground)	(3)	(3)	(3)	(3)	(3)	(3)	17,800	216,569
Zinc (recoverable content of ores, etc.)	------------	------------	------------	------------	24	8,736	3	996
Undistributed: Bromine, gem stones, graphite, magnesite (1949), magnesium chloride (for metal), magnesium compounds (except for metal, 1949), mercury (1951), pumice and pumicite, sodium sulfate, stone (crushed basalt and dimension granite, 1950–51), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	------------	14,763,409	------------	17,367,031	------------	26,837,027	------------	31,693,142
Total	------------	142,536,000	------------	169,947,000	------------	188,487,000	------------	198,368,000
Total mineral fuels	------------	2,237,257,000	------------	2,504,003,000	------------	3,080,068,000	------------	3,180,189,000
Total Texas	------------	2,379,793,000	------------	2,673,950,000	------------	3,268,555,000	------------	3,378,557,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

UTAH

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Clays (including fuller's earth) [9]	221,701	$624,164	293,958	$929,964	285,128	$1,269,203	180,066	$1,115,642
Copper (recoverable content of ores, etc.)	197,245	77,714,530	278,630	115,910,080	271,086	131,205,624	282,894	136,920,696
Fluorspar	8,332	180,166	18,936	337,912	17,827	398,480	17,304	438,699
Gold (recoverable content of ores, etc.) troy ounces	314,058	10,992,030	457,551	16,014,285	432,216	15,127,560	435,507	15,242,745
Iron ore (usable) long tons, gross weight	2,698,632	4,403,767	3,111,167	5,746,808	4,637,239	10,141,653	3,990,505	15,025,899
Lead (recoverable content of ores, etc.)	53,072	16,770,752	44,753	12,083,310	50,451	17,456,046	50,210	16,167,620
Lime (open-market)	36,082	355,516	49,419	456,471	(3)	(3)	(3)	(3)
Manganese ore (35 percent or more Mn) gross weight	----------	----------	120	(3)	----------	----------	95	(3)
Manganiferous ore (5 to 35 percent Mn) do	4,981	39,983	3,041	(3)	1,369	(3)	3,397	(3)
Perlite (crude)	731	2,762	2,585	13,072	3,422	16,017	(3)	(3)
Phosphate rock long tons	----------	----------	(3)	(3)	580	2,900	(3)	(3)
Pumice and pumicite	(3)	(3)	8,719	10,891	9,422	11,478	(3)	(3)
Salt (common)	78,611	386,935	116,694	511,938	131,444	570,379	136,125	522,721
Sand and gravel	2,331,688	1,553,408	3,435,277	2,251,515	2,971,268	2,268,750	3,260,044	2,350,412
Silver (recoverable content of ores, etc.) troy ounces	6,724,880	6,086,356	7,083,808	6,411,204	7,310,665	6,616,521	7,194,109	6,511,032
Stone (except limestone for cement and lime)	283,020	427,418	929,410	880,667	1,226,710	1,291,118	[8] 852,351	[9] 1,123,108
Tungsten concentrate 60-percent WO_3 basis	1	(3)	----------	----------	(5)	565	3	9,449
Zinc (recoverable content of ores, etc.)	40,670	10,086,160	31,678	8,996,552	34,317	12,491,388	32,947	10,938,404
Undistributed: Cement, diatomite (1950), gem stones (1949), gypsum, molybdenum, potassium salts, quartz crystal (1950), stone (crushed marble, 1952), vanadium, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)	----------	15,613,281	----------	22,494,349	----------	20,526,911	----------	20,889,335
Total	----------	145,237,000	----------	193,049,000	----------	219,395,000	----------	227,256,000
Total mineral fuels	----------	32,588,000	----------	36,907,000	----------	37,750,000	----------	38,246,000
Total Utah	----------	177,825,000	----------	229,956,000	----------	257,145,000	----------	265,502,000

VERMONT

Gold (recoverable content of ores, etc.)....troy ounces..	120	$4,200	146	$5,110	156	$5,460	162	$5,670
Lime (open-market)....	28,914	356,381	32,843	415,910	32,179	432,483	(3)	(3)
Pyrites....long tons..							17,892	(3)
Sand and gravel....	1,581,614	728,394	1,040,977	661,994	965,702	646,702	1,264,490	749,835
Silver (recoverable content of ores, etc.)....troy ounces..	27,446	24,840	28,205	25,527	41,300	37,379	45,361	41,054
Slate....	184,040	3,624,230	238,740	4,471,869	(3)	(3)	(3)	(3)
Stone (except limestone for lime)....	441,770	8,276,287	447,310	8,038,892	450,980	7,253,824	404,391	6,016,530
Talc....	64,508	788,341	72,135	906,396	78,694	998,792	71,027	926,646
Undistributed: Asbestos, clays, copper, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)....		3,581,645		4,037,573		[5] 9,141,814		10,150,945
Total Vermont....		17,384,000		18,563,000		[5] 18,516,000		17,891,000

VIRGINIA

Clays (except for cement)....	449,122	$403,598	545,984	$519,641	544,147	$593,999	648,334	$704,189
Feldspar (crude)....long tons..	33,936	234,442	26,879	188,153	30,979	232,099	(3)	(3)
Iron ore (usable)....long tons, gross weight..	4,349	(3)	5,245	(3)	7,248	(3)	(3)	(3)
Lead (recoverable content of ores, etc.)....	3,313	1,046,908	3,254	878,580	1,508	521,768	3,792	1,221,024
Lime (open-market)....	349,132	3,213,897	428,339	3,861,932	452,680	4,551,656	442,845	4,448,924
Manganese ore (35 percent or more Mn)....gross weight..	224	(3)	56	(3)			1,011	(3)
Manganiferous ore (5 to 35 percent Mn)....do....	1,279	(3)						
Marl, calcareous (except for cement)....	62,482	117,251	52,181	53,861	(3)	(3)	(3)	(3)
Sand and gravel....	4,412,583	4,049,157	4,373,984	4,144,846	5,772,781	5,750,409	7,136,112	5,556,953
Stone (except limestone for cement and lime)....	7,509,740	12,442,765	9,272,740	16,434,602	9,277,252	16,621,116	9,670,961	16,969,952
Zinc (recoverable content of ores, etc.)....	13,166	3,265,168	12,396	3,520,464	7,332	2,668,848	13,409	4,451,788
Undistributed: Abrasive stone (millstones, 1949-50), aplite, cement, gypsum, kyanite, mica, phosphate rock (1949), pyrites, salt, ground sand and sandstone, slate, talc and ground soapstone, titanium concentrate, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)....		9,132,172		11,171,649		14,284,190		16,155,952
Total....		33,905,000		40,774,000		45,224,000		49,509,000
Total mineral fuels....		82,503,000		97,032,000		116,028,000		115,170,000
Total Virginia....		116,408,000		137,806,000		161,252,000		164,679,000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

WASHINGTON

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Abrasive stone:								
Pebbles (grinding)	20	$240	25	$300	28	$336	20	$240
Pulpstones	28	1,975	33	2,100	22	1,970	12	908
Antimony ore and concentrate ... gross weight	14	1,425			110	(3)	100	(3)
Clays (except for cement)	219,738	267,300	216,886	251,850	205,187	285,631	225,277	286,719
Copper (recoverable content of ores, etc.)	5,275	2,078,350	5,057	2,103,712	4,089	1,979,076	4,357	2,108,788
Gold (recoverable content of ores, etc.) ... troy ounces	71,994	2,519,790	92,117	3,224,095	67,405	2,359,175	54,776	1,917,160
Gypsum (crude)			(3)	(3)	(3)	(3)	7,900	29,625
Lead (recoverable content of ores, etc.)	6,417	2,027,772	10,334	2,790,180	8,002	2,768,692	11,744	3,781,568
Manganese ore (35 percent or more Mn) ... gross weight							436	(3)
Manganiferous ores (5 to 35 percent Mn) ... do							142	(3)
Olivine	1,070	(3)	40	(3)	(3)	(3)	(3)	(3)
Pumice and pumicite	8,610	18,221	11,013	22,672	5,105	10,832	3,604	8,089
Sand and gravel	9,215,914	6,391,412	10,605,791	7,435,340	10,546,949	7,595,837	13,322,279	9,422,117
Silver (recoverable content of ore, etc.) ... troy ounces	357,853	323,875	363,656	329,127	334,948	303,145	315,645	285,675
Stone (except limestone for cement and lime)	[8] 3,688,890	[8] 4,105,516	4,930,820	5,734,563	5,029,735	5,664,433	4,523,234	5,491,525
Tungsten concentrate ... 60-percent WO_3 basis					9	33,417	4	14,008
Zinc (recoverable content of ores, etc.)	10,740	2,663,520	14,807	4,205,188	18,189	6,620,796	20,102	6,673,864
Undistributed: Cement, diatomite (1949–50, 1952), epsom salt made from epsomite (1949–51), gem stones, lime, magnesite, quartz, ground sand and sandstone, stone (dimension unclassified, 1949), talc, and minerals whose value must be concealed for particular years indicated in appropriate column by footnote reference 3)		14,379,357		17,076,954		20,772,634		19,982,946
Total		34,779,000		43,176,000		48,396,000		50,003,000
Total mineral fuels		6,084,000		5,879,000		6,158,000		6,126,000
Total Washington		40,863,000		49,055,000		54,554,000		56,129,000

WEST VIRGINIA

Clays (except for cement)	477, 503	$759, 065	569, 615	$925, 305	992, 599	$2, 183, 979	865, 077	$2, 304, 716
Lime (open-market)	350, 311	3, 535, 352	(3)	(3)	(3)	(3)	(3)	(3)
Salt (common)	355, 515	1, 288, 471	367, 942	1, 238, 588	379, 299	1, 314, 818	392, 519	1, 438, 490
Sand and gravel	[11] 3, 284, 805	[11] 5, 491, 274	3, 613, 046	6, 241, 057	4, 735, 271	8, 314, 195	4, 120, 105	7, 275, 370
Stone (except limestone for cement and lime)	4, 854, 590	6, 960, 191	[8] 5, 367, 510	[8] 7, 825, 653	[8] 5, 754, 378	[8] 8, 472, 639	[8] 4, 869, 442	[8] 6, 826, 113
Undistributed: Abrasive stones, bromine, calcium magnesium chloride, cement, calcareous marl, sand and gravel (noncommercial, 1949), ground sand and sandstone, stone (dimension limestone, 1950–52), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		5, 786, 036		10, 662, 099		12, 715, 426		11, 898, 325
Total		23, 820, 000		26, 893, 000		33, 001, 000		29, 743, 000
Total mineral fuels		694, 299, 000		802, 731, 000		908, 722, 000		795, 932, 000
Total West Virginia		718, 119, 000		829, 624, 000		941, 723, 000		825, 675, 000

WISCONSIN

Abrasive stone: Pebbles, grinding	(3)	(3)	530	$10, 600	1, 327	$26, 540	723	$17, 352
Clays (except for cement)	80, 198	$64, 932	80, 293	70, 317	48, 376	48, 376	31, 817	31, 857
Iron ore (usable) long tons, gross weight	1, 405, 775	(3)	1, 701, 619	(3)	1, 745, 120	(3)	1, 485, 845	(3)
Lead (recoverable content of ores, etc.)	857	270, 812	532	143, 640	1, 391	481, 286	2, 000	644, 000
Lime (open-market)	107, 339	1, 254, 751	124, 530	1, 448, 095	124, 852	1, 562, 200	107, 813	1, 368, 556
Marl, calcareous (except for cement)	18, 533	10, 293	22, 025	13, 931	20, 625	12, 925	17, 000	8, 833
Sand and gravel	17, 023, 466	10, 456, 561	19, 117, 115	11, 959, 012	19, 391, 772	12, 392, 464	24, 895, 947	16, 938, 228
Stone (except limestone for cement and lime)	7, 326, 710	13, 636, 020	6, 999, 630	14, 494, 750	7, 609, 323	14, 671, 858	8, 578, 882	16, 754, 675
Zinc (recoverable content of ores, etc.)	5, 295	1, 313, 160	5, 722	1, 625, 048	15, 754	5, 734, 456	20, 588	6, 835, 216
Undistributed: Abrasive stone (tube-mill liners), cement, quartz (1949, 1951–52), ground sand and sandstone, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		8, 861, 346		11, 917, 595		13, 415, 199		13, 107, 504
Total		35, 868, 000		41, 683, 000		48, 345, 000		55, 706, 000
Total mineral fuels		10, 000		10, 000		5, 000		4, 000
Total Wisconsin		35, 878, 000		41, 693, 000		48, 350, 000		55, 710, 000

For footnotes, see end of table.

TABLE 5.—Mineral production in the United States, 1949–52, by States [1]—Continued

WYOMING

Mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Clays (except for cement)	369,782	$3,567,044	413,271	$4,102,122	483,050	[5] $5,999,451	706,748	$9,176,507
Gem stones (estimated)	(10)	20,000	(10)	(3)	(10)	(3)	(10)	(3)
Gold (recoverable content of ores, etc.) troy ounces	389	13,615			9	315	1	35
Iron ore (usable) long tons, gross weight	539,554	(3)	491,906	(3)	616,949	(3)	484,945	(3)
Phosphate rock long tons	(3)	(3)	(3)	(3)	178,948	1,186,523	137,675	919,987
Pumice			1,460	6,353	1,867	9,141	2,851	10,918
Sand and gravel	2,352,493	1,912,838	1,937,943	1,251,220	2,347,078	1,730,900	2,426,999	1,738,548
Silver (recoverable content of ores, etc.) troy ounces	21	19			2	2		
Stone (except limestone for cement)	1,802,580	2,227,096	1,841,400	2,214,037	1,645,475	1,857,267	1,466,567	1,688,890
Sulfur ore for direct agricultural use long tons	3,112	57,322	(3)	(3)	(3)	(3)	(3)	(3)
Undistributed: Cement, feldspar (1949), gypsum, sodium carbonate and sulfate, vermiculite (1950–52), and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 3)		4,128,407		4,794,582		5,408,858		4,337,869
Total		11,926,000		12,368,000		16,192,000		17,873,000
Total mineral fuels		139,072,000		165,209,000		185,646,000		186,622,000
Total Wyoming		150,998,000		177,577,000		[5] 201,838,000		204,495,000

[1] Production as measured by mine shipments or mine sales (including consumption by producers), except that fuels and the following additional minerals are strictly production: Gypsum, iodine, magnesite, pyrites, bauxite, and mercury. Excludes uranium ores and monazite.
[2] Excludes puzzolan cement, value for which is included with "Undistributed."
[3] Value included with "Undistributed."
[4] Less than 1 ton.
[5] Revised figure.
[6] Estimate.
[7] Sales in 1948 included with 1949.
[8] Excludes certain stone, value for which is included with "Undistributed."
[9] Except clays sold or used for cement.
[10] Weight not recorded.
[11] "Commercial." Value of "Noncommercial" included with "Undistributed."
[12] Excludes natural cement, value for which is included with "Undistributed."
[13] "Noncommercial." Value of "Commercial" included with "Undistributed."
[14] Value reported for zinc in New Jersey is estimated smelting value of recoverable zinc content of ore after freight, haulage, smelting, and manufacturing charges are added.

TABLE 6.—Mineral production in Territories of the United States, 1949–52, by individual minerals

Territory and mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Alaska:								
Antimony ore and concentrate……gross weight	74	$31,356			301	(1)	420	(1)
Copper (recoverable content of ores, etc.)	4	1,576	6	$2,496	[2] 1	$387		
Gold (recoverable content of ores, etc.)……troy ounces	229,416	8,029,560	289,272	10,124,520	239,637	8,387,295	240,557	$8,419,495
Lead (recoverable content of ores, etc.)	51	16,116	149	40,230	[2] 21	7,266	1	386
Mercury……76-pound flasks	100	7,946					28	5,575
Sand and gravel	(1)	(1)	3,050,020	2,377,407	6,887,646	3,738,516	10,781,926	8,650,582
Silver (recoverable content of ores, etc.)……troy ounces	36,056	32,633	52,638	47,640	32,870	29,749	32,986	29,854
Tin (content of ore and concentrate)……long tons	51	114,800	79	170,281	69	197,163	82	220,956
Tungsten concentrate……60-percent WO_3 basis			13	(1)	10	(1)	8	(1)
Zinc (recoverable content of ores, etc.)	2	496	6	1,704	[2] 1	218		
Undistributed: Gem stones (1952), platinum-group metals, pumice (1950), stone, and minerals whose value must be concealed for particular years (indicated in appropriate column by footnote reference 1)		4,005,086		2,054,735		3,441,090		3,195,336
Total		12,240,000		14,819,000		15,802,000		20,523,000
Total mineral fuels		3,309,000		3,033,000		3,767,000		5,779,000
Total Alaska		15,549,000		17,852,000		19,569,000		26,302,000
Hawaii: [3]								
Lime (open-market)	8,404	226,926	8,141	219,861	8,740	236,052	8,894	240,786
Sand and gravel					2,561	5,710	1,069	936
Stone	[4] 653,890	[4] 718,705	696,310	1,554,906	[4] 650,094	[4] 1,337,474	705,994	1,545,301
Undistributed: Other nonmetallic minerals		42,826				147,063		17,164
Total Hawaii		988,000		1,775,000		1,726,000		1,804,000
Total Territories		16,537,000		19,627,000		21,295,000		28,106,000

[1] Value included with "Undistributed."
[2] Produced in 1950, but not shipped until 1951 from a mine not active in 1951.
[3] Includes Palmyra, Johnston and Jarvis Islands.
[4] Excludes certain stone value for which is included with "Undistributed."

TABLE 7.—Mineral production in possessions of the United States, 1949–52, by individual minerals

Possession and mineral	1949		1950		1951		1952	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Canal Zone:								
Sand and gravel [1] [2]	39,000	$58,500	22,000	$15,000	32,000	$26,000	56,600	$53,000
Stone (crushed) [1] [2]	109,200	163,800	53,000	83,000	55,500	112,000	86,000	152,000
Total Canal Zone	------------	222,000	------------	98,000	------------	138,000	------------	205,000
Canton: Stone (crushed) [1]	(3)	(3)	(3)	(3)	360	900	150	375
Guam: Stone [1]	2,605,000	5,209,000	[2] 1,528,000	[2] 3,055,000	720,000	[4] 675,000	948,000	870,000
Midway: Stone (crushed) [1]	(3)	(3)	(3)	(3)	(3)	(3)	7,200	[5] 6,000
Puerto Rico:								
Cement .... 376-pound barrels	2,171,486	6,109,041	3,187,451	8,299,186	4,297,583	11,252,350	3,994,483	10,517,894
Iron ore (usable) .... long tons	------------	------------	------------	------------	39,219	225,509	138,613	797,025
Lime (open-market)	7,347	184,618	8,166	180,828	10,350	191,415	8,575	195,000
Salt (common)	12,664	77,322	13,545	137,225	10,566	119,338	12,676	122,158
Sand and gravel	(6)	(6)	101,013	103,806	99,628	99,657	122,730	164,166
Stone	[7] 519,870	[7] 826,621	[7] 250,010	[7] 574,709	283,697	613,751	[7] 689,320	[7] 1,807,388
Undistributed: Other nonmetallic minerals	------------	138,641	------------	1,375	------------	------------	------------	6,328
Total Puerto Rico	------------	7,336,000	------------	9,297,000	------------	12,502,000	------------	13,610,000
Virgin Islands: Stone (crushed) [1] [2]	[8] 9,700	[5] [8] 16,000	[8] 2,540	[5] [8] 4,000	11,600	47,300	12,900	51,900
Wake: Stone (crushed) [1]	(3)	(3)	(3)	(3)	240	600	4,260	8,000
Total	------------	12,783,000	------------	12,454,000	------------	13,364,000	------------	14,751,000

[1] Quantities are estimated equivalents of cubic yards reported.
[2] Data for fiscal years ended June 30.
[3] Data not available.
[4] Revised figure.
[5] Estimate.
[6] Value included with "Undistributed."
[7] Excludes certain stone value for which is included with "Undistributed."
[8] St. Croix Island only. Data for St. Thomas Island not available.

TABLE 8.—Comparison of world and United States production of principal minerals and metals, 1951–52

[Compiled by Berenice B. Mitchell, Pauline Roberts, Helen Hunt, and Lee Petersen]

Mineral	1951			1952		
	World	United States		World	United States	
	Thousand metric tons		Percent of world	Thousand metric tons		Percent of world
Metals, mine basis:						
Antimony[1] ... Sb content	62	3	5	46	2	4
Arsenic[1]	57	15	26	46	14	30
Bauxite	10,984	1,878	17	12,837	1,694	13
Beryl[1]	6	(2)	7	7	(2)	7
Bismuth ... thousand kilograms	1,700	(3)	(3)	1,800	(3)	(3)
Cadmium ... do	6,120	3,770	62	6,280	3,886	62
Chromite	2,800	6	(4)	3,200	19	(4)
Cobalt[1] ... contained	8	(5)	4	10	(5)	4
Columbium ... thousand pounds	2,850	(6)	(6)	3,400	5	(4)
Copper ... Cu content	2,630	842	32	2,735	839	31
Gold ... thousand fine ounces	33,500	1,895	6	34,200	1,927	6
Iron ore	294,000	118,375	40	297,000	99,490	33
Lead ... Pb content	1,685	352	21	1,820	354	19
Manganese ore	7,100	95	1	7,700	105	1
Mercury ... thousand flasks	148	7	5	150	13	9
Molybdenum	21	18	86	22	20	91
Nickel ... Ni content	159	1	(4)	173	1	(4)
Platinum group ... thousand troy oz. Pt, Pd, etc	675	37	5	675	34	5
Silver[1] ... thousand fine ounces	197,500	39,907	20	210,200	39,840	19
Tantalite ... thousand pounds	38	1	3	95	(7)	(7)
Tin[1] ... thousand long tons	170	(8)	(4)	173	(8)	(4)
Titanium:						
Ilmenite	893	486	54	893	480	54
Rutile	42	(3)	(3)	47	(3)	(3)
Tungsten concentrate ... 60-percent WO_3 basis	51	6	12	55	7	13
Zinc ... Zn content	2,290	618	27	2,522	604	24
Metals, smelter basis:						
Aluminum	1,790	759	42	2,050	850	41
Copper	2,815	940	33	2,830	929	33
Iron, pig (including ferroalloys)	150,000	65,745	44	152,000	57,507	38
Lead	1,604	376	23	1,796	429	24
Magnesium	81	37	46	151	96	64
Steel ingots	211,000	95,435	45	212,000	84,520	40
Tin[1] ... thousand long tons	169	32	19	171	23	13
Zinc	2,097	800	38	2,199	821	37
Nonmetallic minerals:						
Asbestos	1,425	47	3	1,425	49	3
Barite	1,825	767	42	1,900	919	48
Cement	148,400	42,548	29	159,000	43,091	27
Corundum	10	---	---	10	---	---
Diamonds ... thousand metric carats	16,780	---	---	18,694	---	---
Diatomite	530	233	44	520	233	45
Feldspar[1]	770	407	53	815	428	53
Fluorspar	1,000	315	32	1,190	303	25
Graphite	190	6	3	190	5	3
Gypsum	24,700	7,861	32	24,300	7,634	31
Magnesite	3,800	608	2	3,800	463	1
Mica (including scrap)	125	65	52	120	69	58
Nitrogen, agricultural ... fiscal year	4,011	996	25	4,380	1,099	25
Phosphate rock	24,000	10,948	46	25,500	12,224	49
Potash ... K_2O equivalent	4,900	1,288	26	5,500	1,511	27
Pumice	940	680	72	780	542	69
Pyrites	13,200	1,034	8	14,200	1,010	7
Salt	54,000	18,332	34	54,000	17,731	33
Sulfur, native ... thousand long tons	5,800	5,278	91	6,000	5,293	88
Talc, pyrophyllite, and soapstone	1,650	581	35	1,475	545	37
Vermiculite[1]	216	190	88	226	190	84

[1] World total, exclusive of U. S. S. R.
[2] United States production was 439 metric tons in 1951 and 467 tons in 1952.
[3] Bureau of Mines not at liberty to publish United States figure separately.
[4] Less than 1 percent.
[5] United States production was 343 metric tons in 1951 and 379 tons in 1952.
[6] Columbium and tantalite production in United States not always differentiated; see tantalite.
[7] Columbium and tantalite production in United States not always differentiated; see columbium.
[8] United States production was 88 long tons in 1951 and 99 tons in 1952.

Employment and Injuries in the Metal and Nonmetal Industries

By Seth T. Reese[1]

THIS CHAPTER of the Minerals Yearbook is confined to employment and injury experience in the metal, nonmetal, and quarry industries of the United States. Each industry is treated separately, and no attempt has been made to combine data to show an overall picture for these sections of the minerals industries. Employment and injury experience for the mineral industries as a whole can be found in volume III.

Lack of comparable and accurate statistics on injuries in the Nation's mineral industries and the importance of such statistics as a measure of the results of the Bureau's endeavor to reduce mining hazards led the Bureau in 1911 to undertake the collection of such statistics. Statistical data on the injury experience at metal- and nonmetal-mining operations were first compiled by the Bureau of Mines for 1911. The first requests to the operators for information on injuries and related employment at their establishments were made early in 1912. The Bureau's list of operators at that time ranged from the lone prospector to the mine on a dividend-paying basis. No distinction was made regarding the size of the operations. The prospector or one doing assessment work was equally exposed to many of the dangers that surrounded a worker at a larger mine.

The response to the first request for injury and employment data was gratifying; most of the larger companies submitted detailed reports, so that from the production point of view, the first statistical data on injuries and employment were fairly representative of the industry. Coverage of the industry has grown to the present time, and the data that appear in this chapter of the Minerals Yearbook represent approximately full coverage of the industry. There is no Federal law which requires the operators of metal and nonmetal mines to submit reports to the Bureau; however, the mining companies who voluntarily furnished reports on injuries and employment have contributed substantially to the promotion of safety in the mineral industries of the United States.

Injury and related employment statistics for the quarry industry were first recorded for 1911 as the result of a request for such information by the Bureau in January 1912. As far as can be ascertained, all

[1] Chief, Accident Analyses Branch, Safety Division, Bureau of Mines.

large companies furnished detailed reports, so that, when measured by production, the available data were largely representative of the industry. The small number that did not reply represented about 12 percent of the total known active operators but constituted only a small segment of the industry in the light of their relatively small production. It was realized at the start that a true accident ratio for the whole quarry industry could be obtained only when complete reports were furnished. Although the Bureau was authorized to collect data relating to accidents at quarry operations, no Federal legislation, then and now, require operators to submit reports. It was hoped that voluntary submission of such data, followed by Bureau dissemination of this information, would aid in establishing a uniform basis for reporting and recording quarry injuries and related employment data. Eventually, a standard form was adopted and submitted to quarry operators in the hope that they would use it to report details relating to injuries. The results have been most encouraging; as a result, present data on injury experience at quarries cover the greater part of the industry.

TABLE 1.—Employment and injury experience at metal mines in the United States, 1931–52 [1] [2]

Year	Men working daily	Average active mine-days	Man-days worked (in thousands)	Man-hours worked (in thousands)	Number of injuries		Injury rate per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
1931	71,991	232	16,692	138,237	147	7,868	1.06	56.92
1932	46,602	209	9,748	80,213	100	4,486	1.25	55.93
1933	49,338	201	9,913	80,006	87	5,180	1.09	64.75
1934	58,411	219	12,776	100,959	108	7,105	1.07	70.38
1935	83,975	218	18,284	145,134	157	9,393	1.08	64.72
1936	90,552	249	22,521	180,803	195	13,606	1.08	75.25
1937	108,412	252	27,296	219,008	206	17,068	.94	77.93
1938	93,501	227	21,255	160,343	150	11,996	.94	74.81
1939	102,279	233	23,836	189,554	163	12,991	.86	68.53
1940	110,340	241	26,631	211,740	209	13,940	.99	65.84
1941	114,202	254	29,034	230,453	213	14,590	.92	63.31
1942	99,769	280	27,968	223,093	215	12,420	.96	55.67
1943	87,880	293	25,790	206,242	195	11,533	.95	55.92
1944	70,480	289	20,366	163,169	130	8,909	.80	54.60
1945	61,470	288	17,728	141,295	96	6,945	.68	49.00
1946	65,234	249	16,238	130,406	90	7,345	.69	56.32
1947	71,228	275	19,567	157,024	126	8,293	.80	52.81
1948	71,436	282	20,124	161,516	104	7,631	.64	47.25
1949	71,664	252	18,067	144,368	69	6,940	.48	48.07
1950	68,292	271	18,522	147,765	84	6,611	.57	44.74
1951	71,603	278	19,913	159,417	95	6,824	.60	42.81
1952	73,400	265	19,443	155,450	110	6,705	.71	43.13

[1] Man-hours not available before 1931.
[2] 1952 figures are preliminary—subject to revision.

TABLE 2.—Employment and injury experience at metal mines in the United States, by industry groups, 1943–47 (average) and 1948–52

Industry and year	Men working daily	Average active mine-days	Man-days worked	Man-hours worked	Number of injuries		Injury rate per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
Iron mines:								
1943–47 (average)	26,111	272	7,112,499	57,112,776	37	1,418	0.65	24.83
1948	27,116	287	7,786,361	62,468,142	34	1,440	.54	23.05
1949	27,792	249	6,907,048	55,422,388	21	1,158	.38	20.89
1950	27,686	268	7,407,111	59,406,348	23	1,126	.39	18.95
1951	30,576	276	8,446,483	67,931,038	33	1,264	.49	18.61
1952 (preliminary)	31,700	245	7,772,000	62,450,000	32	1,015	.51	16.25
Copper mines:								
1943–47 (average)	17,138	307	5,263,425	42,109,059	37	2,140	.88	50.82
1948	16,280	305	4,959,483	39,684,197	31	1,572	.78	39.61
1949	16,027	271	4,341,202	34,729,944	13	1,190	.37	34.26
1950	15,383	305	4,688,299	37,345,430	17	1,176	.46	31.49
1951	16,274	305	4,959,135	39,676,673	19	1,304	.48	32.87
1952 (preliminary)	14,800	314	4,645,000	37,200,000	26	1,150	.70	30.91
Lead-zinc mines:								
1943–47 (average)	16,771	281	4,715,436	37,604,610	36	3,423	.96	91.03
1948	16,113	264	4,255,190	34,034,255	22	3,050	.65	89.62
1949	16,333	243	3,971,971	31,738,565	24	2,810	.76	88.54
1950	14,038	257	3,612,051	28,878,165	28	2,411	.97	83.49
1951	14,520	271	3,937,874	31,488,680	18	2,497	.57	79.30
1952 (preliminary)	16,500	276	4,553,000	36,280,000	35	2,925	.96	80.62
Gold-silver mines:								
1943–47 (average)	4,215	261	1,098,925	8,588,067	8	751	.93	87.45
1948	5,276	273	1,442,554	11,328,421	13	986	1.15	87.04
1949	5,309	258	1,369,960	10,651,525	9	1,190	.84	111.72
1950	5,112	261	1,333,387	10,328,735	10	1,270	.97	122.96
1951	4,261	251	1,070,753	8,294,331	15	963	1.81	116.10
1952 (preliminary)	3,900	254	991,000	7,880,000	7	795	.89	100.89
Gold placers:								
1943–47 (average)	2,377	200	474,342	4,066,333	1	125	.25	30.74
1948	3,772	230	867,709	7,423,065	1	180	.13	24.25
1949	3,523	216	760,202	6,087,196	-------	187	-------	30.72
1950	3,457	218	753,922	6,037,624	-------	184	-------	30.48
1951	2,649	210	557,482	4,475,624	3	198	.67	44.24
1952 (preliminary)	2,100	227	477,000	3,820,000	1	155	.26	40.58
Miscellaneous: [1]								
1943–47 (average)	4,598	274	1,258,702	10,118,062	8	740	.79	73.14
1948	2,879	282	813,035	6,578,055	3	403	.46	61.26
1949	2,680	267	716,405	5,738,514	2	405	.35	70.58
1950	2,616	278	727,325	5,768,379	6	444	1.04	76.97
1951	3,323	283	941,591	7,550,962	7	598	.93	79.20
1952 (preliminary)	4,400	228	1,005,000	7,820,000	9	665	1.15	85.04
Total:								
1943–47 (average)	71,210	280	19,923,329	159,598,907	127	8,597	.80	53.87
1948	71,436	282	20,124,332	161,516,135	104	7,631	.64	47.25
1949	71,664	252	18,066,788	144,368,132	69	6,940	.48	48.07
1950	68,292	271	18,522,095	147,764,681	84	6,611	.57	44.74
1951	71,603	278	19,913,318	159,417,308	95	6,824	.60	42.81
1952 (preliminary)	73,400	265	19,443,000	155,450,000	110	6,705	.71	43.13

[1] Includes antimony, bauxite, chromite, cobalt, manganese, mercury, molybdenum, pyrite, titanium, tungsten, and vanadium-uranium mines.

METAL MINES

The overall injury record at metal mines was not favorable in 1952. A total of 110 fatal injuries, or 15 more than in 1951, occurred at a rate of 0.71 per million man-hours, an increase of 18 percent. Fatal experience was worse in each group of mines except at gold-silver-lode and gold-placer operations, where the fatality-frequency rates decreased sharply. The total number of nonfatal injuries decreased 119 to 6,705 injuries in 1952; but, owing to a greater percentage of decrease in the man-hours of worktime, the frequency at which lost-time injuries occurred rose to 43.13 from 42.81 per million man-hours.

Nonfatal injuries were less frequent at each group of mines except lead-zinc and miscellaneous metal operations.

Employment increased slightly to an average of 73,400 men working daily. Employment was higher in 1952 at iron, lead-zinc, and miscellaneous metal mines and lower at copper, gold-silver-lode, and gold-placer operations. The aggregate time worked at metal mines declined 2½ percent from 1951 to a total of 155½ million man-hours. This decline resulted mainly from the smaller number of active mine days, which in 1952 averaged 265, or 13 less than in 1951. The average length of shift for all metal mines was 8 hours, and the average employee worked 2,118 hours during 1952, a reduction of 108 hours from 1951.

Iron.—Although the number of fatal injuries at iron mines declined to 32, compared with 33 deaths in 1951, the rate at which the former number occurred was slightly greater due to an 8-percent decrease in the total man-hours worked. The rate at which nonfatal injuries occurred declined to 16.25 from 18.61 per million man-hours in 1951. This improved performance was due entirely to a 20-percent decrease in the number of nonfatal injuries, which more than offset the decrease in worktime at iron mines in 1952.

The average number of men at work daily at iron mines increased slightly to a total of 31,700 in 1952. Iron mines averaged 245 active days during the year and had a total of 62½ million hours of worktime, or approximately 5½ million man-hours less than in 1951. The average employee at iron mines had a workyear of 1,970 hours, or 252 hours less than the preceding year, owing principally to the fewer active days the mines were operated.

Copper.—Fatality experience at copper mines was worse than in 1951. There were 26 fatal injuries—7 more than in 1951—and the frequency rate increased almost 50 percent to 0.70 per million man-hours. As the decline in number of nonfatal injuries was greater proportionately than the decline in the man-hours of exposure, the nonfatal-injury frequency rate improved 6 percent in 1952.

The average daily employment of 14,800 men at copper mines during the year was a slight reduction from the number of men working at these mines in 1951. As these mines operated an average of 314 days in 1952, the total of 37.2 million man-hours was 6 percent less than in 1951. Each employee averaged 2,514 hours of work during the year, or 76 more than in 1951.

Lead Zinc.—Fatality experience at lead-zinc mines was worse than in 1951. There were 35 fatal injuries in 1952, and the frequency rate increased 68 percent to 0.96 per million man-hours. Nonfatal injuries at lead-zinc mines increased 17 percent in number to 2,925; but the frequency rate, although slightly higher than in 1951, was not similarly affected, as the man-hours of worktime increased 15 percent above the previous year's total.

Employment at lead-zinc mines increased 13½ percent to an average daily working force of 16,500 men in 1952. Although these men worked 5 more days than in 1951, the average employee had only 30 hours more worktime during the year, owing to a 4-percent reduction in the number of hours worked per shift.

342070—55——7

Gold-Silver-Lode.—The fatality record improved sharply at gold-silver-lode mines, and the nonfatal-injury record was also better in 1952 than in 1951. The total of 7 fatals was less than in 1951. They occurred at a frequency of 0.89 per million man-hours, a 51-percent improvement. There was a 17½-percent reduction in the number of nonfatal injuries; but, as the total worktime was reduced in lesser proportion, the nonfatal-frequency rate was reduced 13 percent to 100.89 injuries per million man-hours in 1952.

The average number of men working at gold-silver-lode mines decreased almost 9 percent from 1951. These men worked 3 more days in 1952, 0.2 hour more each day, and were able to accumulate a total year's work of 2,021 hours, or 74 more than in 1951.

Gold Placer.—The safety record at gold-placer mines improved during 1952. The fatality-frequency rate of 0.26 was 61 percent lower than in the preceding year. The number of nonfatal injuries was reduced 22 percent from 1951, and the resulting frequency rate of 40.58 injuries per million man-hours represented an 8-percent improvement.

The average number of men working daily declined to 2,100 in 1952. The men worked 17 days more but had an aggregate worktime of 3.8 million man-hours, 15 percent below 1951. However, because of the increased number of days, the average employee was able to accumulate a total of 1,819 hours or 129 more than in 1951.

Miscellaneous Metal.—This group includes mines producing antimony, bauxite, chromite, cobalt, manganese, mercury, molybdenum, pyrite, titanium, tungsten, and vanadium-uranium. The safety record at miscellaneous metal mines was not as good as in 1951. There were 9 fatal injuries, and the frequency rate increased 24 percent to 1.15 per million man-hours. The number of nonfatal injuries increased 11 percent, resulting in a raise in the frequency rate from 79.20 in 1951 to 85.04 per million man-hours in 1952. The average number of men working daily increased 32 percent above the 1951 working force. However, because these mines operated 55 fewer days, the total man-hours worked did not increase in the same proportion. The average worker accumulated 1,777 hours during 1952, or 495 less than in 1951, owing to the smaller number of active plant days and a 3-percent decrease in the average hours worked per day.

NONMETAL MINES (EXCEPT STONE QUARRIES)

Employment gained slightly in 1952 to a total of 12,800 men at work daily in this group of nonmetal mines, which is comprised of barite, feldspar, fluorspar, gypsum, magnesite, mica, phosphate rock, rock-salt, sulfur, and miscellaneous nonmetallic-mineral operations. However, as the operations were active an average of 284 days, or 14 less than in 1951, the total hours of worktime during 1952 were slightly more than in the preceding year. The overall injury record at nonmetal mines improved in 1952. Although no appreciable change was reflected in the fatality experience, the nonfatal-injury experience was improved sharply. The number of nonfatal injuries decreased 31 percent, and the nonfatal-frequency rate declined in the same proportion.

TABLE 3.—Employment and injury experience at nonmetal mines (except stone quarries) in the United States, 1931–52 [1] [2]

Year	Men working daily	Average active mine-days	Man-days worked (in thousands)	Man-hours worked (in thousands)	Number of injuries		Injury rate per million man-hours	
					Fatal	Non-fatal	Fatal	Non-fatal
1931	8,949	227	2,029	17,941	11	841	0.61	46.88
1932	6,686	201	1,347	11,825	7	528	.59	44.65
1933	7,678	225	1,729	14,134	8	745	.57	52.71
1934	8,234	236	1,947	15,187	8	787	.53	51.82
1935	8,339	250	2,068	16,168	7	813	.43	50.28
1936	10,380	259	2,689	21,556	4	1,044	.19	48.43
1937	10,017	256	2,561	20,536	13	987	.63	48.06
1938	9,526	236	2,251	17,827	6	726	.34	40.72
1939	9,630	228	2,196	17,281	10	719	.58	41.61
1940	9,780	247	2,416	18,988	14	826	.74	43.50
1941	11,088	263	2,920	23,225	17	1,182	.73	50.89
1942	12,677	274	3,473	28,093	22	1,537	.78	54.71
1943	12,713	269	3,426	27,999	25	1,471	.89	52.54
1944	11,261	282	3,171	25,760	17	1,283	.66	49.81
1945	10,371	291	3,016	24,613	16	1,145	.65	46.52
1946	11,312	291	3,297	26,877	26	1,369	.97	50.94
1947	12,176	292	3,555	28,809	12	1,308	.42	45.40
1948	11,950	287	3,432	27,784	15	1,176	.54	42.33
1949	12,077	277	3,340	26,948	10	1,125	.37	41.75
1950	11,977	293	3,512	28,456	19	1,238	.67	43.51
1951	12,500	298	3,729	30,130	17	1,351	.56	44.84
1952	12,800	284	3,635	29,510	17	930	.58	31.51

1 Man-hours not available before 1931.
2 1952 figures are preliminary—subject to revision.

TABLE 4.—Employment and injury experience at nonmetal mines (except stone quarries) in the United States, 1943–47 (average) and 1948–52 [1]

Year	Men working daily	Average active mine-days	Man-days worked	Man-hours worked	Number of injuries		Injury rate per million man-hours	
					Fatal	Non-fatal	Fatal	Non-fatal
1943–47 (average)	11,567	285	3,292,897	26,812,584	19	1,315	0.71	49.05
1948	11,950	287	3,432,304	27,784,119	15	1,176	.54	42.33
1949	12,077	277	3,340,482	26,948,124	10	1,125	.37	41.75
1950	11,977	293	3,512,094	28,455,936	19	1,238	.67	43.51
1951	12,500	298	3,728,821	30,130,424	17	1,351	.56	44.84
1952 (preliminary)	12,800	284	3,635,000	29,510,000	17	930	.58	31.51

1 Includes barite, feldspar, fluorspar, gypsum, magnesite, mica, phosphate rock, rock-salt, sulfur, and miscellaneous nonmetallic mineral mines.

METALLURGICAL PLANTS

The overall safety record at metallurgical plants was not as favorable in 1952 as in the preceding year. The combined (fatal and nonfatal) frequency rates of 22.12 and 25.87 per million man-hours at ore-dressing plants and nonferrous reduction plants and refineries, respectively, were higher than the corresponding rates for 1951. There was the same number of fatalities in each year—16—but the number of nonfatal injuries increased 11 percent to a total of 3,015.

TABLE 5.—Employment and injury experience at metallurgical plants in the United States, 1931–52 [1] [2]

Year	Men working daily	Average active plant days	Man-days worked (in thousands)	Man-hours worked (in thousands)	Number of injuries		Injury rate per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
1931	28,938	299	8,642	70,374	16	1,393	0.23	19.79
1932	21,564	257	5,542	44,856	8	837	.18	18.66
1933	21,999	267	5,875	46,180	13	1,079	.28	23.37
1934	26,932	274	7,366	57,966	13	1,320	.22	22.77
1935	36,493	291	10,632	83,874	28	1,962	.33	23.39
1936	41,167	309	12,727	101,218	32	2,240	.32	22.13
1937	47,530	313	14,899	117,551	41	3,217	.35	27.37
1938	39,043	292	11,383	90,018	20	2,273	.22	25.25
1939	41,583	303	12,594	96,737	24	2,171	.25	22.44
1940	49,068	295	14,484	113,116	18	2,582	.16	22.83
1941	54,349	311	16,916	132,102	34	3,410	.26	25.81
1942	51,154	334	17,073	134,998	29	3,674	.21	27.22
1943	64,735	336	21,755	173,633	31	4,666	.18	26.87
1944	58,085	329	19,113	152,326	38	4,158	.25	27.30
1945	46,467	329	15,268	121,491	19	3,271	.16	26.92
1946	44,954	284	12,783	101,673	20	2,794	.20	27.48
1947	49,082	313	15,353	122,630	21	3,228	.17	26.32
1948	47,768	317	15,121	121,028	14	2,749	.12	22.71
1949	47,663	294	14,031	112,095	23	2,567	.21	22.90
1950	46,277	314	14,539	116,430	29	2,574	.25	22.11
1951	48,019	318	15,247	122,088	16	2,714	.13	22.23
1952	48,200	319	15,381	123,040	16	3,015	.13	24.50

[1] Man-hours not available before 1931.
[2] 1952 figures are preliminary—subject to revision.

Overall employment changed only slightly from 1951, and the aggregate man-hours of work was 1 percent higher than in 1951.

ORE-DRESSING PLANTS

This group includes crushing, screening, washing, jigging, magnetic separation, flotation, and other milling operations on metallic ores. Injury experience at metal mills was not as good in 1952 as in 1951. Although there was 1 less death, the number of nonfatal injuries increased 15 percent, resulting in a rise of the frequency rate from 19.86 to 22.00 injuries per million man-hours. Fatality experience was better at iron, gold-silver, and miscellaneous-metal mills and the nonfatal-injury experience was improved at gold-silver, lead-zinc, and miscellaneous-metal mills. The sharp increase in number of nonfatal injuries and subsequent nonfatal-frequency rate at copper mills was responsible for the poorer safety record at metal mills as a whole in 1952. The average number of men working daily increased for each group except iron and gold-silver mills. The overall gain was 5 percent. Although employment was 15 percent lower at gold-silver mills, the plants were active 16 more days in 1952, with the result that man-hours worked in this group, while not as numerous as in 1951, was not reduced in the same proportion as the average daily work force. At miscellaneous-metal mills, the gain in employment resulted in an appreciable increase in man-hours worked in 1952, although the plants in this group were active 15 fewer days than in 1951.

TABLE 6.—Employment and injury experience at ore-dressing plants in the United States, by industry groups, 1943–47 (average) and 1948–52 [1]

Industry and year	Men working	Average active mill days	Man-days worked	Man-hours worked	Number of injuries: Fatal	Number of injuries: Nonfatal	Injury rate per million man-hours: Fatal	Injury rate per million man-hours: Nonfatal
Copper:								
1943–47 (average)	6,194	327	2,022,845	16,175,389	3	356	0.19	22.01
1948	6,308	317	1,998,932	15,998,431	4	289	.25	18.06
1949	6,582	294	1,937,717	15,526,435	3	233	.19	15.01
1950	5,828	337	1,966,475	15,731,325	2	243	.13	15.45
1951	6,033	336	2,025,542	16,205,429		226		13.95
1952 (preliminary)	6,200	346	2,146,000	17,170,000	1	345	.06	20.09
Iron:								
1943–47 (average)	3,336	243	812,117	6,595,876	2	100	.30	15.16
1948	3,259	267	870,632	7,040,488		101		14.35
1949	3,701	215	794,121	6,446,190	3	96	.47	14.89
1950	3,401	239	814,406	6,568,250	3	74	.46	11.27
1951	3,756	250	937,338	7,588,231		69		9.09
1952 (preliminary)	3,700	222	820,000	6,620,000		60		9.06
Gold-silver:								
1943–47 (average)	862	284	244,650	1,924,098	1	98	.52	50.93
1948	919	287	263,644	2,064,381	1	106	.48	51.35
1949	935	288	269,389	2,106,362		83		39.40
1950	769	285	219,266	1,707,555		75		43.92
1951	708	287	203,161	1,579,353	2	55	1.27	34.82
1952 (preliminary)	600	303	182,000	1,460,000		35		23.97
Lead-zinc:								
1943–47 (average)	4,635	291	1,348,673	10,806,304	5	349	.46	32.30
1948	3,998	263	1,050,895	8,430,578	3	237	.36	28.11
1949	4,018	241	968,005	7,747,429	1	220	.13	28.40
1950	3,489	259	903,009	7,223,114	2	226	.28	31.29
1951	3,441	270	930,091	7,444,528	2	222	.27	29.82
1952 (preliminary)	3,600	272	978,000	7,860,000	4	220	.51	27.99
Miscellaneous metals: [2]								
1943–47 (average)	1,923	287	551,654	4,432,286	1	157	.23	35.42
1948	1,150	280	321,751	2,570,479	1	101	.39	39.29
1949	1,452	270	391,600	3,147,204		166		52.75
1950	1,469	303	444,660	3,584,752		167		46.59
1951	2,401	331	793,658	6,361,298	2	206	.31	32.38
1952 (preliminary)	3,000	316	948,000	7,580,000		235		31.00
Total:								
1943–47 (average)	16,950	294	4,979,939	39,933,953	12	1,060	.30	26.54
1948	15,634	288	4,505,854	36,104,357	9	834	.25	23.10
1949	16,688	261	4,360,832	34,973,620	7	798	.20	22.82
1950	14,956	291	4,347,816	34,814,996	7	785	.20	22.55
1951	16,339	299	4,889,790	39,178,839	6	778	.15	19.86
1952 (preliminary)	17,100	297	5,074,000	40,690,000	5	895	.12	22.00

[1] Includes crushers, grinders, washers, ore concentration, sintering, cyaniding, leaching, and all other metallic ore-dressing plants and auxiliary works.
[2] Includes antimony, bauxite, mercury, manganese, tungsten, chromite, vanadium, molybdenum, and other metals.

NONFERROUS REDUCTION PLANTS AND REFINERIES

The reduction plants and refineries in this group are engaged in the primary extraction of nonferrous metals from ores and concentrates and the refining of crude primary nonferrous metals; iron and steel plants are not included. Injury experience at nonferrous smelters and refineries was less favorable in 1952 than in 1951. The total of 11 fatalities occurred at a rate of 0.13 per million man-hours compared with 10 fatalities and a rate of 0.12 in 1951. Nonfatal-injury experience was better at copper and lead smelters, but those improvements were more than offset by less favorable frequencies at zinc and miscellaneous-metal smelters. Employment and man-hours worked declined at copper and lead smelters and rose at zinc and miscellaneous smelters. The overall decrease in employment was 2 percent, but since the smelters were operated 4 more days than in 1951, the aggregate time worked did not decline proportionately in man-hours.

TABLE 7.—Employment and injury experience at primary nonferrous reduction and refinery plants in the United States, by industry groups, 1943–47 (average) and 1948–52 [1]

Industry and year	Men working daily	Average active smelter-days	Man-days worked	Man-hours worked	Number of injuries: Fatal	Number of injuries: Nonfatal	Injury rate per million man-hours: Fatal	Injury rate per million man-hours: Nonfatal
Copper:								
1943–47 (average)	12,223	335	4,090,329	32,732,388	7	646	0.21	19.74
1948	12,419	326	4,053,333	32,495,627	2	592	.06	18.22
1949	11,626	305	3,549,484	28,395,270	8	511	.28	18.00
1950	11,756	323	3,799,981	30,401,750	7	521	.23	17.14
1951	11,928	325	3,874,388	31,198,141	3	506	.10	16.22
1952 (preliminary)	10,600	324	3,436,000	27,480,000	6	360	.22	13.10
Lead:								
1943–47 (average)	3,652	312	1,140,492	9,121,575	2	177	.22	19.40
1948	4,037	323	1,302,463	10,419,706	1	188	.10	18.04
1949	4,045	306	1,239,792	9,918,334	2	164	.20	16.54
1950	3,946	305	1,202,755	9,606,222	4	166	.42	17.28
1951	3,939	302	1,189,986	9,520,909	2	112	.21	11.76
1952 (preliminary)	3,700	317	1,174,000	9,390,000	2	100	.21	10.65
Zinc:								
1943–47 (average)	10,381	350	3,636,558	28,691,450	3	947	.10	33.01
1948	9,843	342	3,367,815	26,875,360	1	843	.04	31.37
1949	9,573	318	3,044,234	24,118,138	5	791	.21	32.80
1950	9,106	350	3,187,484	25,314,896	9	779	.36	30.77
1951	9,160	353	3,236,675	25,744,087	2	788	.08	30.61
1952 (preliminary)	9,800	355	3,477,000	27,680,000	3	860	.11	31.07
Miscellaneous metals: [2]								
1943–47 (average)	9,459	318	3,006,936	23,871,160	2	793	.08	33.22
1948	5,835	324	1,891,583	15,132,655	1	292	.07	19.30
1949	5,731	320	1,836,176	14,689,399	1	303	.07	20.63
1950	6,513	307	2,001,201	16,292,286	2	323	.12	19.83
1951	6,653	309	2,056,024	16,445,647	3	530	.18	32.23
1952 (preliminary)	7,000	317	2,220,000	17,800,000	--------	800	--------	44.94
Total:								
1943–47 (average)	35,715	332	11,874,315	94,416,573	14	2,563	.15	27.15
1948	32,134	330	10,615,194	84,923,348	5	1,915	.06	22.55
1949	30,975	312	9,669,686	77,121,141	16	1,769	.21	22.94
1950	31,321	325	10,191,421	81,615,154	22	1,789	.27	21.92
1951	31,680	327	10,357,073	82,908,784	10	1,936	.12	23.35
1952 (preliminary)	31,100	331	10,307,000	82,350,000	11	2,120	.13	25.74

[1] Includes smelters, refineries, roasting, electrolytic, retort, and all other nonferrous-metal reducing or refining plants.
[2] Includes mercury, antimony, tin, and magnesium plants.

STONE QUARRIES

Injury experience in the quarry industries in 1952 was less favorable than in 1951, and the rates of occurrence of both fatal and nonfatal injuries increased over the preceding year. The combined rate of 26.61 injuries (fatal and nonfatal) was higher than the corresponding rate for 1951. Operating activity showed little change, and man-hours of worktime declined less than 1 percent compared with the previous year. The average number of men working daily was 1,600 less than in 1951, but the number of hours worked per man during 1952 was 27 more, due to an increase of 7 active plant days.

TABLE 8.—Employment and injury experience at stone quarries in the United States, 1924–52 [1] [2]

Year	Men working daily	Average active mine days	Man-days worked (in thousands)	Man-hours worked (in thousands)	Number of injuries		Injury rate per million man-hours	
					Fatal	Non-fatal	Fatal	Non-fatal
1924	94,242	269	25,328	236,983	138	14,777	0.58	62.35
1925	91,872	273	25,046	233,222	149	14,165	.64	60.74
1926	91,146	271	24,708	230,464	154	13,201	.67	57.28
1927	91,517	271	24,783	229,806	135	13,459	.59	58.57
1928	89,667	272	24,397	224,953	119	10,568	.53	46.98
1929	85,561	268	22,968	211,766	126	9,810	.59	46.32
1930	80,633	255	20,559	186,502	105	7,417	.56	39.77
1931	69,200	224	15,527	133,750	61	5,427	.46	40.58
1932	56,866	195	11,114	93,710	32	3,574	.34	38.14
1933	61,927	183	11,362	87,888	59	3,637	.67	41.38
1934	64,331	204	13,108	95,259	60	3,924	.63	41.19
1935	73,005	200	14,623	110,033	51	4,152	.46	37.73
1936	80,022	236	18,874	147,064	91	5,717	.62	38.87
1937	84,094	241	20,264	158,299	77	6,348	.49	40.10
1938	77,497	223	17,256	133,766	82	5,027	.61	37.58
1939	79,449	236	18,726	143,847	48	5,204	.33	36.18
1940	79,509	240	19,121	147,244	72	5,188	.49	35.23
1941	86,123	260	22,370	173,165	76	6,870	.44	39.67
1942	84,270	271	22,808	180,836	112	6,349	.62	35.11
1943	69,877	274	19,136	155,280	80	5,199	.52	33.48
1944	58,476	268	15,691	129,302	73	4,437	.56	34.32
1945	58,180	264	15,376	127,168	53	4,121	.42	32.41
1946	70,265	274	19,262	158,528	55	5,137	.35	32.40
1947	75,245	279	20,996	171,979	75	5,504	.44	32.00
1948	77,344	284	21,993	179,111	75	4,994	.42	27.88
1949	82,209	275	22,569	182,258	66	4,826	.36	26.48
1950	85,730	272	23,346	189,535	54	4,762	.28	25.12
1951	84,802	277	23,470	191,113	57	4,945	.30	25.87
1952	83,200	284	23,664	189,755	71	4,980	.37	26.24

[1] Man-hours not available before 1924.
[2] 1952 figures are preliminary—subject to revision.

Cement.—The 21 fatalities that occurred in cement mills and quarries represented a sharp increase over the 15 deaths in 1951. The fatality rate of 0.28 per million man-hours was 40 percent higher than the corresponding rate for the preceding year. The nonfatal-injury frequency rate in both years was virtually identical, although 10 fewer injuries were reported in 1952 than in 1951. This improvement had little effect on the rate at which injuries occurred, as there was a proportionate decrease in man-hours of exposure to hazards. Employment in cement quarrries and mills during the year registered a slight decrease, the average daily work force being approximately 500 less than in 1951. Cement plants were worked 10 more days in 1952 than in the preceding year, but the average employee was able to accumulate only 4 hours additional work, owing chiefly to working one-quarter hour less each day the plants were active.

Limestone.—Fatality experience at limestone operations was less favorable in 1952 than in 1951. The 25 fatalities occurred at a rate of 0.44 per million man-hours, compared with 21 deaths and a frequency rate of 0.38 in 1951. The nonfatal-injury rate, while slightly higher than in the previous year, was controlled to a large extent by increased employment activity. Although the average daily

TABLE 9.—Employment and injury experience at stone quarries in the United States, by industry groups, 1943–47 (average) and 1948–52

Industry and year	Men working daily	Average active mine-days	Man-days worked	Man-hours worked	Number of injuries		Injury rate per million man-hours	
					Fatal	Non-fatal	Fatal	Non-fatal
Cement: [1]								
1943–47 (average)	24,272	300	7,270,599	57,659,047	16	733	0.29	12.71
1948	28,278	328	9,270,125	73,778,909	24	786	.33	10.65
1949	28,824	327	9,411,961	73,540,505	18	597	.24	8.12
1950	29,003	324	9,383,895	73,758,750	17	548	.23	7.43
1951	29,096	329	9,561,969	75,325,959	15	480	.20	6.37
1952 (preliminary)	28,500	339	9,672,000	73,890,000	21	470	.28	6.36
Limestone:								
1943–47 (average)	19,931	240	4,790,760	40,825,672	27	1,742	.66	42.67
1948	22,335	244	5,445,881	45,665,097	26	1,703	.57	37.29
1949	25,710	232	5,954,282	49,828,625	27	1,829	.54	36.71
1950	28,588	232	6,621,221	55,337,191	22	1,922	.40	34.73
1951	27,626	236	6,528,367	54,952,659	21	2,055	.38	37.40
1952 (preliminary)	27,200	251	6,817,000	56,378,000	25	2,170	.44	38.49
Lime: [1]								
1943–47 (average)	8,999	303	2,722,575	21,959,389	9	1,066	.41	48.54
1948	9,459	304	2,878,887	22,867,674	9	931	.39	40.71
1949	9,138	297	2,709,511	21,344,370	8	798	.37	37.39
1950	8,837	295	2,607,969	20,970,469	6	677	.29	32.28
1951	9,085	296	2,688,965	21,674,253	9	692	.42	31.93
1952 (preliminary)	9,600	290	2,783,000	22,470,000	4	605	.18	26.92
Marble:								
1943–47 (average)	2,055	264	543,004	4,588,705	1	155	.22	33.78
1948	2,747	266	730,699	5,876,884	1	167	.17	28.42
1949	2,815	255	719,207	5,962,020	--------	227	--------	38.07
1950	2,600	246	640,281	5,330,295	3	168	.56	31.52
1951	2,584	254	656,579	5,486,709	--------	191	--------	34.81
1952 (preliminary)	2,600	245	637,000	5,242,000	1	205	.19	39.11
Granite:								
1943–47 (average)	4,779	249	1,188,978	10,022,172	5	466	.50	46.50
1948	5,818	256	1,490,656	12,467,119	6	590	.48	47.32
1949	6,972	247	1,719,109	14,216,896	5	574	.35	40.37
1950	7,400	249	1,842,512	15,237,563	2	587	.13	38.52
1951	7,211	247	1,777,947	14,775,534	7	596	.47	40.34
1952 (preliminary)	6,400	245	1,566,000	13,096,000	9	540	.69	41.23
Traprock:								
1943–47 (average)	2,258	235	530,711	4,507,991	3	232	.67	51.46
1948	2,505	238	594,938	5,064,034	4	257	.79	50.75
1949	2,815	230	647,414	5,503,529	3	240	.55	43.61
1950	3,066	225	691,022	5,829,466	2	292	.34	50.09
1951	2,908	234	680,826	5,835,796	3	303	.51	51.92
1952 (preliminary)	3,000	228	685,000	6,288,000	3	230	.48	36.58
Slate:								
1943–47 (average)	1,275	263	335,105	2,973,695	2	164	.67	55.15
1948	1,952	262	512,126	4,511,472	3	188	.66	41.67
1949	1,820	260	472,868	4,061,750	3	217	.74	53.43
1950	2,032	268	544,213	4,633,830	1	203	.22	43.81
1951	2,093	270	565,624	4,773,785	--------	239	--------	50.07
1952 (preliminary)	1,800	273	492,000	4,268,000	--------	345	--------	80.83
Sandstone:								
1943–47 (average)	2,840	250	710,402	5,914,828	4	322	.68	54.44
1948	4,250	252	1,070,005	8,879,320	2	372	.23	41.90
1949	4,115	227	934,969	7,800,638	2	344	.26	44.10
1950	4,204	242	1,015,370	8,437,247	1	365	.12	43.26
1951	4,199	240	1,009,415	8,288,499	2	389	.24	46.93
1952 (preliminary)	4,100	247	1,012,000	8,123,000	8	415	.98	51.09
Total:								
1943–47 (average)	66,409	272	18,092,134	148,451,499	67	4,880	.45	32.87
1948	77,344	284	21,993,317	179,110,509	75	4,994	.42	27.88
1949	82,209	275	22,569,321	182,258,333	66	4,826	.36	26.48
1950	85,730	272	23,346,483	189,534,811	54	4,762	.28	25.12
1951	84,802	277	23,469,692	191,113,194	57	4,945	.30	25.87
1952 (preliminary)	83,200	284	23,664,000	189,755,000	71	4,980	.37	26.24

[1] Includes burning or calcining and other mill operations.

working force was not as large as in 1951, limestone operations were worked 15 days and 1.4 million man-hours more. As a result of this increased activity, the average employee had a total of 2,073 hours of work in 1952, or 84 more than in 1951.

Lime.—Fatality experience at lime plants and associated quarries improved remarkably in 1952. There were 4 fatalities during the year, compared with 9 deaths chargeable to 1951. The rate of 0.18 death per million man-hours was significantly lower than the rate of 0.42 for the preceding year. Nonfatal-injury experience likewise was much better in 1952. The rate of 26.92 injuries per million man-hours was appreciably better than the rate of 31.93 for 1951. Employment at lime plants and associated quarries increased to a total of 9,600 men who worked an average of 290 days, 6 less than in 1951. The aggregate worktime at these plants and quarries (22.4 million man-hours) was 4 percent higher than the comparable total for the preceding year.

Marble.—Injury experience at marble operations was less favorable in 1952 than in 1951. One fatality was recorded at these quarries, whereas the previous year was fatality-free. The number of nonfatal injuries was increased by 14; and this increase, coupled with a decrease in the total worktime, resulted in a 12-percent higher nonfatal-injury rate. The average number of men working daily was virtually unchanged from 1951; but, as there was 9 fewer working days in 1952, the total man-hours declined almost 5 percent. The average employee worked 2,016 hours during 1952 and had a shift of 8.23 hours.

Granite.—The safety record at granite quarries was less favorable than in 1951, and the frequency rates for both fatal and nonfatal injuries increased. There were 9 fatalities in 1952—2 more than in the preceding year—and the nonfatal injuries dropped to 540, or 56 less than in 1951. However, the less favorable rates of occurrence resulted from a 11-percent decline in the aggregate worktime in the industry. Employment declined 11 percent, and there were 2 fewer days of work in 1952. The average worker had a shift of 8.36 hours and worked 2,046 hours during the year—3 more than in 1951.

Traprock.—The traprock industry had the sharpest improvement in injury experience among the quarry industries. The combined rate of 37.06 for the 3 fatalities and 230 nonfatal injuries per million man-hours was a 29-percent reduction from the corresponding rate of 52.43 in 1951. The 1952 rate was the best annual frequency rate for all injuries in the traprock industry since these rates were first compiled in 1931. Employment increased slightly; but the average length of shift was increased from 8.57 to 9.18 hours, thus enabling the average employee to accumulate a total of 2,096 hours during the year, or 89 more hours than in 1951.

Slate.—No fatal injuries were reported at slate quarries during 1952. The frequency of nonfatal injuries, however, increased 49 percent to 80.83 per million man-hours—the sharpest recession in injury experience among the quarry industries. Activity, as gaged by employment data, was at a lower level in 1952 than in 1951. The average number of men working daily dropped 14 percent, and the total man-hours of worktime showed a nearly similar decrease of 11 percent. The average employee had a longer shift and worked 90 hours more during 1952 than he did in 1951.

Sandstone.—The safety record at sandstone quarries was less favorable than in 1951, and the frequency rates of both fatal and nonfatal injuries increased. There were 8 fatalities in 1952, compared with 2 in the previous year, and the rate at which they occurred increased 308 percent to 0.98 per million man-hours. Likewise, the nonfatal-injury rate was raised 9 percent to 51.09. Employment declined to a total of 4,100 men working at sandstone quarries. Days active increased 7 to 247 in 1952; however, the decrease in employment, coupled with a decrease in the length of shift worked, had the effect of reducing the man-hours of worktime to the extent that the average employee accumulated only 7 hours more work in 1952 than he did in 1951.

Abrasive Materials

By Henry P. Chandler [1] and Annie L. Marks [2]

DOMESTIC production and use of abrasive materials in the United States during 1952 declined, in many instances, from the high levels reached in 1951, when records were established in the production and use of many abrasive commodities, both natural and artificial.

The outstanding gain in 1952 was in the importation of industrial diamonds. A record was established, both in quantity and value, exceeding the previous record year of 1944 by 7 percent in weight and 123 percent in value.

Production of artificial and metallic abrasives decreased during 1952, corundum imports declined slightly, and no imports of emery were reported.

This chapter includes data for most materials used for abrasive purposes, but certain clays, carbides, oxides, and other substances noted under Miscellaneous Mineral-Abrasive Materials are not covered. Certain abrasive products for which figures are given also have important nonabrasive uses. Data on the production and use of diatomite and pumice and pumicite, which formerly were included

TABLE 1.—Salient statistics of the abrasives industries in the United States, 1951–52

	1951		1952		Percent of change	
	Short tons	Value	Short tons	Value	Short tons	Value
Natural abrasives (domestic) sold or used by producers:						
Tripoli	37,476	$1,105,135	35,459	$1,043,124	−5	−6
Quartz	281,047	1,165,370	246,604	1,013,637	−12	−13
Ground sand and sandstone	818,479	7,163,343	792,802	6,922,586	−3	−3
Grindstones	5,549	313,901	3,962	246,526	−29	−21
Pulpstones	22	1,970	12	908	−45	−54
Millstones	(1)	6,000	(1)	9,285		+55
Tube-mill liners	1,408	77,027	1,083	66,218	−23	−14
Grinding pebbles	3,062	84,306	4,140	96,537	+35	+15
Garnet	14,050	1,246,947	11,390	981,841	−19	−21
Emery	11,634	160,212	10,352	141,911	−11	−11
Artificial abrasives:						
Silicon carbide—production [2]	100,498	11,734,812	91,531	12,040,946	−9	+3
Aluminum oxide—production [2]	216,329	21,444,343	180,375	17,813,760	−17	−17
Metallic abrasives (steel shot and grit)—shipments	165,138	17,923,301	157,034	17,582,275	−5	−2
Foreign trade (natural and artificial abrasives):						
Imports		[3] 65,267,112		67,418,543		+2
Exports		25,157,033		19,196,200		−24

[1] Tonnage not recorded.
[2] Includes Canadian production.
[3] Revised figure.

[1] Commodity-industry analyst.
[2] Statistical clerk.

in this chapter, are now shown in separate chapters under their respective titles.

NATURAL SILICA ABRASIVES

Tripoli.—Sales of tripoli, amorphous silica, and rottenstone totaled 35,500 short tons valued at $1,043,100 in 1952, a decrease of 5 percent in tonnage and 6 percent in value from 1951. These materials were produced in Illinois, Missouri, and Pennsylvania.

The use of tripoli as an abrasive accounted for the decline; its use as a filler remained the same, while for foundry facings and other uses its sales increased slightly.

Companies producing tripoli, amorphous silica, and rottenstone in 1952 were: Ozark Minerals Co., Cairo, Ill. (amorphous silica); Tamms Industries, Inc., 228 North LaSalle St., Chicago 1, Ill. (amorphous silica); American Tripoli Corp., Seneca, Mo. (tripoli); Penn Paint & Filler Co., Antes Fort, Pa. (rottenstone); and Keystone Filler & Mfg. Co., Muncy, Pa. (rottenstone).

TABLE 2.—Tripoli [1] sold or used by producers in the United States, 1943–47 (average) and 1948–52, by uses [2]

Year	Abrasives		Filler		Other, including foundry facings		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	16,310	$312,191	4,262	$76,801	2,451	$41,724	23,023	$430,716
1948	22,193	606,402	2,723	45,000	1,929	54,121	26,845	705,523
1949	20,972	587,241	2,820	53,938	1,733	49,385	25,525	690,564
1950	34,865	968,497	6,744	147,379	2,111	57,771	43,720	1,173,647
1951	28,000	869,000	7,000	155,000	2,476	81,135	37,476	1,105,135
1952	25,000	771,000	7,000	156,000	3,459	116,124	35,459	1,043,124

[1] Including amorphous silica and Pennsylvania rottenstone.
[2] Partly estimated.

Quotations on tripoli in E&MJ Metal and Mineral Markets during 1952 remained the same as in the previous year. The following prices were quoted (per short ton, paper bags, minimum carlot 30 tons, f. o. b. Missouri): Once-ground through 40-mesh, rose and cream, $30; double-ground through 110-mesh, rose and cream, $32; air-floated through 200-mesh, $35.

Quotations appearing in Oil, Paint and Drug Reporter: Air-floated, 2 cents a pound; double-graded, 1.85 cents a pound; single-graded, 1.75 cents a pound; all prices, in bags, C. L. works.

Importations of tripoli and rottenstone in 1952 totaled 1,461 long tons valued at $116,407. The more important countries of origin, in order named, were: West Germany, France, Mexico, and British East Africa.

Quartz.—Total sales of crude, crushed, and ground quartz from pegmatite veins or dikes and from quartzite in 1952 decreased 12 percent in tonnage and 13 percent in value compared with 1951. Production figures for both the crushed and the ground quartz declined, while crude quartz increased. The principal uses included glass and ferrosilicon, with smaller quantities for abrasives, filters, pottery, tile, and various other uses.

TABLE 3.—Quartz (crude, crushed, and ground) sold or used by producers in the United States, 1943–47 (average) and 1948–52 [1]

Year	Crude		Crushed		Ground [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	21,255	$77,714	53,234	$145,431	8,328	$94,498	82,817	$317,643
1948	41,081	250,184	104,496	374,781	16,284	125,702	161,861	750,667
1949	15,816	74,562	72,432	257,213	19,304	143,716	107,552	475,491
1950	11,062	52,591	117,499	430,256	31,947	223,877	160,508	706,724
1951	8,236	23,098	237,806	890,918	35,005	251,354	281,047	1,165,370
1952	14,473	79,317	207,935	739,882	24,196	194,438	246,604	1,013,637

[1] Does not include sales of quartzite to cement mills or certain sales of quartz or quartzite for use in the manufacture of ferrosilicon.
[2] To avoid duplication, the ground material shown here is only that ground by the original producers of the crude quartz or by grinders who purchase from small miners not reporting their production.

TABLE 4.—Quartz (crude, crushed, and ground) [1] sold or used by producers [2] in the United States, 1950–52, by States

State	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Arizona; California; Oregon; Washington	[3] 89,290	[3] $318,720	193,444	$747,161	178,437	$670,061
Connecticut	27,560	166,810	31,459 (Connecticut and Massachusetts)	193,127	20,199	123,600
Massachusetts	2,145	23,646				
Other States [4]	41,513	197,548	56,144	225,082	47,968	219,976
Total	160,508	706,724	281,047	1,165,370	246,604	1,013,637

[1] To avoid duplication, the ground material included is only that ground by the original producers of the crude quartz or by grinders who purchase from small miners not reporting their production.
[2] Does not include sales of quartzite to cement mills or certain sales of quartz or quartzite for use in the manufacture of ferrosilicon.
[3] Arizona included with "Other States" to avoid disclosure of individual company operations.
[4] Arizona (1950), Maine, Maryland (1952), North Carolina, and Wisconsin (1951–52).

The average value of the quartz reported in this section was $4.11 per short ton in 1952 compared with $4.15 in 1951 and $4.40 in 1950.

Ground Sand and Sandstone.—Sales of ground sand and sandstone in 1952 decreased 3 percent from 1951, both in tonnage and value. The average value per ton in 1952 was $8.73 compared with $8.75 in 1951 and $8.61 in 1950. Illinois, with 34 percent of the total, continued to be the largest ground-sand- and sandstone-producing State; its output in 1952 increased in both tonnage and value over 1951, as contrasted with the national decline in production of that commodity.

TABLE 5.—Ground sand and sandstone sold or used by producers in the United States, 1943–47 (average) and 1948–52

Year	Short tons	Value	Year	Short tons	Value
1943–47 (average)	570,802	$4,183,338	1950	750,673	$6,462,503
1948	692,773	5,778,277	1951	818,479	7,163,343
1949	610,789	5,258,464	1952	792,802	6,922,586

TABLE 6.—Ground sand and sandstone sold or used by producers in the United States, 1950–52, by States

State	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Georgia	1,176	$11,760	1,874	$18,740	1,765	$17,650
Idaho	3,700	29,600	11,968	107,738	9,500	80,000
Illinois	263,122	2,278,237	262,488	2,300,102	267,180	2,342,549
Massachusetts	1,829	9,882	(1)	(1)	(1)	(1)
New Jersey	131,744	936,817	144,098	1,053,991	138,434	1,011,844
Ohio, Virginia, and West Virginia	218,281	2,002,703	249,345	2,305,825	227,878	2,090,278
Other States [2]	130,821	1,193,504	148,706	1,376,947	148,045	1,380,265
Total	750,673	6,462,503	818,479	7,163,343	792,802	6,922,586

[1] Included with "Other States" to avoid disclosure of individual company operations.
[2] California, Massachusetts (1951–52), Michigan (1951–52), Missouri, North Carolina (1950), Oklahoma, Pennsylvania, Washington, and Wisconsin.

Firms producing 85 percent of the ground sand and sandstone reported the end uses of the material. Of this reported quantity the pottery, porcelain, and tile industries consumed 38 percent; abrasive industries—chiefly cleansing and scouring compounds—23 percent; foundries, 15 percent; fillers, 14 percent; and all others, 10 percent.

A process for removal of iron impurities from industrial and quartz sands has been described.[3]

The mining and processing of silica sand produced in Illinois were discussed in a paper presented at a meeting of a technical society.[4]

A supply of high-grade silica for eastern Canadian plants including manufacturers of silicon carbide will be available from a processing plant under construction near Montreal.[5]

TABLE 7.—Ground sand and sandstone sold or used by producers in the United States in 1952, by uses

Use	Short tons	Value	
		Total	Average per ton
Abrasive:			
Cleansing and scouring compound	149,920	$1,203,725	$8.03
Other	8,129	67,168	8.26
Enamel	27,027	216,884	8.02
Filler	91,240	696,885	7.64
Filter	1,375	11,512	8.37
Foundry	101,154	836,194	8.27
Glass	10,125	94,322	9.32
Pottery, porcelain, and tile	255,986	2,493,909	9.74
Other uses [1]	29,707	230,302	7.75
Use reported, total	674,663	5,850,901	8.67
Use unspecified	118,139	1,071,685	9.07
Grand total	792,802	6,922,586	8.73

[1] Includes paint, plaster, roofing, and siding.

[3] Hill, Craig C., Removal of Iron Impurities From Sand and Other Nonmetallic Minerals: Ceram. Age, vol. 60, No. 3, September 1952, pp. 24–25.
[4] Rock Products, Engineers Discuss Nonmetallic Minerals in Chicago Area: Vol. 55, No. 10, October 1952, pp. 118, 120, 140.
[5] Rock Products, Canadian Silica Plant: Vol. 55, No. 6, June 1952, p. 110.

Abrasive Sands.—Considerable tonnages of natural sands with a high silica content are sold for abrasive purposes, such as glass grinding, stone polishing, and sand blasting. Sales of these sands in 1952 totaled 1,236,000 short tons valued at $2,939,000 compared with 1,477,000 short tons valued at $3,112,000 in 1951. The 1952 figures include 605,000 short tons of blast sand valued at $2,053,000, an increase of 10 percent in quantity and 9 percent in value compared with 1951.

In the Sand and Gravel chapter of this volume, where detailed data regarding tonnages produced in each State appear, the quantity and value of these sands are included in the figures given.

SPECIAL SILICA-STONE PRODUCTS

Grindstones and Pulpstones.—The sales of grindstones in 1952 declined 29 percent in tonnage and 21 percent in value from the 1951 figure, and the sales of pulpstones declined 45 percent in tonnage and 54 percent in value. Ohio and West Virginia were the only States reporting the manufacture of grindstones. Pulpstones were produced only in Washington.

Oilstones and Other Sharpening Stones.—Output of natural sharpening stones declined during 1952 from the 1951 figure. The Bureau of Mines is not at liberty to publish the exact figures because of the small number of firms engaged in this industry. Producing States in 1952 were: Arkansas—oilstones and whetstones; Indiana—whetstones; and New Hampshire—scythestones.

Millstones.—The only millstone producer in the United States that reported its production to the Bureau of Mines in 1952 is in Rowan County, N. C. The value of its output increased 55 percent over the preceding year. No firm reported the production of chasers in 1952.

TABLE 8.—Grindstones and pulpstones sold by producers in the United States 1943–47 (average) and 1948–52

Year	Grindstones		Pulpstones		
	Short tons	Value	Quantity: Pieces	Quantity: Equivalent short tons	Value
1943–47 (average)	10,473	$425,244	172	1,353	$42,842
1948	7,921	402,667	12	33	2,100
1949	4,479	244,704	7	28	1,975
1950	4,435	230,462	12	33	2,100
1951	5,549	313,901	6	22	1,970
1952	3,962	246,526	4	12	908

TABLE 9.—Value of millstones and chasers sold by producers in the United States, 1943–47 (average) and 1948–52 [1]

Year	Number of producers	Value	Year	Number of producers	Value
1943–47 (average)	4	$14,385	1950	2	$11,300
1948	3	17,733	1951	1	6,000
1949	2	9,400	1952	1	9,285

[1] Produced in Minnesota (1945 only), New York (1943–48 only), North Carolina, and Virginia (1943–50 only).

Grinding Pebbles and Tube-Mill Liners.—The combined output of grinding pebbles and tube-mill liners in 1952 increased 17 percent in tonnage and 1 percent in value over 1951. Grinding-pebble production was reported from the following States: Minnesota, North Carolina, Texas, Washington, and Wisconsin. Tube-mill liners were produced in Minnesota, North Carolina, and Wisconsin.

TABLE 10.—Grinding pebbles and tube-mill liners sold or used by producers in the United States, 1943–47 (average) and 1948–52

Year	Grinding pebbles		Tube-mill liners		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	7,413	$151,386	2,100	$43,077	9,513	$194,463
1948	4,026	101,583	1,297	41,555	5,323	143,138
1949	2,374	64,038	1,166	47,093	3,540	111,131
1950	1,923	53,007	1,523	62,535	3,446	115,542
1951	3,062	84,306	1,408	77,027	4,470	161,333
1952	4,140	96,537	1,083	66,218	5,223	162,755

NATURAL SILICATE ABRASIVE

Garnet.—Domestic production of garnet declined 19 percent in tonnage and 21 percent in value from the preceding year. The trend in output (sales) of garnet since 1920 is shown in figure 1. New York continued to be the leading State in production, with Idaho second. Small quantities of garnet were produced as byproducts of the concentration of other minerals, but the larger portion of the production came from deposits mined only for their garnet content. Garnet producers reporting sales in 1952 were: Idaho Garnet Abrasive Co., Fernwood, Idaho; Cabot Carbon Co., Willsboro, N. Y.; Barton Mines Corp., North Creek, N. Y.; and Florida Ore Processing Corp., Melbourne, Fla. Garnet mining in Idaho was the subject of a paper presented at a meeting of the American Institute of Mining and Metallurgical Engineers.[6]

TABLE 11.—Abrasive garnet sold or used by producers in the United States, 1947–52

Year	Short tons	Value	Year	Short tons	Value
1947	8,722	$614,071	1950	9,304	$793,558
1948	8,039	587,797	1951	14,050	1,246,947
1949	6,578	505,231	1952	11,390	981,841

The production and export of garnet have been reported from Madagascar [7] and Brazil.[8]

The average reported price of garnet at the mine in 1952 was $86.20 a short ton.

[6] McDivitt, J. V., Garnets in Idaho: Min. Eng., vol. 4, No. 7, July 1952, pp. 711–712.
[7] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 1, January 1952, p. 24.
[8] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 3, March 1952, p. 38.

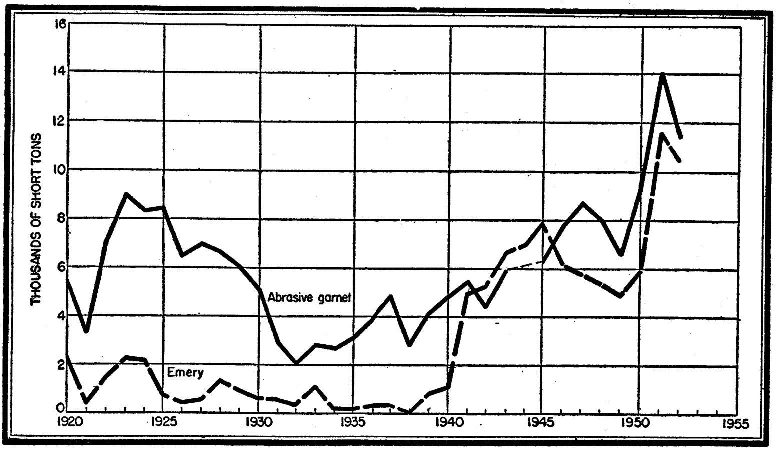

FIGURE 1.—Marketed production of abrasive garnet and domestic emery in the United States, 1920–52.

NATURAL ALUMINA ABRASIVES

Corundum.—The world's largest producer and exporter of corundum continued to be the Union of South Africa; the output in that country was 3,791 metric tons during 1952.

India's production was principally for local consumption. The Geological Survey of India listed 4 producers during 1952.[9]

Small quantities of corundum were produced in Malaya,[10] Nyasaland,[11] and the Belgian Congo,[12] but the mines of Madagascar, formerly productive, were inactive.[13]

Promising corundum deposits are reported to exist in Namaqualand, South Africa.[14]

No commercial production of corundum was reported in the United States or Canada.

Notes on the occurrence and use of corundum appeared in the technical press.[15]

Prices of corundum during 1952, as quoted by an abrasive company, were as follows: Per pound, in ton lots, grinding wheel grain, 12¼ cents, delivered; optical grain, sizes 120 and coarser, 10½ cents, f. o. b.; optical grain, sizes 140 and finer, 11½ cents, f. o. b.; optical powders, size 500 and finer, 31½ cents, f. o. b.

Emery.—Domestic production of emery in 1952 declined 11 percent from 1951 in both tonnage and value. No importation of emery ore was reported. As in recent years, the only domestic producers of emery in 1952 were Joe DeLuca and DiRubbo & Ellis, both of Peekskill, N. Y.

The average value of domestic emery at the mine in 1952 was $13.71 a short ton. The sales of emery since 1920 are presented graphically in figure 1.

---

9 Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 1, January 1952, p. 24.
10 Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 4, October 1952, p. 28.
11 Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 2, August 1952, p. 28.
12 Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, p. 48.
13 Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 4, October 1952, p. 28.
14 South African Mining and Engineering Journal, Base Metals in Namaqualand: Vol. 62, No. 3077, Feb. 2, 1952, p. 985.
15 Chemical Engineering and Mining Review, Corundum: Vol. 44, No. 8, May 10, 1952, p. 318.

TABLE 12.—World production of corundum by countries,[1] 1947–52,[2] in metric tons

[Compiled by Helen L. Hunt]

Country [1]	1947	1948	1949	1950	1951	1952
Brazil	2	(3)	(3)	(3)	(3)	(3)
French Equatorial Africa	3				(3)	(3)
India	182	284	1,493	304	557	(3)
Kenya				2		
Madagascar	1	4	7			
Malaya, Federation of [4]				10	25	(3)
Mozambique		6		16		(3)
Nyasaland			113	187	101	47
Southern Rhodesia		114				
South-West Africa				10		
Union of South Africa	2,313	2,537	2,464	3,201	4,563	3,791
Total (estimate) [1]	8,000	8,000	9,000	9,000	10,000	10,000

[1] In addition to countries listed, corundum is produced in Argentina and U. S. S. R., but data on production are not available, and estimate is included in the total.
[2] This table incorporates a number of revisions of data published in previous annual reviews of corundum.
[3] Data not available; estimate by seniör author of chapter included in total.
[4] Estimate.

TABLE 13.—Emery sold or used by producers in the United States, 1943–47 (average) and 1948–52

Year	Short tons	Value	Year	Short tons	Value
1943–47 (average)	6,690	$66,611	1950	5,949	$75,308
1948	5,405	69,408	1951	11,634	160,212
1949	4,909	60,917	1952	10,352	141,911

Production of emery in Turkey during 1952 totaled 8,239 metric tons compared with 7,363 metric tons in 1951. Exports of emery were 6,237 metric tons in 1952 compared with 10,889 metric tons in 1951. Export shipments were made through the port of Güllük.[16]

Exports of emery from Greece in 1951 totaled 10,056 metric tons valued at U. S. $201,320.[17]

INDUSTRIAL DIAMONDS

World production of diamonds of all types in 1952 totaled approximately 18,700,000 metric carats, of which some 15,800,000 carats was classed as industrial stones. This was a 13-percent increase over 1951 in the production of industrial diamonds. Belgian Congo continued to be, as in recent years, the largest producer of industrial diamonds, contributing in 1952 about 71 percent of the world's supply.

About 99 percent of all the industrial diamonds mined during 1952 originated in Africa.

[16] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, p. 56.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 4, April 1952, p. 47.

TABLE 14.—World production of industrial diamonds, by countries, 1951–52, in metric carats

Country	1950	1951	1952
Africa:			
Angola	237,000	323,000	305,000
Belgian Congo	9,740,000	10,040,000	11,200,000
French Equatorial Africa	118,000	122,000	147,000
French West Africa	94,000	94,000	110,000
Gold Coast	800,000	1,360,000	1,860,000
Sierra Leone	433,000	314,000	312,000
South-West Africa	24,000	96,000	108,000
Tanganyika	37,000	53,000	62,000
Union of South Africa:			
"Pipe" mines:			
Premier		900,000	1,000,000
DeBeers group	970,000	400,000	393,000
Others		7,000	7,000
Alluvial mines		150,000	140,000
Total Africa	12,453,000	13,859,000	15,644,000
Brazil [1]	120,000	100,000	100,000
British Guiana	10,000	13,000	13,000
Venezuela	15,000	25,000	40,000
Australia, Borneo, India, etc.[1]	2,000	3,000	3,000
World total	12,600,000	14,000,000	15,800,000

[1] Estimate.

While nearly all of the diamond-producing areas continued either to maintain or increase production of industrial diamonds, a substantial gain in the output of the Native Reserve in the Gold Coast was noteworthy.

Statistics giving the production of industrial diamonds in various regions, and descriptions of diamond mining operations, frequently appeared in trade journals during 1952.[18]

Importation of industrial diamonds of all classifications into the United States during 1952 totaled 13,677,248 carats, valued at $51,818,003, an increase of 11 percent by weight and 11 percent in value over 1951.

The United States Government continued during 1952 to purchase industrial diamonds for the national stockpile.

The diamond-grinding-wheel industry continued to be the largest consumer of industrial diamonds. A large proportion of these wheels is used in grinding cemented-carbide tools and other objects made of

[18] Mining World, South-West Africa: Vol. 14, No. 2, February 1952, p. 54.
Mining and Industrial Magazine of Southern Africa, Record Diamond Sales in 1951: Vol. 42, No. 2, February 1952, p. 59.
Mining Journal (London), Diamonds: Vol. 238, No. 6086, Apr. 11, 1952, p. 370.
Mining World and Engineering Record (London), DeBeers Group: Vol. 162, No. 4230, Apr. 26, 1952, p. 258.
Mining and Industrial Magazine of Southern Africa, Diamond Statistics: Vol. 42, No. 5, May 1952, p. 203
Mining Journal (London), Anglo-American Interests in British Guiana: Vol. 239, No. 6099, p. 41; Diamond Sales Attain New Peak in First Six Months: July 11, 1952, p. 47.
Mining Journal (London), The Diamond Industry: Vol. 238, No. 6094, June 6, 1952, p. 595.
Mining Journal (London), Diamonds: Vol. 239, No. 6100, July 18, 1952, pp. 65–66.
South African Mining and Engineering Journal, Important Diamond Agreement: Vol. 63, No. 3098, June 28, 1952, p. 761.

TABLE 15.—Industrial diamonds (including diamond dust and manufactured bort) imported for consumption in the United States, 1951–52, by countries

[U. S. Department of Commerce]

Country	Bort, manufactured (diamond dies)		Bort (glaziers' and engravers' diamonds, unset, and miners')		Carbonado and ballas		Dust	
	Carats	Value	Carats	Value	Carats	Value	Carats	Value
1951								
Argentina			155	$4,337				
Australia							500	$1,125
Belgian Congo			6,685,514	12,959,227			19,661	52,057
Belgium-Luxembourg	500	$19,217	402,934	4,372,051			43,448	26,849
Brazil			[1] 90,023	[1] 1,482,951	2,239	$31,629		
British Guiana			187	2,404				
Canada	5	425	[1] 331,134	1,889,450			7,821	19,874
Colombia			1,200	3,840				
France	3,824	234,117	60,755	1,180,971				
Germany	234	8,549						
Israel	18	114	2,625	25,031				
Netherlands	1,253	127,989	120,472	1,088,664			5,500	11,200
Switzerland	537	19,679	[1] 68,917	[1] 889,816			31,625	12,822
Union of South Africa			[1] 451,547	[1] 1,495,815			5,385	18,043
United Kingdom	288	2,615	[1] 3,891,086	[1] 20,650,161			47,820	320,776
Venezuela			[1] 11,859	[1] 251,275			5,000	8,750
Total	6,659	412,705	[1] 12,118,408	[1] 46,295,993	2,239	31,629	166,760	471,496
1952								
Argentina					1,855	20,405		
Australia			1,778	18,885				
Belgian Congo			6,862,047	15,383,284			24,570	75,279
Belgium-Luxembourg	4,355	55,411	160,105	1,933,587			12,368	19,566
Bermuda			3,115	36,111				
Brazil			30,519	611,230	8,188	115,101		
British Guiana			255	5,005				
Canada	23	453	687,885	3,441,061			26,857	68,225
France	2,459	148,380	7,865	121,981			1,100	6,000
French Equatorial Africa			3,703	130,398	2,284	19,557		
Germany, West	784	28,296	12	105			200	1,334
India			3,101	59,334				
Israel			1,543	17,234				
Japan			520	8,628				
Netherlands	3,429	144,981	66,624	723,920			125	250
Surinam			237	4,104				
Sweden			91	2,100				
Switzerland	163	4,129	131,413	1,173,691				
Union of South Africa			402,637	1,168,789			9,222	21,416
United Kingdom	418	9,750	5,047,074	25,419,771	131	1,469	149,987	600,881
Venezuela			29,826	609,272	11	30		
Total	11,631	391,400	13,440,350	50,868,490	12,469	156,562	224,429	792,951

[1] Revised figure.

TABLE 16.—Industrial diamonds (excluding diamond dust and manufactured bort) imported for consumption in the United States, 1947–52

[U. S. Department of Commerce]

Year	Carats	Value		Year	Carats	Value	
		Total	Average			Total	Average
1947	3,999,119	$13,312,668	$3.33	1950	11,039,036	$36,792,832	$3.33
1948	10,421,207	32,581,385	3.13	1951	[1] 12,120,647	[1] 46,327,622	[1] 3.82
1949	6,279,096	17,392,288	2.77	1952	13,452,819	51,025,052	3.79

[1] Revised figure.

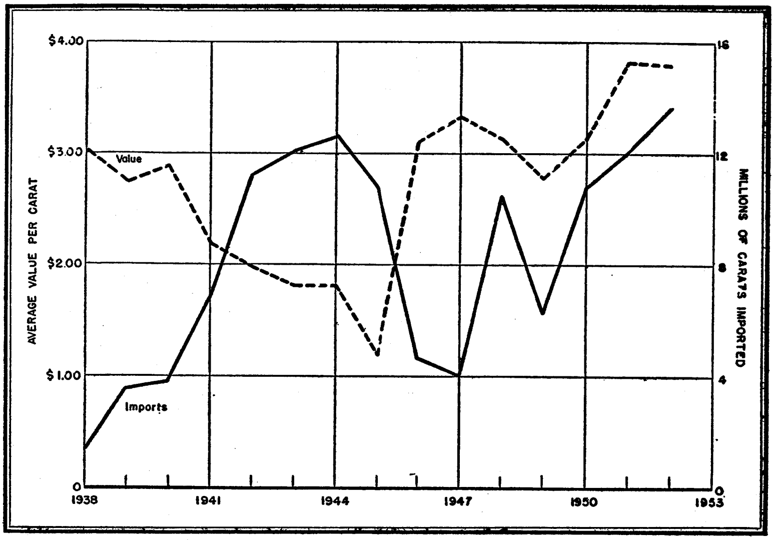

FIGURE 2.—United States imports and average price per carat of industrial diamonds, 1938–52.

carbides. The industry anticipates further increases in the demand for industrial diamonds and of diamond dust for finishing carbide parts.[19]

Owing to the increased price and the high demand for certain types of industrial diamonds, the questions of recovering diamond material from grinding sludges, used diamond wheels, and tools, has been given much consideration, and several firms are now engaged in such recovery.[20]

Efforts also were made to use diamond grinding wheels and tools more efficiently,[21] and substitute grinding methods are being tried in an attempt to conserve the industrial diamond supply.[22]

---

[19] American Metal Market, Increased Volume of Machine Tool Work Lifts Diamond Consumption: Vol. 59, No. 230, Dec. 2, 1952, pp. 1, 3.

[20] Waste Trade Journal, Chrysler Speeds Recovery of Industrial Diamonds: Vol. 93, No. 25, Sept. 13, 1952, p. 48.
Modern Industry, Are Diamonds Your Plant's Big Problem?: Vol. 24, No. 5, Nov. 15, 1952, pp. 133–134.
Iron Age, Diamond Conservation Worth Cost: Vol. 170, No. 6, Aug. 7, 1952, p. 89.
Compressed Air Magazine, Norton Co., Industrial Diamonds: Vol. 57, No. 4, April 1952, p. 119.
Iron Age, Diamond-Dust Salvage: Vol. 170, No. 9, Aug. 28, 1952, p. 84.
Screw Machine Engineering, Diamond Dust Reclaimed: September 1952, p. 63.
Product Engineering and Management, Diamond Salvage Pays Dividends: Vol. 30, No. 4, October 1952, p. 80.
Weavind, R. G., and Young, R. S., Diamond Recovery From Grinding-Wheel Sludges: Ind. Diamond Review, vol. 12, No. 135, February 1952, p. 38.
Steel, Industrial Diamonds in Rough: Vol. 131, No. 21, Nov. 24, 1952, p. 75.

[21] Larsen, E. T., How to Conserve Diamond Wheel: Am. Machinist, vol. 96, No. 4, Feb. 18, 1952, pp. 173–175.
Kauffman, D., Wet Grinding Saves Diamonds: Tool Eng., vol. 29, No. 4, October 1952, pp. 45–47.
Taeyaerts, J., Diamond-Wheel Life Extended by Plunge-Cut Grinding of Carbides: Ind. Diamond Rev., vol. 12, No. 145, December 1952, pp. 266–270.
Ashburn, A., Why and How: We Must Conserve Diamond Boart: Am. Machinist, vol. 96, No. 23, Nov. 10, 1952, pp. 151–153.
American Machinist, Drive on to Conserve Industrial Diamonds: Vol. 96, No. 10, May 12, 1952, p. 190.

[22] Metzger, L. R., What You Can Do About the Diamond-Wheel Shortage: Iron Age, vol. 169, No. 10, Mar. 6, 1952, pp. 203–207.
Thibault, N. W., and Anderson, B. H., Electrolytic Grinding of Carbides Fully Tested: Iron Age, vol. 170, No. 20, Nov. 13, 1952, pp. 162–165.
Beardslee, K. R., Substitutes for Diamonds: Steel, vol. 131, No. 22, Dec. 1, 1952, p. 104.
U. S. National Production Authority, Diamond-Grinding-Wheel Limitations Proposed: Jour. Commerce, New York, Jan. 11, 1952.

The supply situation and distribution methods were discussed in many articles in the public press.[23]

Reports of the development of methods for increasing recovery during mining operations and efficiency of use in industry have appeared in technical publications.[24]

A symposium was held in Johannesburg, South Africa, at which the various phases of diamond core drilling were discussed.[25]

The correct size and type of diamond set in a bit designed to drill specific rock were discussed in a trade paper.[26]

A technique has been developed for cutting drill cores with diamond-faced wheels.[27]

Recent developments in diamond blast-hole drilling have been described.[28]

The relative hardness of various abrasive materials, including several types of industrial diamonds, was the subject of a recent publication.[29]

Standardization received some attention during the year. One writer proposed that the term boart (bort), as applied to certain kinds of diamonds, be applied to diamonds useful only for crushing purposes.[30] Another noted the need for diamond-tool standards.[31]

A review of the subject of synthetic diamonds was given in an article in a trade paper.[32]

Further investigation on the orientation of industrial diamonds in setting diamond bits for core drilling was described in a Bureau of Mines report.[33]

ARTIFICIAL ABRASIVES

Production of all types of artificial abrasives declined in 1952 from the preceding year. Aluminum oxide declined 17 percent both in tonnage and value; silicon carbide declined 9 percent in tonnage, but its value increased 3 percent; and metallic abrasives declined 5 percent in tonnage and 2 percent in value. The production of aluminum oxide included 16,620 short tons of "white high-purity" material valued at $2,294,960 in 1952, compared with 27,262 short tons valued

[23] Financial Times (London), Marketing of Diamonds: Feb. 2, 1952, p. 2.
Stock Exchange Gazette (London), Diamonds, A Controlled Commodity: Vol. 52, No. 2669, Feb. 22, 1952, pp. 326–327.
Iron Age, No Boost in Diamond Stock Seen: Vol. 169, No. 12, Mar. 20, 1952, p. 63.
Steel, Industrial Diamond Supply: Vol. 131, No. 21, Nov. 24, 1952, p. 75.
American Metal Market, Industrial Diamond Problems Are Discussed: Dec. 6, 1952.
Mining Journal (London), Black Market in Diamonds: Vol. 238, No. 6074, Jan. 18, 1952, p. 77.
South African Mining and Engineering Journal, Black Market in Diamonds: Vol. 62, No. 3077, Feb. 2, 1952, p. 975.

[24] Weavind, R. G., Treatment and Recovery of "Wettable" Diamonds: South African Min. and Eng. Jour., vol. 63, No. 3105, Aug. 16, 1952, pp. 1023–1027.
Wagner, H. W., Cost of Grinding Carbide: Am. Machinist, vol. 96, No. 8, Apr. 14, 1952, p. 183.
Dauncey, G. B., and Young, R. S., Machining of Tungsten Carbide With Diamond Tools: Ind. Diamond Rev., vol., 12, No. 141, August 1952, pp. 161–164.

[25] Mining Magazine (London), Diamond-Drilling Symposium in Johannesburg: Vol. 238, No. 6091, May 16, 1952, pp. 502–503, 533–534, 558–559.

[26] Westman, Burton J., Drilling Tips for Diamond Bits: Min. World, vol. 14, No. 12, November 1952, pp. 32, 39–40.

[27] Mining World, Diamond-Drill Cores Sawed for Easy Study and Storage: Vol. 14, No. 11, October 1952, p. 39.

[28] Gayfer, E. R., and Peterson, V. E., Diamond Blast-Hole Drilling at Mufulira: Min. and Ind. Mag., vol. 42, No. 8, August 1952, pp. 186–189.

[29] Kohn, J. A., Survey of the Study of Hardness: Ind. Diamond Rev., vol. 12, No. 137, April 1952; Spec. Suppl., 13 pp. and bibliography.

[30] Grodzinski, P., The Meaning of "Boart": Ind. Diamond Rev., vol. 12, No. 144, November 1952, pp. 233–234.

[31] Strauss, H. L., Jr., Wanted: Diamond-Tool Standards: Iron Age, vol. 169, No. 4, Jan. 24, 1952, p. 69.

[32] Chemical Age (London), Synthetic Diamonds: Vol. 67, No. 1739, Nov. 8, 1952, p. 638.

[33] Long, Albert E., and Slawson, C. B., Diamond Orientation in Diamond Bits: Bureau of Mines Rept. of Investigations 4853, 1952, 6 pp.

at $3,749,670 in 1951, a decrease of 39 percent in quantity and 39 percent in value for that item. Of the production of artificial abrasives, 4 percent of the aluminum oxide and 46 percent of the silicon carbide were used for refractories or other nonabrasive purposes. These percentages are the same as in the preceding year.

The ratio of production to annual plant capacity for aluminum oxide was 71 percent compared with 87 percent in 1951; silicon carbide 82 percent compared with 94 percent; and for metallic abrasives 69 percent compared with 68 percent in 1951.

An increase in the capacity of a silicon carbide plant in Washington was reported.[34]

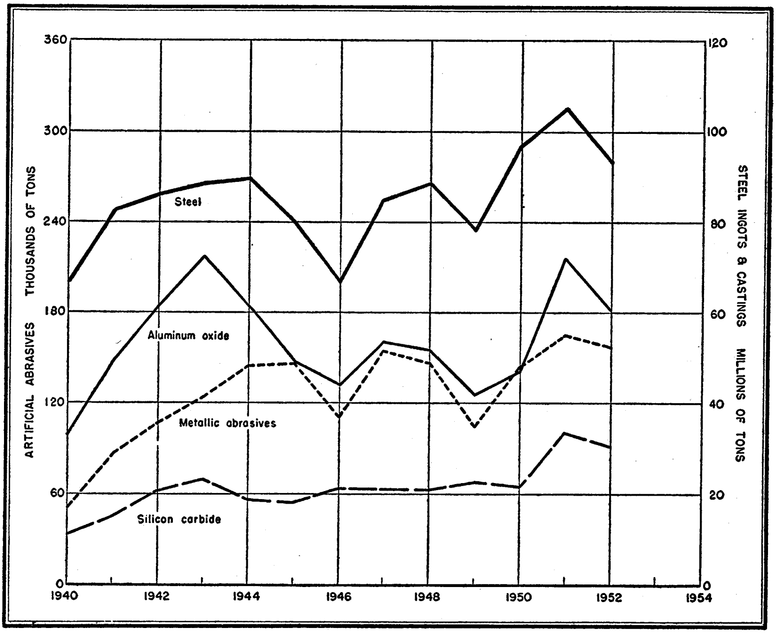

FIGURE 3.—Relationship between ingot-steel and artificial abrasive production.

TABLE 17.—Crude artificial abrasives produced in the United States and Canada, 1943–47 (average) and 1948–52

Year	Silicon carbide [1]		Aluminum oxide [1] (abrasive grade)		Metallic abrasives [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	61,469	$5,192,127	168,424	$10,505,358	136,393	$8,577,279	366,286	$24,274,764
1948	63,033	5,874,731	154,972	10,279,583	147,218	15,174,773	365,223	31,329,087
1949	67,539	6,055,763	125,806	8,500,074	104,778	9,312,368	298,123	23,868,205
1950	65,004	7,303,671	140,352	11,958,035	144,333	11,699,764	349,689	30,961,470
1951	100,498	11,734,812	216,329	21,444,343	165,138	17,923,301	481,965	51,102,456
1952	91,531	12,040,946	180,375	17,813,760	157,034	17,582,275	428,940	47,436,981

[1] Bureau of Mines not at liberty to publish data for United States separately. Figures include a small quantity used for refractories and other nonabrasive purposes.
[2] Shipments from United States plants only.

[34] News Letter, Raw Materials Survey, Inc., Carborundum to Double Vancouver Plant: Issue 1, Ser. 52, Mar. 10, 1952, p. 1.

The need for careful study of grinding and finishing operations and the use of the correct abrasive and specifications for each operation has been emphasized in a trade-journal article.[35]

The use of coated abrasives (paper or cloth, coated with abrasives), more especially those made with aluminum oxide and silicon carbide, is expanding, and new applications of this type of use for artificial abrasives has been described.[36]

Artificial abrasive grain is finding a wide application in tumbling operations where precision finishes for metal parts are required.[37]

TABLE 18.—Stocks of crude artificial abrasives and capacity of manufacturing plants, as reported by producers in the United States and Canada, 1943–47 (average) and 1948–52, in short tons

Year	Silicon carbide		Aluminum oxide		Metallic abrasives [1]	
	Stocks, Dec. 31	Average annual capacity	Stocks, Dec. 31	Average annual capacity	Stocks, Dec. 31	Average annual capacity
1943–47 (average)	6,302	71,763	30,549	231,258	6,571	205,407
1948	5,387	73,250	34,177	233,500	9,907	240,129
1949	21,964	81,121	49,505	237,072	10,144	231,650
1950	8,766	84,398	22,025	238,500	7,291	209,850
1951	11,786	106,741	32,428	249,000	9,843	244,178
1952	25,347	111,200	60,354	255,100	9,801	226,427

[1] Figures pertain to United States plants only.

MISCELLANEOUS MINERAL-ABRASIVE MATERIALS

In addition to the natural and manufactured abrasive materials for which data are included herein, many other minerals are used for abrasive purposes. A number of oxides, including tin oxides, magnesia, iron oxides (rouge and crocus), and cerium oxide are employed as polishing agents. Certain carbides, such as boron carbide and tungsten carbide are used for their abrasive properties, especially when extreme hardness is demanded. Other substances with abrasive applications include finely ground and calcined clays, lime, talc, ground feldspar, river silt, slate flour, and whiting.

FOREIGN TRADE[38]

Imports.—The total value of imports of abrasive materials, both natural and artificial, for consumption during 1952 increased 3 percent over 1951. Although substantial gains were noted in the imports of industrial diamonds of all types, the imports of artificial abrasives declined. Imports of corundum ore declined slightly, and no importations of emery ore were reported.

[35] Glenn, C. R., Use of Abrasives: Am. Machinist, vol. 96, No. 12, June 23, 1952, pp. 102–103.

[36] Hyler, John E., Uses for Industrial Coated Abrasives Expanded: Iron Age, vol. 170, No. 4, July 24, 1952, pp. 98–101; and vol. 170, No. 5, July 31, 1952, pp. 91–95.

[37] Metal Progress, Abrasive Tumbling Gives Precision Finishes Economically: Vol. 62, No. 4, October 1952, pp. 104–108.

[38] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

Exports.—Exports of natural and artificial abrasives declined 24 percent in 1952 from 1951. Exports included 9,984 short tons of aluminum oxide valued at $2,632,113 and 7,679 short tons of silicon carbide valued at $2,476,960. Also included were 199,937 reams and rolls of abrasive paper and cloth valued at $5,400,522.

TABLE 19.—Abrasive materials (natural and artificial) imported for consumption in the United States, 1950–52, by kinds

[U. S. Department of Commerce]

Kind	1950		1951		1952	
	Quantity	Value	Quantity	Value	Quantity	Value
Burrstones: Bound up into millstones short tons	3	$514	18	$3,142	7	$1,236
Grindstones, finished or unrefined short tons	297	13,586	213	15,892	195	16,367
Hones, oilstones, and whetstones short tons	19	26,398	12	28,098	17	39,058
Corundum (including emery):						
Corundum ore short tons	3,543	194,427	[1] 4,754	[1] 261,809	4,571	273,527
Emery ore do	1,726	21,560	2,810	33,519		
Grains, ground, pulverized, or refined pounds	21,097	1,442	20,872	1,154	25,644	1,791
Paper and cloth coated with emery or corundum reams	18,552	193,305	4,669	141,068	2,005	106,133
Wheels, files, and other manufactures of emery pounds	15,542	12,657	59,829	49,171	10,278	10,591
Wheels of corundum or silicon carbide pounds	2,755	1,863	2,343	4,064	6,439	16,523
Garnet in grains, ground, etc do	6,181	159			3,000	250
Tripoli or rottenstone short tons	(2)	68	11	430	1,636	116,407
Diamonds:						
Bort, manufactured carats	2,694	175,556	6,659	412,705	11,631	391,400
Crushing bort do	[1] 11,035862	36,742,326	[1] 12,118,408	[1] 46,295,993	8,806,473	19,920,968
Other industrial diamonds do					4,633,877	30,947,522
Carbonado and ballas do	3,174	50,506	2,239	31,629	12,469	156,562
Dust do	159,315	207,846	166,760	471,496	224,429	792,951
Flint, flints, and flintstones, unground short tons	34,802	187,113	17,780	[1] 419,572	7,871	186,688
Grit, shot, and sand, of iron and steel pounds	2,707,274	281,067	3,068,156	729,050	434,693	194,689
Artificial abrasives:						
Crude, n. s. p. f.:						
Carbides of silicon (carborundum, crystalon, carbolon, and electrolon) pounds	79,862,853	3,377,890	131,969,230	5,684,492	101,367,729	4,862,990
Aluminous abrasives, alundum, aloxite, exolon, and lionite pounds	234,208,185	7,003,527	[1] 333,578,195	[1] 10,751,288	266,541,342	9,164,982
Other do	2,225,600	73,008	1,624,240	59,130	1,601,853	70,063
Manufactures:						
Grains, ground, pulverized, refined, or manufactured pounds	761,849	80,791	1,951,005	204,450	1,192,390	125,221
Wheels, files, and other manufactures, not specifically provided for pounds	28,372	11,354	37,711	28,960	23,685	22,624
Total		48,656,963		[1] 65,627,112		67,418,543

[1] Revised figure.
[2] Less than 1 ton.

TABLE 20.—Abrasive materials (natural and artificial) exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Grindstones and pulpstones		Diamond dust		Diamond grinding wheels		Other natural, artificial, and metallic abrasives, and products[1] (value)	Total value
	Pounds	Value	Carats	Value	Pounds	Value		
1948	2,887,995	$131,725	52,600	$80,352	11,562	$270,929	$14,784,664	$15,267,670
1949	1,407,680	82,090	55,637	133,917	10,285	321,936	16,909,456	17,447,399
1950	1,027,599	55,283	58,563	126,089	12,807	502,523	15,491,157	16,175,052
1951	1,344,458	76,330	60,621	166,539	15,317	539,770	24,374,394	25,157,033
1952	789,786	59,258	79,183	216,115	(2)	501,239	18,419,588	19,196,200

[1] Exclusive of steel wool.
[2] January 1 through June 30: 4,992 pounds ($256,946); July 1 through December 31: 47,253 carats ($244,293).

Aluminum

By Delwin D. Blue[1]

DESPITE an increase in the United States production of both primary and secondary aluminum, the demand for this metal exceeded supply, and Government control of prices, distribution and consumption was continued throughout 1952. Market conditions in the United States contrasted with those of the other non-Soviet aluminum-producing countries where supply appeared to be catching up with demand during the latter part of 1952, and a number of countries were actively seeking export markets. Although domestic consumers needed additional supplies, the asking price for foreign aluminum (exclusive of Canadian) was not generally competitive with similar domestic products. The expansion programs in progress in both the production and fabrication segments of the aluminum industry, plus the technologic advances in aluminum fabrication, uses, and products, indicated a continued high level of demand.

TABLE 1.—Salient statistics of the aluminum industry, in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Primary production short tons	634, 613	623, 456	603, 462	718, 622	836, 881	937, 330
Value	$181, 219, 600	$180, 755, 000	$190, 303, 000	$235, 977, 000	$305, 074, 000	$344, 320, 000
Quoted price per pound cents	15. 0	15. 7	17. 0	17. 7	19. 0	19. 4
Secondary production short tons	312, 181	286, 777	180, 762	243, 666	292, 608	304, 522
Imports	$38, 115, 602	$42, 203, 519	$36, 815, 965	[1] $68, 565, 980	[1] $63, 469, 555	$61, 769, 406
Exports	$47, 887, 804	$43, 219, 940	$32, 924, 653	$22, 152, 985	$19, 259, 942	[2] $12, 888, 013
World production short tons	1, 405, 000	1, 395, 000	1, 440, 000	1, 650, 000	1, 975, 000	2, 260, 000

[1] Revised figure.
[2] Data not strictly comparable with previous years due to changes in classification.

DOMESTIC PRODUCTION

PRIMARY

Production of primary aluminum in the United States was at an alltime yearly high in 1952, surpassing the previous peak established in 1943 by over 17,000 tons. The maximum monthly production of 85,175 tons, obtained in August, was still below the production rate of the last 4 months of 1943.

The continued increase in quarterly production that had occurred since the first quarter of 1950 was interrupted in the last quarter of 1952 when a hydroelectric power shortage in the Pacific Northwest and in the Tennessee Valley resulted in production losses from reduction plants at Troutdale, Oreg.; Vancouver, Longview, Wenatchee,

[1] Assistant chief, Light Metals Branch.

and Spokane, Wash.; Alcoa, Tenn.; and Badin, N. C. Production during November at the height of the power shortage decreased 12 percent from August to 74,639 tons despite increased production from new plants at Rockdale and San Patricio, Tex., and Chalmette, La.

TABLE 2.—Production of primary aluminum in the United States 1948–52 by quarters,[1] in short tons

	1948	1949	1950	1951	1952
1st quarter	146, 340	157, 957	161, 213	200, 716	226, 377
2d quarter	157, 284	165, 169	180, 353	202, 875	235, 158
3d quarter	161, 145	157, 520	185, 973	215, 943	240, 425
4th quarter	158, 687	122, 816	191, 083	217, 347	235, 370
Total	623, 456	603, 462	718, 622	836, 881	937, 330

[1] Quarterly production adjusted to final annual totals.

Although fall and winter hydroelectric power shortages have occurred frequently, the lost production was felt more acutely in the defense economy when requirements were running well ahead of the supply. On September 3, seven-eighths of the Pacific Northwest power supplied to the aluminum industry under contracts that permitted power interruptions during periods of low water supply were withdrawn. On November 1 all such power was withdrawn; and, effective November 17, all industrial users were ordered by the Government to cut consumption of power supplied under firm contracts to 90 percent of the amounts used in the like period of 1951. Production losses in the Pacific Northwest at established reduction plants during the September through December period were estimated at approximately 30,000 tons. In addition, new facilities at Wenatchee (2 potlines) and Spokane (1 potline) that could have initiated production or that had just begun production could not be operated, resulting in an additional estimated production loss of 18,000 tons. In the Tennessee Valley, power shortages resulted in a loss of 13,000 to 14,000 tons at Alcoa and Badin. Earlier in 1952, on June 24, a severe electrical storm at Massena, N. Y., damaged that installation and forced a shutdown of 9 of the 13 operating potlines. During the 5-week period required for repairs and resumption of full-scale operations, production losses were about 6,000 tons.

The 100,000-ton increase over 1951 primary-aluminum production was obtained from three new reduction plants, increased production from new potlines at established plants, a full year's production from facilities that started operating in 1951, and a better power supply (largely high-cost) at the Massena, N. Y., and Listerhill, Ala., plants. The Wenatchee, Wash., and Rockdale, Tex., smelters of the Aluminum Co. of America (Alcoa), tapped the first metal in June and November, respectively; and the San Patricio, Tex., smelter of the Reynolds Metals Co. started production in April. Alcoa placed one new potline in operation during March and a second in June at the Point Comfort, Tex., plant; Kaiser Aluminum & Chemical Corp. opened its eighth potline at Spokane, Wash., in July, and production at Kaiser's Chalmette, La., plant, which was initiated in December 1951, increased throughout the year; in November the fourth and final potline of the first of two 100,000-ton-annual-capacity plants at this location began operation. At Reynolds' Jones Mills plant, the first full year of production was obtained from the new facilities completed in 1951. Production from new facilities yielded approximately 100,000 tons in 1952. The plants at Rockdale, Wenatchee, Point Comfort, Chalmette, and San Patricio had not reached rated capacity at the end of 1952. Plants being constructed at Chalmette, La. (second 100,000-ton plant), by Kaiser, near Arkadelphia, Ark., by Reynolds, and at Columbia Falls, Mont., by Anaconda Aluminum Co. had not begun production.

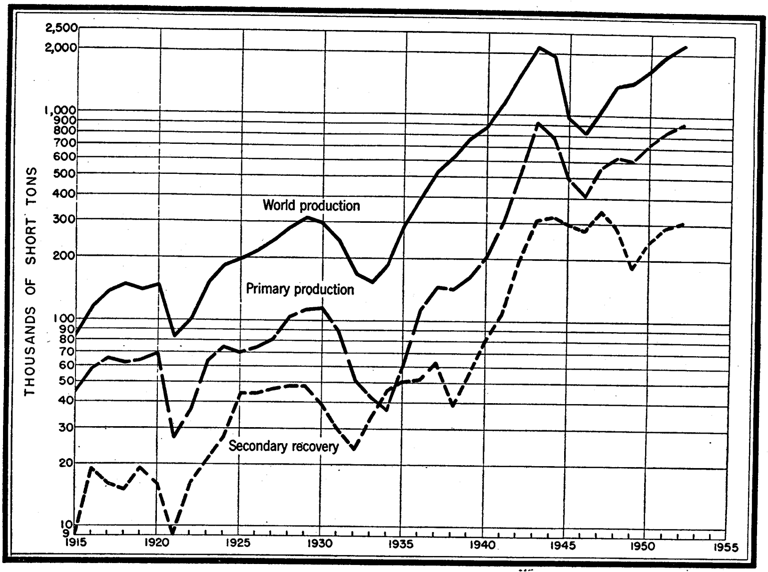

FIGURE 1.—World and domestic primary production and domestic secondary recovery of aluminum, 1915–52.

The threat of a labor strike, which hung over the primary-aluminum industry throughout the first half of 1952, was removed during July and August, when the three primary producers signed agreements with AFL and CIO Unions. Alcoa operated under contracts with the CIO (United Steel Workers of America) and the AFL (Aluminum Workers of America). The Alcoa contract with CIO, due to expire November 30, 1951, was extended to December 31, 1951, the date on which Kaiser's contract with CIO expired. Alcoa's contract with AFL expired on February 3, 1952, and Reynolds' with the CIO on April 15, 1952. Union demands were similar to those being considered by the Wage Stabilization Board in the steel wage dispute, and the unions postponed strikes pending outcome of the steel hearings. On July 9, Alcoa and the AFL signed a contract, with settlement based on recommendations of the WSB in the steel dispute. Agreements with the CIO Union were made on July 9 by Kaiser and on July 29 by Alcoa and Reynolds. All the agreements followed the pattern set by provisions in contracts that terminated midyear strikes in the steel industry and included (1) a reduction in north-south wage differentials; (2) establishment of a job-evaluation program; (3) general wage increases; (4) a modified union shop; (5) improved vacations; (6) increases in insurance benefits and hospitalization; and (7) increases in shift differentials.

Expansion.—The aluminum expansion program initiated by the Government in 1950 under authority of the Defense Production Act had provided by the end of 1951 for the construction of 677,000 tons annually of new reduction capacity. All of the new capacity, except for a 50,000-ton plant planned by the Anaconda Aluminum Co., was distributed among the 3 established producers. The expansion goal was subject to continual reappraisal; throughout 1952, the Office of Defense Mobilization and the Defense Production Administration solicited the views of industry, the Congress, and various Government agencies on the desirability of increasing aluminum supplies and, if necessary, the best means of obtaining increased supplies. In March the DPA proposed an increase in domestic productive capacity of 140,000 annual tons and increased imports from Canada. The Congress rejected a scheme for a guaranteed increase in Canadian Aluminum imports (see section on Foreign Trade), and on October 1 the Director of Defense Mobilization announced a "third round" of primary-aluminum expansion of 200,000 tons annually and invited American business firms that might wish to participate to send in firm proposals. The new capacity was to come from new producers as far as possible. Olin Industries, Inc., East Alton, Ill., was approved for 110,000 tons of capacity (location undetermined) on November 19, followed by the Harvey Machine Co. of Torrance, Calif., with a 54,000 ton-per-year plant to be located at The Dalles, Oreg. The Wheland Co., Chattanooga, Tenn., was negotiating for entry into aluminum production.

A plan for constructing an aluminum reduction plant in the Taiya Valley district near Skagway, Alaska, was announced by Alcoa on August 25. The plan called for a smelter with an initial capacity of 200,000 tons annually and a potential expansion to 400,000 tons annually. Hydroelectric generating facilities would be supplied by damming the Yukon River and driving a 13-mile tunnel through the mountain range. Alcoa announced that it would undertake construction without governmental guarantee of markets and with a minimum of governmental contractual assistance. Obstacles to the plan were the necessity for obtaining United States Government permission to purchase the approximately 20,000 acres of land needed and agreements with Canada for constructing dams and tunnels and using Canadian water.

Expansion of fabrication and metal-treating facilities was required for processing the constantly increasing aluminum supply. Although many independent fabricators and consumers were reportedly operating at only a fraction of capacity, there was a need for facilities that could produce larger mill products, especially of the high-strength heat-treatable variety. The Air Force initiated a "heavy press program" for producing larger extrusions and forgings than previously possible. At the end of 1952, 17 presses were included under this program. Six companies were participating in the program; the companies, locations and types of presses were as follows: Alcoa—Cleveland, Ohio, a 35,000- and a 50,000-ton forge press, Lafayette, Ind., an 8,000-ton and a 12,000-ton extrusion press; Reynolds—Phoenix, Ariz., an 8,000- and a 12,000-ton extrusion press; Kaiser—Newark, N. J., a 35,000- and a 25,000-ton extrusion press, Halethorpe, Md., two 8,000-ton extrusion presses; Wyman-Gordon—North Grafton, Mass., a 35,000- and a 50,000-ton forge press—Harvey Machine—Torrance, Calif., a 25,000- and a 35,000-ton forge press and an 8,000- and a 20,000-ton extrusion press; Curtiss-Wright—Buffalo, N. Y., a 12,000-ton extrusion press. None of the presses had been constructed at the end of 1952, and the largest presses in operation were 15,000- and 20,000-ton German-built presses used by Alcoa and Wyman-Gordon. On October 29 the Defense Production Administration announced expansion goals for aluminum-sheet production and for sheet and plate heat-treating facilities. These goals were to increase the 1950 annual aluminum plate, sheet, and foil capacity by 342,000 tons to 1,296,000 and sheet and plate heat-treating capacity by 423,000 tons to 774,000 by 1955. Government assistance under the goal was to be restricted to facilities capable of producing sheet 48 inches or wider, with heat-treating facilities capable of processing a minimum of 50 percent of the sheet and plate capacity and so designed that heat-treating facilities for the total capacity could be easily installed. An interim goal of $15,000,000 capital investment was set for facilities to produce welded-aluminum tubing. The Department of Defense was planning to install rolling facilities for production of tapered sheet at existing fabricating plants.

The Aluminum Co. of America was expanding and modernizing its fabricating facilities during 1952. At Vancouver, Wash., work was progressing on modernization of ingot casting facilities to provide ingots for future product diversification planned at this plant, such as extrusions, special wire-drawing equipment, and modified rod rolling. A 15,000-ton, German-made, forge press leased from the Air Force was installed at the Cleveland works; a 25,000-pound spring-suspended steam-powered drop hammer was installed at the Vernon, Calif., plant; and insect-wire-screen manufacturing equipment was purchased from John A. Roebling's Sons Co., New Jersey plant, for installation in one of Alcoa's plants. Alcoa was licensed by the Alfin Division of the Fairchild Engine & Airplane Corp. to use the Alfin process for molecular bonding of aluminum to steel and iron. A stretcher with 3 million pounds of pull was ordered for the Lafayette, Ind., plant to straighten extrusions produced in a 13,200-ton extrusion press leased from the Air Force. A new plant for production of screw machine products, fasteners, rivets, and nails was planned for near Lancaster, Pa., and removal of these operations from Edgewater, N. J., was to provide space for additional sheet, foil, and extrusion facilities. The Air Force was to install a 144-inch, 4-high, hot and cold reversing tapered sheet rolling mill at Alcoa's Davenport, Iowa, works. This mill would produce sheet 10 feet wide and 33 feet long; present limits are 5½ feet by 25 feet.

The Reynolds Metals Co. Plant No. 9 at Louisville, Ky., was being altered to handle all steps of aluminum-foil production. This plant previously made foil from coil processed at other plants, and the modernization called for billet-casting facilities, new ovens and rolling facilities. A plant for production of fabricated aluminum parts for the air-frame industry was planned for the Los Angeles, Calif., area. The Phoenix, Ariz., plant was being enlarged to provide space for new extrusion presses included in the Air Force heavy-press program.

The Kaiser Aluminum & Chemical Corp. was installing a new continuous welding pipe mill and a new "plate stretcher", with a pull of up to 5-million pounds at the Trentwood, Wash. (near Spokane), plant. The capacity of Kaiser's foil plant at Permanente, Calif., was being expanded by 50 percent, and the width of available foils was to be approximately doubled. A new 60-inch, 4-high, high-speed mill capable of rolling foil at 3,000 feet per minute was to be installed. New plants at Halethorpe, Md., and Newark, Ohio, were under construction adjacent to Kaiser's fabricating plants as a part of the heavy-press program.

Revere Copper & Brass, Inc., the largest nonintegrated aluminum fabricator, doubled the capacity of its extrusion and tube drawing equipment at the Baltimore plant and initiated aluminum fabrication at a plant in Los Angeles. The Bridgeport Brass Co., Bridgeport, Conn., entered the aluminum-products field; Anderson Brass Works, Inc., was planning to build a new aluminum foundry at Leeds, Ala.; and Bohn Aluminum & Brass Corp. was operating the Government-owned experimental aluminum extrusion and forging plant at Adrian, Mich. Willys-Overland was operating a forging plant at Erie, Pa., that had been idle since World War II. The Fabricast Division of General Motors announced construction of a new permanent-mold casting plant at Jones Mills, Ark., and the Chrysler Corp. was planning a new aluminum foundry for the Michaud Ordnance Plant, New Orleans, La. The Wisco Aluminum Corp., Detroit, Mich., contracted for construction of a new 4-high, single-stand cold aluminum-strip rolling mill for strip up to 40 inches wide; Aluminum Foils, Inc., began construction of a 600-ton-per-month capacity hot and cold aluminum strip mill east of Jackson, Tenn., to manufacture coil for further processing to foil. Aluminum Air Seal Mfg. Co. installed a new 2,500-ton extrusion press at Youngstown, Ohio, and Pax Metals Corp. was constructing a new extrusion plant at Van Nuys, Calif. Nichols Wire & Cable Co. of Davenport, Iowa, expanded rod- and wire-production facilities, and Harvey Machine Co. at Torrance, Calif., was expanding its ingot and fabricating plant in addition to that planned under the heavy-press program. South Gate Aluminum & Magnesium Co., Los Angeles, Calif., constructed a plant for high-speed machining of aluminum and magnesium castings; Universal Die Casting Mfg. Corp. purchased a modern aluminum die casting plant at Malvern, Ark.: a new firm, Aluminum Billets, Inc., was established at Youngstown, Ohio, to operate a plant reported to be using a new type of furnace for faster production of standard size billets from both scrap and virgin aluminum; and Enterprise Aluminum Co. built a plant at Oneonta, N. Y., to fabricate aluminum products. Kropp Forge Co., at Chicago, Ill., expanded facilities to provide for all phases of the forging operation, particularly the production of aircraft parts.

SECONDARY

Domestic recovery of aluminum from secondary sources totaled 304,522 short tons in 1952. Recovery from new scrap increased from 216,017 tons in 1951 to 233,258 in 1952; recovery from old scrap decreased from 76,591 tons to 71,264. Recovery from new scrap is largely a function of consumption and increased at the expected rate. A contributing factor in the decreased recovery from old scrap was the ceiling price. Dealers reported that, in many instances, it was not economical to segregate old aluminum—for example, aluminum pistons in motors. The large quantities of aluminum recovered from old scrap during the 1946–48 period were due to the large tonnages available from aircraft and other scrapped war materials; in 1950 and the first half of 1951 recovery from old scrap was promoted by the high prices offered for scrap metals.

Secondary aluminum was recovered from aluminum-base scrap by the 3 primary aluminum producers, about 70 secondary smelters, and several thousand foundries, chemical producers, and other miscellaneous consumers. Aluminum values were also recovered from other nonferrous alloys—copper, zinc, and magnesium—as an alloy constituent. Aluminum recovered as commercially pure aluminum was 4,897 tons, as aluminum alloys 294,582 tons, in brass and bronze 387 tons, zinc-base alloys 898 tons, and magnesium-base alloys 465 tons, and in chemical compounds 3,293 tons. Recovery of aluminum from non-aluminum-base alloy scrap was calculated by using assumed aluminum contents based on average aluminum content of alloys containing aluminum. The midyear strike in the steel industry caused a depression in the secondary-aluminum industry. Production of deoxidizing ingot in June, July, and August averaged 2,220 tons per month as compared to a 4,660-ton-per-month average for the preceding months. Production of other secondary alloys, especially of the AXS679 and 319 varieties, also dropped during this period.

The high-copper, high-silicon (Cu 3+ percent, Si 5+ percent) casting alloys accounted for approximately 40 percent of secondary ingot produced at independent secondary smelters, deoxidizing grades of ingot 18 percent, high copper-low silicon (No. 12 type) 8 percent and high silicon-low copper (Cu less than 0.6 percent) 6 percent.

Detailed information regarding aluminum scrap and secondary aluminum in 1952 is given in the Secondary Metals—Nonferrous chapter of this volume.

CONSUMPTION AND USES

Apparent consumption of primary aluminum in 1952 was 1,072,686 short tons, as computed by adding primary production and net imports of pig, ingot, slab, plate, sheet, bar, and other crude and semifabricated forms and adjusting for stock changes at primary reduction plants. This computed apparent consumption included metal going into the National Stockpile, excluded withdrawals from the National Stockpile, and did not reflect stock changes by aluminum-metal consumers.

Secondary aluminum for consumption was obtained from domestic and imported scrap. Imported scrap aluminum was largely in pig form to facilitate handling and shipping but included small quantities of "loose" scrap. Aluminum recovered from "loose" scrap was included in secondary domestic recovery. A recovery factor of 90 percent was used to adjust for duplication and for losses in remelting. The factored net scrap imports were considered as additional metal available for consumption.

The total new supply of aluminum pig and ingot and ingot equivalent of scrap to United States consumers during 1952 was 1,376,383 tons, an increase of 106,391 tons over 1951. The supply comprised domestic primary production, secondary recovery from both old and new purchased and toll treated scrap, imports of pig and ingot, and ingot equivalent of imported scrap. Home scrap is omitted from this total. Exports of crude forms of aluminum were not considered as a decrease in the supply of crude aluminum but as a form of consump-

TABLE 3.—Apparent consumption of primary aluminum and ingot equivalent of secondary aluminum in the United States, 1943–47 (average) and 1948–52, in short tons

Year	Primary			Secondary		
	Sold or used by producers	Imports (net)[1]	Apparent consumption	Domestic recovery: From old scrap	Domestic recovery: From new scrap	Imports (net)[2]
1943–47 (average)	633, 376	47, 651	678, 529	67, 537	244, 644	6, 249
1948	625, 834	40, 041	[3] 684, 575	95, 648	191, 129	64, 165
1949	587, 532	48, 424	635, 956	44, 596	136, 166	35, 751
1950	731, 087	167, 249	898, 336	76, 358	167, 308	60, 443
1951	845, 392	[4] 129, 870	[4] 975, 262	76, 591	216, 017	16, 694
1952	938, 181	134, 505	1, 072, 686	71, 264	233, 258	5, 374

[1] Crude and semifabricated, excluding scrap and mill shapes. May include some secondary.
[2] Ingot equivalent of net imports (wt. × 0.9). Imports are largely scrap pig. Some duplication of secondary aluminum occurs because of small amount of loose scrap imported, which is included as secondary recovery from old scrap.
[3] For 1948, apparent consumption modified by changes in stocks held by the Office of Metals Reserve.
[4] Revised figure.

TABLE 4.—Sources of aluminum supply—crude and scrap,[1] 1927–52, in short tons

Year	Primary production	Recovery from scrap[2]: Old	Recovery from scrap[2]: New	Imports[3]	Total supply	Exports[3]
1927	81, 804	46, 200		31, 123	159, 127	1, 763
1928	105, 272	47, 800		19, 411	172, 483	1, 195
1929	113, 987	48, 400		25, 429	187, 816	307
1930	114, 519	38, 600		12, 706	165, 825	304
1931	88, 773	30, 300		7, 332	126, 405	755
1932	52, 444	24, 000		4, 032	80, 476	1, 952
1933	42, 563	33, 500		7, 539	83, 602	2, 757
1934	37, 089	46, 400		9, 186	92, 675	4, 026
1935	59, 648	51, 400		10, 538	121, 586	1, 681
1936	112, 465	51, 500		12, 579	176, 544	477
1937	146, 341	62, 560		22, 351	231, 252	2, 360
1938	143, 441	38, 800		8, 756	190, 997	4, 835
1939	163, 545	37, 763	16, 184	13, 525	231, 017	28, 552
1940	206, 280	45, 806	34, 556	18, 018	304, 660	13, 087
1941	309, 067	43, 113	63, 744	12, 880	428, 804	801
1942	521, 106	41, 633	154, 831	106, 279	823, 849	17, 863
1943	920, 179	33, 094	280, 867	135, 722	1, 369, 862	56, 754
1944	776, 446	22, 899	302, 746	100, 921	1, 203, 012	133, 461
1945	495, 060	27, 311	271, 076	337, 088	1, 130, 535	2, 991
1946	409, 630	90, 535	187, 538	54, 531	742, 234	1, 683
1947	571, 750	163, 847	180, 990	29, 729	946, 316	12, 807
1948	623, 456	95, 648	191, 129	147, 723	1, 057, 956	1, 633
1949	603, 462	44, 596	136, 166	113, 450	897, 674	8, 375
1950	718, 622	76, 358	167, 308	237, 941	1, 200, 229	1, 382
1951	836, 881	76, 591	216, 017	[4] 140, 430	[4] 1, 269, 919	2, 274
1952	937, 330	71, 264	233, 258	134, 531	1, 376, 383	2, 312

[1] Ingot equivalent of scrap.
[2] Separate data for old and new scrap not available before 1939.
[3] Crude metal (ingot, pig, slabs, etc.) plus ingot equivalent (wt. × 0.9) of scrap.
[4] Revised figure.

tion. This supply figure represents the quantity of aluminum available at the ingot of "ingot-equivalent" stage of aluminum consumption; that is, for use in producing castings, semifabricated wrought shapes, for dissipative uses, such as hardeners, deoxidizers, chemicals, etc., and ingot for export, and for increases in stocks. Stock changes at all levels of production and consumption are not included because of the lack of complete statistical data (see Stocks).

In past years statistical information on aluminum consumption by type of manufacture or end-use pattern, other than data on shipments of aluminum wrought products and castings, collected by the Bureau of the Census, United States Department of Commerce, was not available. A distribution pattern for aluminum, as reported by Alcoa and based on its operations has been presented in previous Minerals Yearbook volumes. In 1952, aluminum distribution was under Government control, and although data for allotments by program symbols were restricted, a grouping of the allotment data showed the following percentage distribution, by major use groupings:

	Percent
Transportation: Land, sea, air	32
Construction and building	15
Electric and electronic	13
Consumer durables	10
Destructive uses	6
Machinery and equipment: Industrial, agricultural, mining, etc	6
Packaging and containers	4
Miscellaneous and unclassified	14

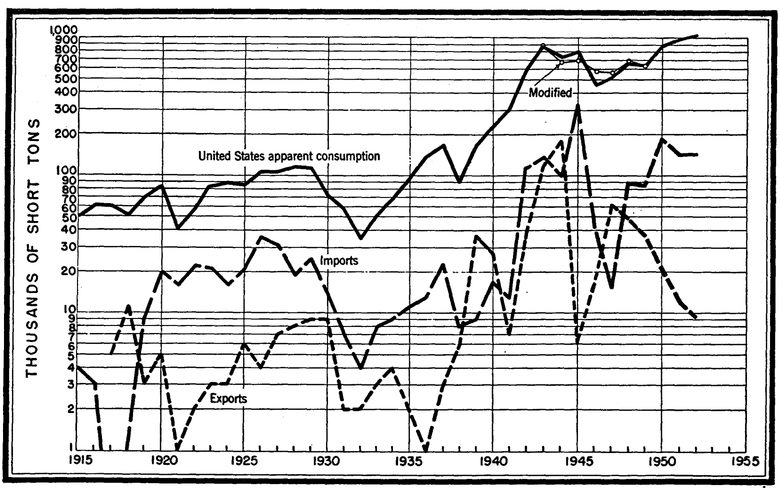

FIGURE 2.—Imports, exports, and apparent consumption of aluminum, 1915–52. Imports and exports do not include scrap.

Distribution of wrought aluminum by type of mill shape for 1952 as compiled from data collected for the National Production Authority for allocation control was:[2]

	Percent
Plate, sheet and strip:	
Non-heat treatable	34.6
Heat-treatable	15.6
Foil	4.6
Rolled structural shapes:	
Rod, bar, etc	10.7
Wire, bare (nonconductor)	2.3
Cable, bare (including steel-reinforced)	9.4
Wire and cable, covered or insulated and bare conductor wire	1.3
Extruded shapes (including tube blooms):	
Soft alloys	11.3
Hard alloys	4.2
Tubing:	
Soft alloys	2.5
Hard alloys	.8
Powder flake and paste	2.7

Shipments of aluminum wrought and cast products, as reported by the Bureau of the Census, totaled 1,221,865 short tons in 1952; 259,490 tons was shipped as castings and 962,375 as wrought products.[3] The percentage increase in shipments of mill products (cast and wrought) over 1951 was slightly below that for the aluminum supply; shipments increased 7.6 and supply 8.4 percent.

The Government controls over distribution and use of aluminum that were in effect at the end of 1951 continued throughout 1952. Amendments and revisions to control orders were issued by the National Production Authority, United States Department of Commerce; they eased or tightened restrictions as dictated by the supply and as found necessary to promote the National defense. Aluminum foil and powder were dropped from the Controlled Materials Plan list in July; inventory restrictions were eased for aluminum distributors for the fourth quarter.

TABLE 5.—Net shipments [1] of aluminum wrought and cast products by producers, 1948–52, in short tons

[U. S. Department of Commerce]

	1948	1949	1950	1951	1952
Wrought products:					
Plate, sheet and strip	634,148	395,012	581,567	536,683	542,849
Rolled structural shapes, rod, bar, and wire	91,496	101,825	134,890	172,582	221,773
Extruded shapes, tube bloom, and tubing	85,972	74,998	129,038	156,472	173,771
Powder flake and paste	8,477	7,238	11,230	12,385	23,982
Total	820,093	579,073	856,725	878,122	962,375
Castings:					
Sand	76,923	61,302	92,391	[2] 96,689	97,308
Permanent mold	91,813	61,761	90,683	[2] 80,005	73,442
Die	64,452	49,170	83,600	[2] 75,733	84,866
Other	2,621	3,656	4,867	[2] 5,139	3,874
Total	235,809	175,889	271,541	[2] 257,566	259,490
Grand total	1,055,902	754,962	1,128,266	[2] 1,135,688	1,221,865

[1] Net shipments consist of total shipments less shipments to other metal mills for further fabrication.
[2] Revised figure.

[2] Bureau of the Census, Facts for Industry: Series M24-2-02. Aluminum Products, July 1951–December 1952.
[3] Bureau of the Census, Facts for Industry: Series M24-1-02.
Bureau of the Census, Facts for Industry: Series M24E-02.

Despite the controls and restrictions on the uses of aluminum, a number of new products was being developed in anticipation of expanded markets. Other aluminum products were being produced in increasing quantities for use in manufactures with new or improved qualities. In the transportation industries new developments in aluminum alloys and fabrication pointed to an ever-increasing number of applications in automotive equipment; experimental cylinder heads for overhead valve engines could be assembled by brazing together relatively simple aluminum castings; iron valve seats were successfully brazed to the aluminum head; aluminum die-cast clutch housings and plaster-cast intricate shapes, such as torque converter parts, were used in commercial automobiles; brazed-aluminum radiators of special brazing sheet were being tested; and decorative and service aluminum hardware was used in increasing quantities.[4] A new stranded automotive electrical cable of electrical-conductor (E. C.)-grade aluminum wire was being produced by Kaiser. A lightweight freight car with cast-aluminum wheels, corrugated-aluminum ends and an aluminum roof was on exhibition. This car weighed 19,000 pounds compared to 42,000 pounds for the conventional freight car. In the trailer industry there was a pronounced trend toward "aluminum-built" units. The S. S. *United States*, which established a new speed record for Atlantic crossings, contained approximately 2,000 tons of aluminum alloys largely concentrated in the superstructure, where light weight contributed to stability. Funnels, deck houses, structural bulkheads, davits, and lifeboats were constructed almost entirely of aluminum.[5] A 65-foot ferryboat constructed largely from aluminum alloys, in use in Sweden, had a reported speed of 35 knots, with very low fuel consumption. A new method of sealing vehicles for storage and shipment was adopted for use by the Army Ordnance Corps; bituminous mastic, aluminum foil, and aluminum paint were used to prevent damage from dampness and corrosion.[6]

An aluminum-coated plywood called "Armorply," that would withstand extreme temperature changes, was used in constructing buildings at the Thule Air Base, Greenland; an elastic glue that expanded and contracted with the metal was used to bond the wood and metal surfaces. "Alumber," a new development not yet on the market in 1952, consisted of aluminum strips in 18 extruded shapes for use in building interior walls; the material could be sawed and nailed or held in place by screws. A new aluminum fixed bridge that could span about 180 feet, carry about 50 percent more weight than similar bridges used in World War II, and be erected in one-third of the time and that weighed 60 percent less than similar steel bridges was announced by the Army Engineers. The aluminum honeycomb sandwich consisting of a cellular aluminum-foil core with sheet-metal facings and having high strength, good stability, uniform density, and light weight was being produced in volume.[7] An English company, Booth & Co., Ltd., was producing for export a portable and

[4] Dunn, J. H., and White, E. P., Aluminum Alloys—Automakers May Use More: Steel, vol. 130, No. 20, May 12, 1952, pp. 95–98.

[5] Smith, Arthur Q., Aluminum Goes to Sea—a New Era in Shipbuilding: Light Metals Age, vol. 10, Nos. 5 and 6, June 1952, pp. 12, 13, 23.

[6] Iron Age, Aluminum Foil Stops Corrosion: Vol. 168, No. 18, May 1, 1952, p. 147.
Modern Metals, Preserving Tanks and Trucks With Aluminum Foil: Vol. 8, No. 2, March 1952, p. 46.

[7] O'Keefe, Philip, Aluminum Honeycomb Sandwich Has Light Weight, High Strength, Good Stability, and Uniform Density: Materials and Metals, vol. 36, No. 6, December 1952, pp. 96–98.
Pajek, T. P., Aluminum-Foil Structural Core: Light Metals Age, vol. 9, Nos. 11 and 12, December 1951, pp. 8, 9, 37.

prefabricated "cluster bungalow" made of aluminum and specially designed for tropical use. Increased usage of external aluminum panels, either wrought or cast, backed with a fireproof wall of lightweight concrete, was anticipated when the aluminum supply increased.

The increasing economic advantage of aluminum, plus advances in technology, application engineering, and design were constantly improving aluminum's contribution in the electrical industry. The most serious problems encountered in the use of aluminum conductors were those of connections; however, new connectors and techniques were being developed.[8] The Conservation Coordinating Committee of the Defense Production Authority urged the use of aluminum instead of copper for electrical conductors in size No. 6 (copper size) and larger for buildings. General Electric Corp. used aluminum bases for approximately 50 percent of its electric-light-bulb production in 1952.

Improved methods for using aluminum foil for containers and packaging were being used and others developed. Convolute plies of kraft paper and aluminum foil capped with steel ends were used in the construction of lightweight drums for chemicals and other liquids.[9] Other aluminum containers were the thermoplastic bonded aluminum "tin can," the flex can, spiral-wound tubes, and barrier cartons.[10] Aluminum handling boxes weighing 245 pounds (a comparable steel box weighed 620 pounds) capable of carrying a 5,000-pound load and with the added advantages of noncorrosion and absence of rust stains were being used in Alcoa's Cleveland works.

Aluminum was finding increased uses in the textile industry; although its major contribution was in moving parts, its nonstaining and nonwarping qualities provided many advantages in other plant equipment.[11] Aluminum was being used in increasing quantities for ammunition shell cases. Lightweight, portable, sprinkler irrigation systems were one of the more important developing uses of aluminum, and increased consumption for this purpose was awaiting only the availability of pipe. New aluminum-consuming products announced in 1952 were an aluminum paint (Sheffield Bronze Paint Co., Sheffield, Ohio) that was reported to withstand temperatures up to 1,600° F. and be anticorrosive, impervious to most ordinary solvents, and weather-resistant; and a new aluminum paste designated as Alcoa Aluminum Tinting Paste No. 222, which gave a brighter finish than was possible with other aluminum pigments (metal content was 65 percent). Aluminum was the principal ingredient of "Fil Solder" (Swiss Laboratories, Cleveland), a filling solder that required 50 percent less heat than the standard tin-alloy solder and filled without fluxing or shrinkage; "No Torch," a cold solder (A. L. Okum Co., 148 58th Ave., Flushing 54, N. Y.), of powdered aluminum that was quick drying and could be applied with a putty knife, brush, or spray to fill imperfections and as a metallic coating on patterns.

The Swiss invention "Aluphoto" for putting photographic reproductions directly on an aluminum base exhibited a group of unusual

---

[8] Avilla, C. F., Boston Edison's 15-kv Underground Aluminum Cable. Hayward, J. P., Wanted—Information on Aluminum Connectors.
Briskborn, H. W., The Outlook for Aluminum in the Electrical Industry: Modern Metals, vol. 8, No. 3, April 1952, pp. 56–62.
Bergen, M. D., What, Why and How of Connectors for Aluminum: Elect. World, vol. 138, No. 2, July 14, 1952, pp. 129–142.
[9] Commercial America, Firms Develop Aluminum Drums: August 1952
[10] Birdsall, G. W., How Aluminum Can Replace Tinplate in Containers: Modern Metals, vol. 8, No. 1, February 1952, pp. 47–51.
[11] Canadian Chemical Processing, Aluminum in the Textile Industry: Vol. 36, No. 5, May 1952, p. 84.

properties and advantages; it was simple to handle, resisted destruction in water, weather, light, and heat up to 1,100° F. and was unaffected by foodstuffs and food acids. The reproduction was substantially grainless and completely nonpoisonous.[12]

STOCKS

Month-end inventories of aluminum at the primary reduction plants averaged 12,150 tons for the 12 months of 1952. Stocks reported for December 31 were 7,274 tons, the lowest of the year, and represented less than 1 week's production.

Stocks of ingot at secondary smelters (excluding secondary operations of primary-metal producers) increased from 3,848 tons on January 1 to 11,051 tons on December 31. The increases in stocks were accumulated during the steel strike in the middle of 1952 and were not appreciably reduced when steel production was resumed. Year-end stocks were equivalent to 17 days' production. Stocks of aluminum-base scrap held by secondary smelters, primary producers, consuming fabricators, foundries, and miscellaneous consumers increased from 12,558 tons at the end of 1951 to 18,720 tons at the end of 1952. This increase in stocks was also realized during the steel strike, and the year-end stock represented about one-half month's consumption.

Stocks of aluminum held by primary- and secondary-metal producers were of negligible importance as a contribution to reserve supply. Data on aluminum held by fabricators, manufacturers, and distributors and on scrap-aluminum stocks held in junkyards and by scrap-metal dealers were not available.

PRICES

The base price of primary-aluminum ingot, 99 plus percent pure, f. o. b. shipping point, was 20 cents per pound at the end of 1952. In July the primary-aluminum producers filed applications for price increases with the Office of Price Stabilization under the provisions of OPS General Overriding Regulation 29, which provided for price increases where necessary to avoid possible interference with the production and supply of essential commodities. The requested increases were based on company-claimed cost increases incurred since January 26, 1951, the effective date of the General Ceiling Price Regulation under which the price of primary aluminum was controlled, plus the cost of an anticipated wage increase. Alcoa and Reynolds requested a 2-cent-per-pound increase in the price of aluminum pig; Kaiser followed with a request for a 2.35-cent-per-pound increase, and Reynolds then increased its request to approximately equal that of Kaiser. Under Supplementary Regulation 113 to the General Ceiling Price Regulation, effective August 4, the ceiling price on aluminum pig and ingot was increased by 1 cent per pound. This action marked the first rise in pig and ingot prices since October 1950, and the new base prices became 19 cents per pound for pig and 20 cents for ingot. In October the primary producers requested an additional price increase based on the clause in the price-control law that allowed contractors to cancel contracts with the Government if the contract price denied the company a reasonable profit. Proposals by the Office of Defense Mobilization that offered a ½-cent-per-pound

[12] Wainer, Eugene, Aluminum! Photographic Process has Industrial Applications: Modern Metals, vol. 35, No. 4, April 1952, pp. 176–186.

increase in the base prices in return for cancellation of the "reasonable profit" clause were rejected by the producers, and no further action had been taken by the end of 1952.

TABLE 6.—Prices of aluminum ingot and other major metals, 1941–52 [1]

Year	Aluminum, primary ingot (cents per pound)	Copper, electrolytic, New York (cents per pound)	Composite finished steel (cents per pound)	Lead, New York (cents per pound)	Zinc, Prime Western, St. Louis (cents per pound)
1941	16.50	11.87	2.65	5.79	7.48
1942	15.00	11.87	2.65	6.48	8.25
1943	15.00	11.87	2.65	6.50	8.25
1944	15.00	11.87	2.65	6.50	8.25
1945	15.00	11.87	2.73	6.50	8.25
1946	15.00	13.92	3.00	8.11	8.73
1947	15.00	21.15	3.42	14.67	10.50
1948	15.74	22.20	3.91	18.04	13.58
1949	17.00	19.36	4.21	15.36	12.15
1950	17.69	21.46	4.40	13.30	13.88
1951	19.00	24.37	4.71	17.49	17.99
1952:					
First quarter	19.00	24.37	4.71	19.00	19.50
Second quarter	19.00	24.37	4.71	16.64	18.25
Third quarter	19.62	24.37	4.91	16.00	14.36
Fourth quarter	20.00	24.37	4.98	14.23	12.75
Average	19.40	24.37	4.83	16.47	16.21

[1] SOURCE: Metal Statistics, 1953 (American Metal Market).

Aluminum was the only major metal except steel that showed price increases during 1952. Steel prices (composite index) increased in about the same proportion as aluminum, copper remained constant under ceiling prices, and lead and zinc prices were greatly reduced. Aluminum, however, still showed a price advantage over the other major metals when compared to the 1941–45 World War II period; at the end of 1952, the price for aluminum had increased 31 percent, zinc 54 percent, steel 87 percent, copper 105 percent, and lead 122 percent over the 1941–45 average.

The price of aluminum scrap and secondary ingot throughout 1952 was controlled under Ceiling Price Regulation 54. Revision 1 of CPR–54, effective January 16, raised the ceiling on selected types of scrap and secondary ingot and directed that ceiling prices for wrecked aircraft and irony aluminum should be established on a delivered basis. Amendment 1 to CPR–54, Revision 1, effective December 3, revised the ceiling price on secondary ingot from a delivered basis to a shipping-point basis to give relief from the effects of freight-rate increases. An allowance was made for transportation charges above 75 cents per 100 pounds. Aluminum scrap and secondary ingot were selling at ceiling prices most of the year. Foundry alloys (low-copper alloys excepted) were reported selling for as much as 1 cent per pound below the OPS ceiling in July but returned to the ceiling in August.

Ceiling prices for producers of aluminum-alloy ingot and aluminum mill products were increased 5 percent in Supplementary Regulation 113 to General Ceiling Price Regulation to allow a passthrough of the increase on aluminum pig and ingot. Aluminum castings were priced under CPR–60. Increased ceilings for resellers of primary-aluminum mill products were established under Amendment 11 to CPR–67 effective August 4. General Overriding Regulation 35 to the General Ceiling Price Regulation, effective September 10, permitted manufacturers to pass along the metal cost increases granted to basic metal producers. General Overriding Regulation 41, effective December 10, provided for price increases 7 percent above the then current manufacturers' selling price for sheet-aluminum cooking utensils and 8½ percent for cast-aluminum utensils.

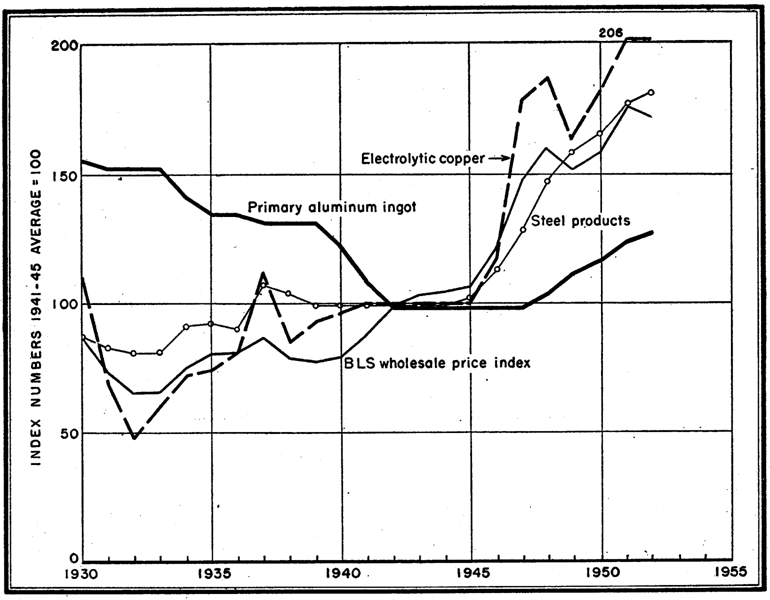

FIGURE 3.—Price of aluminum ingot, electrolytic copper, and finished steel, compared with Bureau of Labor Statistics general wholesale price index, 1930–52. Index numbers computed for aluminum ingot, electrolytic copper, and finished steel from prices reported by the American Metal Market. Bureau of Labor Statistics index transposed from 1926 to 1941–45 base.

FOREIGN TRADE [13]

United States foreign trade in crude and semicrude aluminum (pig, ingot, slab, scrap, and semifabricated shapes) in 1952, as indicated by the value of imports and exports, decreased 11 percent from 1951 to $62,031,269. The value of exported crude and semifabricated aluminum decreased 27 percent, of similar imported products 8 percent. The Bureau of the Census, United States Department of Commerce, revised the export-classification categories [14] effective January 1, 1952, and because of this regrouping of aluminum-export products, data for 1952 were not strictly comparable with those of previous years.

Canada, traditionally the major foreign source of aluminum to the United States, supplied 129,557 tons or 86 percent of the tonnage of imports of crude and semicrude (pig, ingot, slab, scrap, and semifabricated shapes). Other countries that supplied over 1,000 tons were Japan (5,059), West Germany (3,660), United Kingdom (3,483), Austria (3,007), Italy (2,179), and the Netherlands (1,855). Crude-aluminum metal and alloys, such as pig, ingot, wirebars, etc., which

[13] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page of the Bureau of Mines, from records of the U. S. Department of Commerce.
[14] U. S. Department of Commerce, Bureau of the Census, Schedule B, Statistical Classificatin of Domestic and Foreign Commodities Exported from the United States: Jan. 1, 1952, ed. and Jan. 1, 1949, ed.

TABLE 7.—Aluminum imported for consumption in the United States, 1950–52, by classes

[U. S. Department of Commerce]

Class	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Crude and semicrude:						
Metal and alloys, crude	176, 778	$48, 366, 733	[1]122,422	[1]$41,400,283	128, 233	$43, 504, 881
Scrap	67, 959	14, 149, 860	20, 009	6, 376, 578	6, 998	2, 591, 609
Plates, sheets, bars, etc	10, 955	5, 016, 561	19, 403	11, 486, 358	15, 507	8, 551, 176
Total	255, 692	67, 533, 154	[1]161,834	[1]59,263,219	150, 738	54, 647, 666
Manufactures:						
Bronze powder and powdered foil	30	30, 791	78	83, 706	8	11, 970
Foil less than 0.006 inch thick	297	335, 088	810	1, 268, 292	950	1, 426, 607
Leaf (5½ by 5½ inches)	(2)	38, 727	(2)	27, 784	(2)	7, 209
Table, kitchen, hospital utensils, etc	163	256, 523	548	1, 010, 295	1, 614	2, 734, 627
Other manufactures	(3)	371, 697	(3)	1, 816, 259	(3)	2, 941, 327
Total	(3)	1, 032, 826	(3)	4, 206, 336	(3)	7, 121, 740
Grand total	(3)	68, 565, 980	(3)	[1]63, 469, 555	(3)	61, 769, 406

[1] Revised figure.
[2] Leaves: 1950, 10,515,034; 1951, 7,790,455; 1952, 1,690,814; equivalent weight not recorded.
[3] Quantity not recorded.

is the most important import classification both as to value and tonnage, was received from 12 countries and distributed as follows: Canada, 90.3 percent; Japan, 3.3 percent; Austria, 2.3 percent; West Germany, 1.7 percent; Netherlands and Italy, 0.9 percent each; Norway, 0.5 percent; and, United Kingdom, Taiwan, Switzerland, Mexico and Belgium, the remainder. Imports of crude aluminum increased during each succeeding quarter of the year, and receipts for December, the highest month, almost equaled those of the first quarter. All but 420 of the 5,150 tons from West Germany and Austria were received in the latter half of 1952. The average per-pound values of imports of crude from the major exporters were: Canada, 16.2 cents; Japan, 26.7 cents; Austria, 24.3 cents; West Germany, 18.3 cents; Netherlands, 18.0 cents; Italy, 29.2 cents; and Norway, 34.3 cents. Despite an increase of 2,500 tons in semifabricated-aluminum products from Canada, imports of this material dropped 20 percent from 1951. All of the other 1951 suppliers decreased their shipments to the United States; there were no shipments from France. Imports of semifabricated aluminum were as follows: Canada, 9,890 tons; United Kingdom, 3,084 tons; Italy, 1,017 tons; West Germany, 702 tons; Belgium, 475 tons and 5 other countries 339 tons. Highest imports of semifabrications were in December (3,550 tons), and 43 percent was received during the last quarter. Aluminum-scrap imports were about one-third of the 1951 receipts and came from 17 countries as compared to 32 in 1951. Only Canada supplied over 1,000 tons, shipping 3,839 tons to the United States in 1952; receipts from West Germany were 800 tons, Netherlands 688 tons, and Japan 565 tons. Almost half of the scrap was imported during the first quarter.

The reclassification of commodities exported from the United States resulted in major changes in the aluminum materials grouped under "other manufactures" as listed in the Minerals Yearbook. A large group of manufactured-aluminum articles, such as bolts, screws, nails, builders' and furniture hardware, plumbing fixtures and fittings, prefabricated buildings, portable bridges, etc., which before 1952 were coded according to specific metal, were grouped by type of product in the 1952 classification and were not identifiable as aluminum manufactures. Changes were also made in the "crude and semicrude" classifications. The separate classification of "mill shapes" was dropped; "castings and forgings" and "primary forms n. e. c. (not elsewhere classified)" were added and absorbed part of the former class. This resulted in a discontinuity in the major groups as presented in the Minerals Yearbook; part of the material classified as "primary forms, n. e. c." in 1952 formerly appeared under "other manufactures," and part of the material formerly classified as "mill shapes" appeared in "other manufactures."

TABLE 8.—Aluminum exported from the United States, 1950–52, by classes

[U. S. Department of Commerce]

Class	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Crude and semicrude:						
Ingots, slabs, and crude	662	$259,408	960	$432,832	1,388	$519,071
Scrap	800	93,317	1,460	130,098	1,027	163,987
Plates, sheets, bars, etc	19,822	10,676,040	10,995	7,544,458	[1] 7,847	[1] 5,853,746
Castings and forgings	(2)	(2)	(2)	(2)	352	780,199
Mill shapes	1,952	2,316,685	1,402	2,052,040	(3)	(3)
Primary forms, n. e. c	(2)	(2)	(2)	(2)	(4)	66,600
Total	23,236	13,345,450	14,817	10,159,428	(4)	[1] 7,383,603
Manufactures:						
Foil and leaf	832	720,885	159	224,602	152	255,941
Powders and pastes, (aluminum and aluminum bronze) (aluminum content).	251	246,505	552	536,525	196	227,281
Table, kitchen, and hospital utensils	678	1,319,548	744	1,656,619	[1] 574	[1] 1,191,171
Other manufactures	(4)	6,520,597	(4)	6,682,768	(4)	[1] 3,830,017
Total	(4)	8,807,535	(4)	9,100,514	(4)	[1] 5,504,410
Grand total	(4)	22,152,985	(4)	19,259,942	(4)	12,888,013

[1] Due to changes in items included in each classification, data are not strictly comparable with earlier years.
[2] Not separately classified before Jan. 1, 1952.
[3] Beginning Jan. 1, 1952, not separately classified.
[4] Quantity not recorded.

The United States major aluminum exports were semifabricated products, such as sheets, plates, bars, castings, forgings, and other mill shapes. Such material was sent to 74 countries, and 81 percent of the total tonnage went to 29 countries of the Western Hemisphere. Canada was the major importer of United States semifabricated aluminum, receiving 3,797 tons (46 percent); Mexico received 339 tons; 8 Central American countries 166 tons; 8 West Indies countries 958 tons, with 798 tons to Cuba; South American countries 1,374 tons, with 572 tons to Brazil and 495 tons to Venezuela. Fifteen countries in Europe received 294 tons, with 255 tons to Finland; 14 Asiatic countries 994 tons, with 553 tons to the Philippines, and 202 tons to Israel; Australia and Oceania 98 tons; and Africa 179 tons. Crude aluminum (pig, ingot, and slab) was exported to 14 countries; 75 percent of the tonnage was shipped to nations of the Western Hemisphere. Mexico received 887 tons and West Germany 234 tons.

Aluminum-base scrap was exported to Canada (531 tons), Haiti (15 tons), United Kingdom (423 tons), and West Germany (58 tons).

During 1952 exports of aluminum and aluminum manufacturers were under embargo or quota controls, depending upon the type of material, administered by the Office of International Trade, United States Department of Commerce. Imports were maintained at the highest levels possible, and a long-term import program from Canada was considered to augment the available supply. In February the Aluminum Co. of Canada (Alcan), at the request of the Office of Aluminum, Defense Production Administration, submitted a proposal to increase its exports of aluminum to the United States. The first proposal expired in April, and on its expiration a more limited proposal was submitted that expired on May 18, 1952. The first proposal covered 1952–59, with a guaranteed minimum delivery by Alcan on demand of 1,850,000 tons and a United States Government commitment to purchase 900,000 tons. The second proposal covered 1952–58 for minimum delivery of 1,110,000 tons and a commitment to purchase 450,000 tons. Availability of aluminum for export from Canada as stipulated in the proposals was presumably based on the total or second-stage expansion at Kitimat (see World Review—Canada), and large increases in tonnage exports to the United States were not possible before the latter part of 1954. The Joint Committee on Defense Production, Congress of the United States, held hearings on May 26 and June 2 and recommended that "any additional supply of aluminum necessary * * * be obtained when economically feasible from our domestic aluminum industry * * * it is desirable that the United States wait and see how the situation develops." [15] In addition to these proposals, Canada appeared to be making every effort to increase exports to the United States. In July and August emergency shipments of 4,350 tons were sent to help replace the loss of production at Alcoa's storm-damaged Massena, N. Y., plant, and imports were increased slightly during the third and fourth quarters by taking the metal from other world markets served by Aluminium, Ltd.

Part of the aluminum imported from Canada was obtained under a series of loan agreements with the United Kingdom and Canada that provided for diversions to the United States of Canadian aluminum scheduled for delivery to the United Kingdom. The United States in return was to increase allotments of finished steel, premium ingots, and iron and steel scrap to the United Kingdom. The first agreement was made in November 1951 and provided for delivery of 11,000 tons of aluminum during the first 5 months of 1952 and repayment during the fourth quarter of 1952. In January 1952 the total of diverted aluminum was increased to 27,500 tons (additional 16,500 tons), with repayment scheduled for the second and third quarters of 1953. A third agreement in October provided for 22,000 additional tons and deferred payment of 16,500 tons of the metal received under the second agreement until 1954 or 1955. At the end of 1952 the total aluminum provided under the US–UK–Canada loan agreements stood at 49,500 tons, of which about 33,000 tons was shipped during 1952.

Duties on aluminum ingot, pig, and semifabrications were unchanged during 1952, being 1½ cents per pound for ingot and pig

[15] Joint Committee on Defense Production, Congress of the United States, Aluminum Program: Defense Production Act, Progress Report 20, Senate Report, 1987 82d Cong., 2d sess., June 30, 1952.

and 3 cents per pound on semifabricated aluminum. The suspension of the 1½ cents per pound duty on scrap aluminum, effective from October 1, 1950, to January 30, 1952 (Public Law 535, 82d Cong.), was renewed on July 14, 1951, to extend to June 30, 1953 (Public Law 869, 82d Cong.). A decision of the United States Customs Court ruled that "aluminum smelter scrap in ingot form" is entitled to free entry as metal scrap. This material was described as aluminum from electric reduction pots containing uncontrollable impurities, not meeting commercial specifications and not fit for use otherwise than for remelting and blending with other aluminum-bearing materials.[16]

TECHNOLOGY

The commercial techniques used in the United States for converting aluminum ores to metal were basically unchanged in 1952, although new plants being constructed under the expansion program were using reduction cells of new design and larger capacity; expanded capacity at older plants was realized by enlargement of pot sizes and by adding additional cells to potlines. There was a pronounced trend toward use of continuous, self-baking electrodes (Soderburg type) for new facilities. Aluminum fabrication and finishing technology, casting, forging, extruding, joining, anodizing, plating, and coating advanced during 1952, leading to greater mechanization, the forming of larger semifabricated shapes, and improved products and giving promise of new commercial applications not possible under established fabrication and use technology.

Research on electrolytic reduction techniques was aimed largely at development of methods for reducing electrical energy and anode-carbon consumption in the reduction cells. A new cell designed with an open top and using automatically controlled oscillating anodes was proposed, which was reported to require less energy.[17] Disadvantages of the cell appeared to be the numerous and complicated controls required and the added difficulties in relining and repairing such cells which would require dismantling of the more complex superstructure. A new process being developed by the British Columbia Aluminum Co. at a small plant at New Westminister near Vancouver, British Columbia, reportedly will reduce electrical power requirements up to 30 percent. Details of the process were not divulged, but it was stated that the "square"-wave, "long"-wave electrical energy was produced by a "magnaquanta converter" and reached the furnace at about 8 volts and 1,600 amperes.[18] A study of the relationship between current efficiency, anode gas composition (CO_2 content), and anode carbon consumption showed that a considerable proportion of the carbon consumed was due to extraneous reactions.[19]

The direct reduction of aluminum-bearing ores, such as various domestic clays, low-grade bauxites, and pyrophyllite, in an electric furnace was investigated by the Bureau of Mines to determine optimum ratios of charge materials, operational techniques, and products obtainable by carbothermic reduction. Part of the investigation was

---

16 Treasury Decisions, Case 55626, vol. 86, No. 25, June 21, 1951.
17 Ferrand, M. Louis, Large, Modern Electrolytic Furnace for Manufacture of Aluminum: Private Prospectives Presented to National Inventors Council, U. S. Dept. of Commerce, March 1952.
18 Steel, New Aluminum Process Disclosed: Vol. 130, No. 8, Feb. 25, 1952, p. 51.
19 Schadinger, R., [The Consumption of Anode Carbon in the Industrial Production of Aluminum]: Allumino, vol. 21, No. 3, 1952, pp. 252–256.

made in cooperation with the Apex Smelting Co.; that company, as a result of this work, was constructing a small plant in Lane County, Ore., for producing aluminum-silicon master alloys. A patent on the production of aluminum-silicon alloys from graphitic shale was granted in which the graphite from the shale was to provide substantially all of the carbon required for reduction of the metal constituents in the charge.[20] By carbothermal reduction it was possible to produce aluminum-silicon alloys that would have commercial applications for blending with aluminum to produce specification alloys. It appeared feasible to add other metallic minerals, such as titanium, required in some aluminum alloys to the charge to obtain a variety of master alloys. The production of commercially pure aluminum by this method required methods for refining the mixed alloy. A number of metallic dissolution schemes for selective leaching of the aluminum have been tested. The zinc dissolution process was tested on a pilot-plant scale in France, and a report on this operation stated that aluminum alloys containing controlled percentages of silicon or a commercially pure aluminum could be produced.[21]

New alloys and clad sheet in production or under test during 1952 were C57S, XC54S, XC56S, SAM alloy (special aluminum mischmetal), SAP alloy (sintered aluminum powder), XA30 brazing sheet, and 75S thinclad. Aluminum Co. of America's C57S had properties that permitted an unusually bright "Alumilite" (anodized) finish and had good mechanical properties. This alloy held great promise as use for automobile trim and had been successfully used in electrical appliances. Alcoa XC54S and XC56S were being developed for heavy-duty structural uses, such as ship superstructure, truck bodies, and tanks; they were of the aluminum-magnesium group of alloys and were developed for improving welding characteristics. The Naval Research Laboratory described an aluminum-mischmetal alloy designated as SAM alloy that showed considerable promise for high-temperature use compared with the conventional age-hardening aluminum alloys that were seemingly limited in long-time use to temperatures of 600° F. or less. SAM alloy had inferior strength properties at room temperatures but was superior at temperatures of 600° C. and above. It could be handled by conventional molding and foundry techniques, except that higher casting temperatures were necessary.[22] An alloy, SAP, produced from aluminum powder by sintering was developed by Aluminum Industrie A.-G. (AIAG) of Switzerland in about 1948 and was reported to have unusual strength and stability properties and a high resistance to creep at elevated temperatures. The properties of a number of SAP-type alloys were reported in 1952. The aluminum oxide in the sintered alloy resulted in improved physical properties, and it appeared that further development of such alloys might extend the temperatures at which aluminum alloys would be of service.[23] XA30 brazing sheet was developed largely for use in liquid-gas heat exchangers, such as

[20] Lichty, Lyall J., assignor to Quebec Metallurgical Industries, Ltd., Toronto, Ontario, Canada, Production of Aluminum-Silicon Alloys: U. S. Patent 2,627,458, U. S. Patent Gaz., vol. 667, No. 1, Feb. 3, 1953, p. 162.

[21] Menegoz, D., and Belon, P., Un Nouveau procédé de fabrication del'aluminium, Le Procédé Loevenstein: Jour. du four électrique et des industries électrochemique, No. 3, 1952, pp. 79–82.

[22] Loring, B. M., Baerand, W. H., Ackerlind, C. G., A Mischmetal Aluminum Alloy for Elevated Temperature Service: Naval Research Laboratory, Rept. 3871, Nov. 1, 1951.

[23] Lyle, John P., Jr., Excellent Properties of Aluminum Powder Metallurgy: Metal Prog., vol. 62, No. 6, December 1952, pp. 109–111.

Gregory, E., and Grant, N. J., Aluminum-Powder Compacts Compared: Iron Age, vol. 170, No. 26, Dec. 25, 1952, pp. 69–73.

automobile radiators, and consisted of a sheet of 3S alloy core with C43S on one side for brazing and alclad on the other side for protection against the electrolytic action of the liquid.[24] Kaiser Aluminum & Chemical Co. announced the commercial production and availability of 75S Thinclad, which had a clad thickness of 1½ percent as compared to a conventional thickness of 4 percent.

In the semifabrication or forming segment of the aluminum industry, one of the most spectacular developments was design and initiation of construction of heavy extrusion and forging presses for the Air Force, Department of Defense. Techniques for forging and extruding aircraft outer skin panels, spars, and ribs in large sections had been investigated for a number of years by aluminum fabricators, aircraft manufacturers, and Air Force technicians. Experimental panels with a net projected area of 973 square inches and integral stiffening ribs were produced on an 18,000-ton forge press. Web thicknesses down to and below 0.09 inch were secured with minimum 1-inch-high ribs.[25] In the heavy forge presses the light metals, aluminum and magnesium, flow under constant pressure to form intricate shapes. The maximum size of forged shapes from the new presses being constructed will be determined only when the presses are placed in operation. The first of the heavy extrusion presses under the Air Force program was scheduled to start operation about the middle of 1953 at Alcoa's Lafayette, Ind., works. In this 13,200-ton press it was expected that ingots up to 29¼ inches in diameter and 70 inches long would be used compared to maximum extrusion ingots 18 inches in diameter and 44 inches long for presses in use in 1952. The press was 172 inches long, 53 feet wide, and 13 feet to 17 feet deep.[26] The forge presses were to be up to 10 stories high; the platen for a 30,000-ton forge press weighed 125 tons. The heavy-press program required larger ingots than any in general use; and a 7,000-pound ingot 32 inches in diameter and 85 inches long, metallurgically and physically sound, was produced, using both mechanical and metallurgical innovations.[27]

Continuous casting and rolling equipment for making redraw rod used in the manufacture of aluminum and copper wire and cable was simpler and operable on a smaller scale than previously economical. The Properzi process, imported from Italy, was used by the Anaconda Wire & Cable Co., Rome Cable Co., General Cable Co., Essex Wire Co., and Nichols Wire Co. Alcoa reportedly purchased such equipment for experimental purposes. This process permitted continuous casting of "Vee" bars for rolling to redraw rod at a rate of approximately 1,500 pounds per hour. The Apex Smelting Co. acquired rights to a patented continuous casting process for production of bar stock and forging stock. The process required no intermediate forming operations. Machines for continuous production of thin-walled shell molds were being designed and developed to speed production of castings by use of the "C" mold, developed in Germany during World War II by Johannes Croning.

[24] Light Metals Age, New Aluminum Brazing Sheet: Vol. 10, Nos. 7 and 8, August 1952, pp. 14–15.
[25] Papen, G. W., and Schroeder, W., Develop New Forging Techniques for Aircraft Parts: Iron Age, vol. 169, No. 6, Feb. 7, 1952, pp. 135–138.
[26] McCormick, T. F., Extruding Aluminum in Giant Presses: Modern Metals, vol. 8, No. 11, December 1952, pp. 54–57.
[27] Light Metals Age, Large Ingot Casting Speeds Heavy-Press Program: Vol. 10, Nos. 7 and 8, August 1952, p. 17.

The soldering of aluminum had been inhibited by the tenacious oxide coating that forms on all aluminum shapes when exposed to the atmosphere, and the strong fluxes used to remove this coating were generally highly corrosive. "Ultrasonic" soldering, which breaks up the oxide coating, was proposed as one method for soldering aluminum without flux. The success of this method depended on the ability of ultrasonic vibrations to set up cavitation in the molten-solder covering. The theory of the cavitation destruction of oxide films and the use of portable soldering tools for accomplishing joining by this method were developed further.[28] "Aluma-flux" for soldering aluminum was reported as a noncorrosive flux available as a nonhygroscopic powder. A new alloy, said to permit welding and soldering of aluminum and zinc base alloys without flux or special cleaning, was reported.[29] The soldering of aluminum had not progressed to the stage where it could be done as easily as with steel, brass, copper, and tin; however, with proper materials and methods it was entirely practical to join many aluminum assemblies by this method. Size of parts was a critical factor because of the high thermal conductivity that made it difficult to bring large parts to required temperatures. Solders possessing a wide range of melting points were available for joining aluminum.[30]

A dipping process for coating steel and other ferrous metals with aluminum, known as "Aldip," was announced by General Motors. The process was simple, practical, and inexpensive, the coating was rust resistant and, when diffused by heat treatment, a heat-resistant material was obtained.[31] A further development in the "Alfin" process for bonding aluminum to ferrous metals was the use of "prodag," a dispersion of colloidal graphite in water, which prevented selected parts of the work piece from becoming coated. The National Bureau of Standards developed a practical process for electrodepositing aluminum at room temperatures. A solution of aluminum chloride and a metal hydride in ether gave dense ductile deposits, and the method was expected to find important applications in electroforming articles with close inside tolerances, as well as for protective coatings.[32] Aluminum was successfully electroplated on steel from a fused aluminum chloride-sodium chloride salt bath at a temperature of 350° F. A smooth matte-type finish was produced at current densities of approximately 15 amperes per square foot.[33] High-purity aluminum deposits were produced by Battelle Memorial Institute from a plating bath consisting of a dispersion of toluene in a toluene solution of the fusion product of ethyl pyridinium bromide and aluminum chloride. The major objective of Battelle's investigation was the forming of lightweight waveguides, and further testing of this system for electrodeposition of protective coatings was recommended.[34]

---

[28] Neppiras, E. A., Ultrasonic Soldering: Metal Ind., vol. 81, No. 6, Aug. 8, 1952, pp. 103–106.
[29] Materials and Methods, New Alloy for Welding and Soldering Aluminum- and Zinc-Base Metals: Vol. 35, No. 2, February 1952, p. 136.
[30] Birdsall, G. W., Materials and Procedures for Soldering Aluminum: Materials and Methods, vol. 35, No. 4, April 1952, pp. 116–118.
[31] Patton, W. G., Complex Parts Easily Coated With Aluminum: Iron Age, vol. 169, No. 24, June 12, 1952, pp. 115–118.
[32] Crouch, D. E., and Brenner, A., A Hydride Bath for Electrodeposition of Aluminum: Jour. Electrochem. Soc., vol. 99, No. 6, June 1952, p. 234.
[33] Collins, F. R., Aluminum Electroplated on Steel From Fused Salt Bath: Iron Age, vol. 169, No. 3, Jan. 17, 1952, pp. 100–101.
[34] Safranek, W. H., Schickner, W. C., and Fauxt, C. L., Electroforming Aluminum Waveguides Using Organo-Aluminum Plating Baths: Jour. Electrochem. Soc., vol. 99, No. 2, February 1952, p. 53.

A number of commercial procedures were available in 1952 for plating aluminum.[35] A process for plating aluminum with nickel, called "Alni-Clad" was announced by the Hamilton Standard Division of the United Aircraft Corp. and Bart Laboratories, Inc. A stress-free, hard, resilient, nickel surface was obtained by spraying the aluminum alloy with a synthetic rubber compound and, after drying, plating the piece to the desired thickness by conventional means. The plating process was developed for the Air Force and Navy to protect aircraft propeller blades from the erosion of sea spray on landings and takeoffs.[36] An etchant for preparing aluminum for nickel plating was developed in England that gave promise for a commercially practicable plating method. The laboratory studies indicated the desirability of tests on a pilot-plant scale. Further laboratory tests were planned to evaluate the corrosion resistance of specimens plated by the new process against others plated by the sodium zincate process.[37] A new caustic etching compound, "Diversey Aluminux" virtually eliminated sludge and scale formation in caustic etching tanks. The dissolved aluminum remained in solution as sodium aluminate with resultant lower "down time," more consistent finishes were reported.[38] Hard coatings for aluminum were being licensed by Alcoa, which had also acquired patent rights to the Martin hard-coating process. Anodic oxide coatings, which form an integral part of the metal, had high resistance to abrasion and corrosion; they had high dielectric strengths and were harder, thicker, and denser than the anodized coatings ordinarily employed for decorative purposes. Aluminum alloys with hard oxide coatings were used or being considered as replacements in aircraft for parts produced from heavier metals of higher inherent hardness.[39] Numerous inorganic finishes were being developed and improved.

World Review

World production of primary aluminum increased for the sixth successive year in 1952 and exceeded 2 million metric tons for the first time in history. Expansion plans in progress and proposed, and new sites being investigated, in many countries indicated that aluminum production would continue to increase for a number of years. A slump in the market for aluminum in Europe and the Far Eastern area during the last half of 1952 indicated that aluminum supply was catching up with demand. There was a trend toward lower prices, particularly for exported metal, and the investigation of new production areas, such as West Africa, Brazil, Borneo, New Guinea, and the Philippines, was based largely on the realization that lower production costs were required to realize expanded consumption.

The United States and Canada continued as the leading producers accounting for 64 percent of world production. European countries (exclusive of U. S. S. R. and Hungary) contributed 20.5 percent, U. S. S. R. and Hungary 13 percent, and the Asiatic area about 2.5 percent. Only 5 countries—United States, Canada, U. S. S. R., France, and West Germany—produced over 100,000 tons. The largest per-

[35] O'Keefe, Philip, Electroplated Coatings on Light Metals: Materials and Methods, vol. 35, No. 6, June 1952, pp. 119–130.
[36] Steel, Nickel-Aluminum Bond Succeeds: Vol. 130, No. 13, Mar. 31, 1952, p. 85.
[37] Thomason, A. G., Plating Aluminum With Nickel: Metallurgia, vol. 44, December 1951, pp. 308–310.
[38] Stell, R. J., Caustic Etch Treats Aluminum Without Sludge or Scale: Iron Age, vol. 169, No. 14, April 3, 1952, p. 138.
[39] Vanden Berg, R. V., Hard Aluminum Finishes Resist Wear and Abrasion: Iron Age, vol. 170, No. 18, Oct. 30, 1952, pp. 81–82.

centage increases over 1951 were by Germany and Austria, where plants that had been partly destroyed during World War II and later prohibited from operating by decree of the occupation authorities were placed in operation.

TABLE 9.—World production of aluminum, by countries,[1] 1948–52, in metric tons [2]

[Compiled by Lee S. Petersen]

Country [1]	1948	1949	1950	1951	1952
Austria	13,319	14,835	17,988	26,380	36,712
Brazil				403	1,085
Canada	333,007	335,172	360,043	405,600	453,370
France	63,701	54,140	60,715	91,080	106,087
Germany, West	7,306	28,848	27,840	74,136	100,474
Hungary	[3] 9,400	[3] 14,000	(4)	(4)	(4)
India	3,421	3,547	3,650	3,960	3,600
Italy	33,081	25,675	37,070	49,750	52,830
Japan	6,965	21,222	24,764	36,900	42,661
Norway	31,041	35,697	47,056	50,261	50,847
Spain	523	1,212	2,167	4,158	4,116
Sweden (includes alloys)	3,279	3,929	4,038	6,720	8,040
Switzerland	19,200	21,600	19,200	27,000	29,500
Taiwan (Formosa)	2,509	1,312	1,761	2,598	3,856
U. S. S. R. [3]	140,000	165,000	190,000	200,000	250,000
United Kingdom	30,510	30,832	29,941	28,170	28,455
United States	565,587	547,449	651,920	759,202	850,327
Yugoslavia	1,884	2,493	1,931	2,828	2,563
Total (estimate)	1,265,000	1,305,000	1,495,000	1,790,000	2,050,000

[1] Aluminum is also produced in East Germany, but production data are not available; estimate by author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous aluminum chapters.
[3] Estimate.
[4] Data not available; estimate by author of chapter included in total.

Australia.—The construction of a primary-aluminum plant at Bell Bay on the Tamar River in Tasmania was promoted during 1952 by the Commonwealth Parliament's passage of the "Aluminum Industry Act, 1952" (operative on a date to be fixed by proclamation), which increased the Commonwealth Government's contribution to the project by A£4,250,000 ($9,520,000). The plant was constructed under the administration of the Australian Aluminum Production Commission, which was established in 1945 pursuant to an agreement between the Commonwealth and Tasmanian Governments whereby each would contribute A£1,500,000 ($3,360,000) to erection of a plant for the production of aluminum ingot. The original estimate was found inadequate for finishing the plant scheduled for an annual capacity of 13,000 metric tons of ingot. The Government of Tasmania stated that it could not contribute any more money; and the additional funds considered necessary to finish the plant were to be supplied by the Commonwealth, with changes in the Commission representation to favor the Commonwealth Government.

The Seventh Annual Report [40] of the Commission stated that design of equipment was virtually completed, deliveries of equipment were delayed beyond scheduled dates, and when practicable British contracts were canceled and arrangements made for local manufacturers to supply from steel stocks available within Australia. Delivery of all steel frameworks for buildings was expected by the end of 1952.

[40] Johnston, L. F., Seventh Annual Report of the Australian Aluminum Production Commission for Year 1st July 1951, to 30th June 1952: Printed and published by the Government of the Commonwealth of Australia, Commonwealth Government Printer, Canberra, No. 127 (Group F)—F.4368, price 9d.

The raw materials—cryolite, pitch, anthracite, and fluorides (CaF_2, NaF, AlF_3)—were on order from Commonwealth or United Kingdom suppliers. No Australian supply of petroleum coke had been located. The idle Glen Davis shale-oil refinery, in New South Wales, which had been suggested for transfer to Bell Bay, was not available to the Commission, and petroleum coke had been ordered from the United States for delivery early in 1953. Although assurances had been received from the Tasmanian Government that supplies of water and electricity would be available as required, debate on the Aluminum Industry Act in the Commonwealth Parliament indicated that the critical lack of electrical power in Tasmania could not be overcome by the scheduled completion date for the aluminum plant in late 1953 or early 1954.

Austria.—Aluminum production in Austria increased for the sixth successive year, and the 1952 production (37,000 metric tons) was exceeded only in the World War II years of 1943 and 1944. The increases were due largely to better hydroelectric power and fuel supplies at the two reduction plants, at Ranshofen and Lend (Salzberg). Production at Ranshofen was approximately 31,000 tons and at Lend 6,000 tons. At Ranshofen, all 5 potlines installed at the plant (annual capacity, 50,000 tons) were in operation during part of 1952 for the first time since World War II. The maximum monthly production of 4,996 tons was obtained in July. Construction of the new Rauris-Kitzblock power plant of the Lend works was temporarily suspended because of financial difficulties.

Austria has been reported as having one of the largest potential hydropower sources in Europe.[41] The development of these potentials could result in more efficient utilization of reduction facilities; however, Austria contained no known metal-grade bauxite deposits and no alumina-production facilities; all calcined alumina used in metal production was imported.

About one-third of the Austrian aluminum pig and ingot production was exported, and aluminum producers were sponsoring promotional procedures and tax-relief measures to meet the increasing competition from other aluminum-producing countries.

The domestic price for aluminum was at the comparatively low level of 1,170 shillings per 100 kilograms (17.4 cents per pound).

The aluminum-fabrication plant at Ranshofen increased its output of sheet, wire, etc., to 14,000 tons, or 20 percent more than in 1951. Approximately one-third of the semifabrications produced were exported to 36 countries.

Brazil.—A reduction plant of 2,200 tons annual capacity was being operated by Electroquimica Brasileira at Ouro Preto, Minas Gerais, during 1952, and a second smelter was being constructed at Aluminio, near Sorocaba, 40 miles from the city of São Paulo, by the Companhia Brasileira de Aluminio (C. B. A.). The C. B. A. anticipated production early in 1953 at a rate of 5,000 metric tons of aluminum annually and had programmed an expansion to 10,000 annual tons in 1954, 15,000 tons by 1957, 20,000 tons by 1960, and 25,000 tons by 1962. The ultimate goal, tentatively scheduled for 1965 was 50,000 annual tons. Initial installations were to include an alumina plant, a reduction plant, and an electrode-manufacturing plant. Fabrication

[41] Konigshofer, Dr. E., The Hydroelectric Potentialities of Austria: Engineering, vol. 173, No. 4486, Jan. 18, 1952.

facilities, including a foundry, extrusion and rolling mill, foil mill a wire-drawing and electric cable plant, and an aluminum products and utensil plant, were also being constructed. A hydroelectric project was started in March on the Juquia River, with a planned initial output of 50,000 kw., which was to be increased to 180,000 kw. Bauxite from the Poços de Caldas deposits 225 miles away was to be used for alumina production. Brazilian aluminum consumption was about 16,000 tons in 1951; and, barring increases, the planned production would make Brazil independent of imports by 1954 or 1955.

The Reynolds Metals Co. (United States firm), submitted a proposal to the Brazilian Government for construction of a 100,000-ton-per-year aluminum plant near Paulo Afonso Falls, using power from the Paulo Afonso hydroelectric project that was under development.

Canada.—Canada increased its production in 1952 at about the same rate as the United States, setting an alltime production record. The increased production was obtained by virtue of a better power supply, absence of strikes, and operation of new reduction facilities at the Isle Maligne plant and marked the sixth successive year in which Canadian production increased. All of the metal was produced by one company, Aluminum Co. of Canada (Alcan), a subsidiary of Aluminium, Ltd. (Alted), at four plants in the Province of Quebec. The two new potlines at Isle Maligne had a total capacity of 45,000 metric tons; the first line was placed in operation in May and the second in September.

Canada has had reduction-plant capacity in excess of power supply for aluminum reduction since World War II; and the expansion of production in Quebec was, in addition to the increased smelting capacity at Isle Maligne, concerned with the development of additional hydrogenerating facilities. Two power plants were being constructed on the Peribonka River north of Lake St. Charles at Chute du Diable and Chute à la Savanne. Each plant was designed for five 54,000 hp. (40,000-kw.) generators. At Chute du Diable the installation was completed in December; at Chute à la Savanne the first generator was ready for operation at the end of the year. The generating capacity owned by Alted and subsidiary companies in Quebec, including the 2 new plants, was 2,580,000 hp. (1,925,000 kw.) out of a total capacity for the Province of 6,755,000 hp. (5,035,000 kw.). This hydroelectric capacity was sufficient to provide power for full utilization of the 465,000 tons of smelting capacity at Arvida, Isle Maligne, and Shawinigan Falls. Power for the fourth plant at Beauharnois (30,000 tons annual capacity) was purchased from the Quebec Hydroelectric Commission.

The Nechako-Kemano-Kitimat project in British Columbia, which included creation of a reservoir area 150 miles long, the driving of tunnels to a powerhouse being constructed at Kemano, a 50-mile transmission line to Kitimat, and smelter, dock, and townsite at Kitimat, was proceeding according to schedule. The Kenney Dam, 1,550 feet long at the crest and 320 feet high, which sealed the eastern watershed, was completed and the diversion tunnel closed in October. The power tunnels and powerhouse excavation were about one-half completed, the transmission line right-of-way over a 5,300-foot mountain pass had been cleared, and a part of the towers was constructed during 1952. At Kitimat port facilities and smelter structures were being constructed. This British Columbia development was engineered for an ultimate aluminum-production capacity of 500,000 tons per year. Although the capacity authorized during 1952 for the aluminum reduction plant and power-generation facilities provided for only 83,000 tons of aluminum annually, additional smelting capacity of approximately 180,000 tons annually would be possible without substantial enlargement of the hydraulic works or transmission lines.

Canadian industry consumed 18 percent of the ingot produced in 1952; the remainder was exported, the major part going to the United Kingdom and the United States. Canada has for many years been the major world exporter of ingot aluminum. Shipments of aluminum in ingot form by Aluminium, Ltd., during the past 5 years were as follows:

	1948	1949	1950	1951	1952
United Kingdom	145,500	146,500	133,000	181,600	234,300
United States	79,800	66,900	147,500	93,700	104,100
Canada	58,200	52,500	60,000	78,500	80,500
Others	70,900	48,100	37,800	48,900	35,600

The United Kingdom Government had first call on 200,000 tons of Alcan's annual output until 1954 and 250,000 tons annually from 1954 to 1971 under agreements in which the United Kingdom Ministry of Supply advanced funds for expanding ingot capacity. In 1952 part of the aluminum scheduled for delivery to the United Kingdom was diverted to the United States (see Foreign Trade).

Aluminium, Ltd., owned or had an interest in bauxite mines, alumina plants, and ingot production and fabricating facilities throughout the world, including United Kingdom, France, Germany, Norway, Sweden, Italy, Netherlands, Denmark, Greece, India, Japan, Australia, British Guiana, Brazil, Mexico, Jamaica, Union of South Africa and West Africa.

The price of aluminum ingot (99+ percent Al) in Canada was 18.0 cents per pound. Government controls on semifabricated aluminum were lifted in June; however, controls similar to those in force in the United States remained on the distribution and use of primary ingot throughout 1952.

France.—Primary aluminum production in France in 1952 was 106,100 tons, surpassing the alltime high attained in 1951 by 15,000 metric tons and almost double the 1949 production. The increased production was obtained from established reduction plants of the Compagnie de Produits Chimiques et Électrométallurgiques Alais, Froges et Camargue (Pechiney) and the Société d'Électrochimie, d'Électrométallurgie et des Acieries Électriques d'Ugine (Ugine). Pechiney was the major producer and supplied 82 percent of the output. The major factors responsible for the increased production were modernization of plant facilities and an improved electrical power supply.

The Saint Jean de Maurienne plant of Pechiney was equipped with advanced-type 100,000-ampere reduction cells, making it one of the most up-to-date in the world, with resulting increased plant capacity. The modernization program was to continue at other plants as warranted by improvements in power supplied and by distribution of labor. The modernization program was extended to the fabrication stage, and a new plant at Issoire (Puy-de-Dôme) capable of producing 50,000 tons of aluminum shapes per year was completed and reported to be the most modern fabrication plant in Europe. The power-generating facilities of France were nationalized in 1946, and the Government undertook to provide the aluminum industry with power throughout the year. The use of higher cost thermal power was required during the winter months, but the success of the Government's power program is reflected in the increased production of aluminum in recent years.[42]

The 19 francs per kilogram (2.5 cents per pound) premium that had been placed on primary aluminum for domestic consumption to cover higher thermal power costs during the winter was reduced by 9 francs in April, giving a price of 191 francs per kilogram (24.8 cents per pound). Effective June 2, the French domestic base price was reduced to 180 francs per kilogram (23.3 cents per pound).

At the end of 1952 it was reported that French aluminum producers were able to resume exports to traditional markets because of an improved supply position. A large surplus for export was not promising, however, as domestic consumption, estimated at between 100,000 and 110,000 tons, was expected to increase at a greater rate than production. In addition to increased use in established markets, a process for extrusion sheathing of insulated cable, evolved and patented by French technicians, was expected to require additional aluminum.[43]

French Guinea.—Further large-scale increases in aluminum production in France were limited by inadequate hydroelectric power conditions and the French aluminum industry was actively studying French Guinea (West Africa) as a location for a reduction plant. Large, rich deposits of bauxite were available, and their local exploitation depended on an electrical power supply. Another African project by French interests involved the mining of calcium and aluminum phosphates in Thies, with shipments to begin as soon as phosphate-transport facilities were completed at Dakar. A special process for recovering aluminum from these phosphates was developed by Pechiney and licensed to a number of foreign firms for exploitation.[44]

Germany.—Production of aluminum in Western Germany, although rising steadily since the middle of 1950, was not sufficient to meet the demands of German consumers throughout most of 1952. Imports of 3,000 metric tons from Canada and the 100,000 tons of domestic primary plus an estimated 40,000 tons of secondary metal were consumed in Germany. A large part of this consumption was, however, exported as semifabricated shapes and finished aluminum articles. During the latter part of the year, increasing primary production, which increased from 5,600 tons in January to 9,700 in October, the higher prices for German aluminum products as compared to Canadian and United Kingdom prices for similar articles, and general softening of the European aluminum market contributed to a near balance in demand and supply. The high prices of German aluminum, which

[42] Maurice Moyal, French Aluminum Industry: Metals Ind., vol. 81, No. 10, Sept. 5, 1952, pp. 191–193.
[43] American Metal Market, vol. 59, No. 236, Dec. 10, 1952, p. 11.
[44] American Metal Market, vol. 59, No. 71, Apr. 11, 1952, p. 10.

were of little importance when supplies were scarce in relation to demand, were increasingly hampering the export business.

A continual improvement in the availability of electrical power promoted the repair and rebuilding of reduction facilities that had been idle since the end of World War II. A third potline at the Luenen (Westphalia) plant was placed in operation during the early part of 1952 and increased production rates at this plant by approximately 25 percent. Further increases could have been realized with an increased power supply. The number of operating electrolytic cells at the Toeging (Bavaria) plant was increased from 90 to 162. The Erftwerke (Rhineland) plant, which was dismantled, was being rebuilt, and production at an annual rate of 10,000 to 12,000 tons (about half the prewar capacity) was anticipated in the latter part of 1953.

The price of primary aluminum was reported as 232 DM per 100 kilograms (25.1 cents per pound) in October.

Aluminum produced in Germany was scheduled for delivery to the United States National Stockpile under a United States Mutual Security Agency contract with Eleusis Bauxite Mines Co. of Greece. Under the contract Greek bauxite was to be delivered to Germany for conversion to metal, and 100,000 tons of aluminum was to be shipped to the United States as repayment for advances made to the mining company.[45]

Gold Coast.—Although primary aluminum has never been produced on the African Continent in commercial quantities, Gold Coast, with the large hydroelectric power potentials of the Volta River and bauxite deposits containing reserves estimated at 230 million metric tons, had been proposed as an aluminum-production site as early as 1924. Bauxite production from these deposits started in 1941 and totaled 162,685 tons in 1943. In 1951 the British Aluminium Co. and Aluminium, Ltd. (Canadian), reported that production of aluminum in Gold Coast was technically and economically sound.

In November 1952, a White Paper[46] entitled the "Volta River Aluminium Scheme" was published and presented to the British Parliament. This paper was the result of exploratory discussions between representatives of the United Kingdom and Gold Coast Governments, Aluminium, Ltd., and the British Aluminium Co. A partnership of Government and private enterprise was proposed in which private enterprise would be primarily responsible for aluminum production, mining, alumina production, and smelting, and the two Governments for the hydroelectric development and public works and services, ports, railroads, etc. The proposal called for construction of a dam and power station at Ajena with a calculated output of 564,000 kw. of firm electric power, an alumina plant and smelter with an annual capacity of 210,000 tons of aluminum at Kpong, 12 miles downstream, a new port at Tema, new roads and railways as required for transportation of ore and metal, and townships that would come into being as a result of the new industry. The development would take place in 3 stages; the first stage 80,000 tons of aluminum capacity annually, the second 120,000 tons, and the final stage 210,000 tons. The

[45] Daily Metal Reporter, vol. 52, No. 60, Mar. 27, 1952, pp. 1–8.
[46] Her Majesty's Stationery Office (London), Volta River Aluminium Scheme: Cmd 8702, November 1952, 22 pp.

estimated capital costs were: For 80,000-ton capacity annually—£100,500,000 ($281,400,000), distributed among the participants as follows: United Kingdom Government 43 percent, Gold Coast Government and private investors 36 percent, and aluminum companies 21 percent; for 120,000 tons capacity annually—£114,500,000 ($320,600,000), with the United Kingdom Government providing 46 percent, Gold Coast Government and private investors 32 percent, and aluminum companies 22 percent; for 210,000 tons capacity annually—£144,000,000 ($403,200,000), with the United Kingdom Government providing 39 percent, Gold Coast and private investors 27 to 31 percent, and aluminum companies 34 to 30 percent.

In return for the United Kingdom Government's investment, the smelter company would be obligated for 30 years from initial production to offer at least 75 percent of the output to United Kingdom buyers. Acceptance of this scheme would provide a long-sought large supply of aluminum from the Sterling area and make the United Kingdom less dependent on Canadian aluminum. This was a major factor that provided impetus to the Volta River Aluminium Scheme.

Hungary.—The only information available in 1952 that presented statistical data on production of aluminum in Hungary stated that in 1951 production of aluminum was 20 times greater than in 1938. This would make 1951 production 30,000 metric tons.[47] However, the few reports concerning the Hungarian aluminum industry usually did not differentiate between primary and secondary production, and in some cases alumina- and aluminum-plant locations appeared to be used interchangeably. Thus, it was difficult to analyze the Hungarian aluminum situation. A new alumina plant was completed at Almasfuzito in 1951, and some reports also placed a new reduction plant at this location. Another "new plant" was scheduled for construction at Inota, where a large generating station began operating in late 1951. The nearby electrical power supply indicated that this plant would be for production of primary aluminum.

India.—Expansion of primary aluminum production capacity of India has been proposed ever since the establishment of this industry during World War II. In 1952 two small reduction plants with an annual capacity of approximately 2,500 metric tons each were in operation, but an inadequate electrical power supply hampered production at both plants.

The Government of India Planning Commission fixed the expansion program for primary-aluminum production during the remaining 4 years of the First Five-Year Plan at 20,000 tons per year from a projected capacity of 25,000 tons. The increased capacity was to be obtained by doubling the capacity of established plants and by erecting a new 15,000-ton-per-year plant near the planned hydroelectric power installations in the Hirakud (Orissa) area. The Government of India further sanctioned proposals to establish thereafter an additional unit of 15,000 tons annually. Expansion of the semifabricating industry was also part of the plan but necessarily had to await completion of some of the major power schemes. The achievement of such an expansion goal presented a number of difficulties. The plant of the Indian Aluminum Co. at Alwaye (Trav-

---

[47] Metal Bulletin, No. 3719, Aug. 22, 1952, p. 19.

ancore) was being expanded, and foundations were completed for a new potline; however, it was thought unlikely that hydroelectric power for the new facilities would be available for several years. At the plant of the Aluminum Corp. of India, Ltd., at Asansol (West Bengal), the thermal power supply for the equipped capacity was being improved by installation of a third boiler. High production costs, lack of semifabrication facilities, and the low and unstable purchasing power of the country were also inhibiting factors.

The long-term future of the Indian aluminum industry, however, was promising. Undeveloped hydroelectric power sites remained for exploitation. The Damodar (Bihar), Jog (Mysore), and Hirakud (Orissa) schemes offered promise for low-cost electrical energy. The cost of other contributing factors, such as indigenous products, particularly petroleum coke, transportation costs for materials required from abroad, and domestic transportation costs might be reduced, with a general rise in industrial activity. The consumption of aluminum in India was approximately four times the primary production, with about two-thirds going into the manufacture of utensils; other markets were relatively undeveloped. High tariffs and Government subsidies were in force to protect the Indian producers.[48]

Italy.—Production of primary aluminum in Italy continued to increase during 1952 due largely to plant modernization and a good power supply. The price of primary aluminum remained at 365 lire per kilogram (24.7 cents per pound) throughout the year. In August the Italian Ministry of Foreign Supply announced that it would permit export from Italy of 1,500 metric tons of aluminum semimanufactures provided that (a) payments were obtained in free United States dollars, Canadian dollars, or Swiss francs and (b) payment from the sterling area was obtained in pounds sterling.

Japan.—The production of primary aluminum in Japan increased about 16 percent over 1951 despite a sharp decline in exports during the middle of the year. Production was 3,926 metric tons in May, a postwar high. The ex mill price of 99.5 percent aluminum was 235,000 to 240,000 yen per ton (30 cents per pound) at the beginning of 1952 and was standardized to 235,000 yen per ton for 99.3 to 99.7 percent aluminum and 225,000 yen per ton for aluminum of less than 99.3 percent quality in July. A discount of 10,000 yen per ton was granted on aluminum sold to rolling mills for the specific purpose of selling rolled aluminum sheets for export. Export quotations were approximately 38 cents per pound in January and declined steadily during the year; in October export quotations were as low as 26 cents per pound. The Japanese aluminum industry was actively seeking new markets during the latter half of 1952. In May the terms of a proposed agreement between Aluminium, Ltd., of Canada and the Japanese Light Metals Co. were announced under which Alted would purchase 50 percent of the shares of the Japanese firm for $2,000,000 and supply $1,800,000 in additional capital in the form of a long-term loan. The Canadian company was also to provide technical assistance and to ship bauxite from its holdings in India or

[48] Light Metals, The Industry in the World Today: Vol. 55, No. 175, September-October 1952, pp. 302, 303, 336, 337.

Malaya. The agreement was opposed by the Japanese Finance Ministry until October, when it was finally approved, with minor amendments, by the Japanese Government. The Canadian company agreed not to acquire over one-half interest in the Japanese company or to inject itself into management policies. It was anticipated that the import price of raw materials, chiefly bauxite, would be lowered and that this, combined with technological improvements and increased output, would result in lower prices in aluminum for export. Japan had a highly developed and integrated aluminum industry during World War II, with an annual capacity of 119,700 tons on the home islands. In 1949–50 the Government initiated a hydroelectric power-development program, and there were indications that Japan could become a significant exporter, particularly to eastern countries, if production costs could be lowered.

Norway.—Production of aluminum in Norway remained at about 50,000 metric tons in 1952 and was almost at capacity throughout the year. Norway's aluminum requirements are less than one-third of its production, and the major part was exported to other European countries. Despite a total lack of high-grade aluminum ore and the necessity for importing all of its alumina requirements, Norway maintained a highly competitive aluminum industry as compared to other European producers because of its large, low-cost hydroelectric resources. The aluminum-production capacity of this country was to be increased approximately 40 percent in 1955, when a new 40,000 ton-per-year smelter was scheduled for completion at Sunndalsora. Construction on the Sunndalsora plant was begun late in 1951; production from 1 of 2 potlines was expected late in 1954 and from the other early in 1955. Many improved features, learned from construction and operation of the Aardal plant, were to be introduced and were expected to reduce costs appreciably. The electrolytic cells were to draw double the power of those at Aardal, and alumina was to be transported in bulk instead of in sacks. Management estimated that costs of production would be just over $280 per ton (12.7 cents per pound). Six thousand tons of construction steel was ordered from Germany. Converters and transformers were to be manufactured in Germany and Norway, and a 10-year contract for the supply of alumina had been negotiated with Aluminium, Ltd., of Canada.

Spain.—Spanish production of primary aluminum in 1952 was about the same as in 1951. Production was obtained from the French-owned (Pechiney) plant at Savinanigo, Huesca Province, and from the Government-controlled plant at Valladolid. Although the Savinanigo plant had a rated annual capacity of 2,000 metric tons, production had never exceeded 1,300 tons because of the necessity for closing the factory during the winter months when hydroelectric power, generated from water originating in the Pyrenees glaciers, was not available. The Valladolid plant began production in 1950 with an initial capacity of 2,500 tons per year; this plant was being expanded to 5,000 tons per year, and further expansion to 10,000 annual tons was planned. It was reported that a new plant was being constructed at Tarrogona. A new semifabrication plant was to be constructed by Aluminio Iberico, S. A., and Manufactureras Metalicas Madrilenas at Alicante. Initial construction was to begin in September 1952, and operation of at least 1 section of the factory was anticipated within 18 months. Initial capacity was to be 8,000 tons of aluminum products per year. Later expansions to an annual total of 40,000 tons was planned. Plant operators were to be trained in a Canadian factory.

Sweden.—Increases in Swedish aluminum production were obtained from an expansion program that started in 1950. The annual productive capacity at the conclusion of the program in 1954 will be about 10,000 metric tons. The Swedish Metallverken in Vaesteraas, Central Sweden, extended its wire-rolling capacity following increased demands for its products.

Switzerland.—Production of primary aluminum in Switzerland was maintained at approximate capacity throughout 1952. The production was from two companies—Société Anonyme pour l'Industrie de l'Aluminium at Chippis (Volais Canton) produced at its capacity of 25,000 metric tons and Usine d'Aluminium Martigny, S. A., at Martigny-Ville (Valais Canton) produced 4,500 tons (estimated capacity, 5,000 tons). Imports of pig and ingot were around 5,000 tons. Alumina for the reduction plants was imported from France, Italy, and Germany, petroleum coke for the Chippis plant was imported from the United States, and baked electrodes for the Martigny plant came from Italy. The export demand for semifabricated products, of which Switzerland is a large exporter, decreased during the latter part of the year, and most aluminum fabricators were compelled to reduce their output 25 percent during the last 2 months compared to the same period of 1951 and to return to 2- instead of 3-shift work. In May, when demand was at a high level, the representative price of pure aluminum, delivered Swiss frontier, was 250 Swiss francs per 100 kilograms (26.0 cents per pound).

Taiwan (Formosa).—Production by the Taiwan Aluminum Corp. (the only producer) was hampered by power shortages and the necessity for importing raw materials and spare parts for machinery and equipment. Available power and raw materials permitted the production of 3,856 metric tons of ingot from a plant with an annual capacity rated at 8,000 tons.

The 800 tons of aluminum ingot exported was valued at NT $7,050,000 (25.7 cents per pound).

United Kingdom.—The United Kingdom's production of primary aluminum is small in relation to consumption. In 1952 primary-aluminum shipments from Government holdings were 223,900 metric tons, and deliveries of secondary metal were 112,500 tons (primary-metal content 15,900 tons). Imports were 237,900 tons (Canada shipped 234,300 tons to the United Kingdom in 1952), and production was 28,455 tons. All primary aluminum produced in and imported into the United Kingdom was controlled by the British Ministry of Supply. This department controlled the distribution and prices. The demand for aluminum, which exceeded supply throughout 1951 and the first half of 1952, weakened in the latter part of the year; deliveries of virgin metal were about 22,000 tons in May and 11,000 tons in December. In July the Ministry of Supply informed the aluminum industry that large quantities of virgin metal would be made available for direct and indirect export. Effective July 1, the price below which general manufactures of aluminum were restricted was raised from £180 to £220 per ton (22.5 to 27.5 cents per pound). The base price of primary aluminum (99.0 to 99.5 percent) was £148 per ton (18.5 cents per pound) on January 1, 1952 and was raised in April to £154 per ton and in July to £157. Further increases resulted in a £166-per-ton (20.8-cents-per-pound) price on December 30. Scrap-aluminum ceiling prices were increased in April and again in July. On November 1 scrap price controls were removed; and low grades of scrap, such as borings and turnings, were moving slowly.

U. S. S. R.—In the Soviet Union's fifth Five-Year Plan—for 1951–55—the production goal for aluminum was set at about 2.6 times the 1950 output, or about 500,000 metric tons. The only clue given as to the location of future aluminum-production facilities was the directives that called for development of hydroelectric power in the Angara River area of Siberia. It was estimated that 50 to 60 percent of the 1952 Soviet aluminum production came from 2 plants in the Urals, 1 at Krasnoturinsh in the northern Urals and the other at Kamensk-Uralsky, southeast of Sverloush in the southern Urals. Electric power for both plants was obtained from steam.[49]

Yugoslavia.—Production of primary aluminum at Yugoslavia's only producing smelter, Lozovac, Dalmatia, decreased slightly (265 metric tons and 9 percent) from 1951. Construction on the alumina and aluminum plant at Strnisce, Dalmatia, near the Austrian border continued during 1952. Alumina facilities were about 75 percent complete, the main items still needed being motors and pumps; the major construction work left to be done was erection of the sintering equipment. The aluminum smelter was about one-third complete; the buildings were virtually complete; and the steel framework for the furnaces of 1 of 4 potlines was largely in place, but only 1 reduction cell had been constructed. Rectifiers for 30,000 tons of capacity had been installed. Most of the chemical equipment was of German origin, the boilers for the power plant came from Austria, and electric furnaces (reduction cells) were to be shipped from Norway. The Strnisce plant was planned for an ultimate capacity of 30,000 tons; initial annual capacity was to be 15,000 tons. It was estimated that about 1 year would be required to complete the alumina plant and an additional 6 months for the reduction plant. The installation of 4,500 tons of annual reduction capacity was also planned for Razina near the present plant at Lozovac. (The Razina plant was also described as an expansion of the Lozovac plant.)

Yugoslavia thus plans to produce 22,500 tons of primary aluminum by 1954 and to further raise output to 37,500 tons by 1956 (capacity operation). The production of semifabricated (rolled) aluminum products was also to be expanded to 18,000 tons per year in 1954 and 23,000 tons by 1956 through construction of a 15,000 ton-per-year rolling mill at Razina and conversion of a mill at Slovenska Bistrica to aluminum.[50] Realization of this expansion program would make Yugoslavia a net exporter of both primary aluminum and semifabricated-aluminum products.

[49] American Metal Market, Russia Embarking on Vast Expansion of Aluminum Capacity: Vol. 59, No. 179, Sept. 16, 1952, p. 10.
[50] Mining Journal (London), Yugoslavia Aluminum Industry: Vol. 239, No. 6104, Aug. 15, 1954, p. 174.

Antimony

By Abbott Renick[1] and E. Virginia Wright[2]

ESTIMATED world production of 50,700 short tons of antimony in 1952 was 17,600 tons less than in 1951 and increased 28 percent over the 1943–47 average (39,700 tons).

Demand for antimony in the United States decreased in 1952, and there was a large increase in available supplies of foreign antimony. Following suspension of operations at the Yellow Pine mine at Stibnite, Idaho, owned and operated by the Bradley Mining Co., domestic mine production dropped to a negligible level. Compared with 1951 domestic production of antimony decreased 38 percent, and smelter production of metal, oxide, sulfide, and primary residues decreased 3 percent. Primary antimony available for consumption was 17 percent less than in 1951. Actual consumption of primary antimony decreased 18 percent; and industry stocks decreased 14 percent. Secondary antimony decreased 4 percent from the 1951 output.

The price of antimony metal and ores dropped sharply in early 1952. Effective April 24, the National Lead Co. announced a reduction in the price of antimony metal from 50 cents to 44 cents a pound, f. o. b. Laredo, Tex. The latter price was quoted until May 19, when the leading smelter announced a reduction in its quotation to 39 cents a pound. A further 4½-cent price cut became effective November 3, 1952, to some extent related to the fact that foreign metal was arriving at levels considerably below the domestic quotations. Quoted prices for antimony, RMM brand in cases, New York City, varied between a low of 36.47 and a high of 51.85 cents per pound. Average price for the metal in bulk, carlots, during 1952, according to the American Metal Market, was 44.02 cents (New York equivalent) per pound compared with 44.17 cents in 1951.

The United States "new supply" of primary antimony in 1952, in terms of recoverable metal, was 17,000 short tons. A breakdown of this supply shows that domestic antimony ores contributed 2,000 tons[3]; domestic and foreign lead-silver ores, 2,800 tons; and imports, 12,200 tons. The contained antimony, imported for consumption, arrived as follows: Ore and concentrates (in terms of recoverable metal), 7,300 tons; metal, 3,400 tons; and oxide, 1,500 tons. In addition, 24 tons of antimony sulfide, not included in the total, also was imported. The supply from secondary sources was 23,100 tons.

Total consumption of antimony in the United States during 1952 was 40,100 tons, comprising 14,300 of primary, 2,800 tons of antimony contained in domestic and foreign silver and lead ores consumed in the manufacture of antimonial lead by primary lead refineries, and 23,000 tons of secondary antimony.

The Defense Minerals Exploration Administration, acting under authority of the Defense Production Act of 1950, as amended, granted

[1] Commodity-industry analyst.
[2] Statistical assistant.
[3] In terms of recoverable metal content (92 percent of gross meta lcontent).

exploration assistance, amounting to 75 percent of costs, to approved antimony-exploration projects. The following applicants were awarded contracts with DMEA from the beginning of the program to the end of 1952:

State and Contractor:	Project location	Value: Total	Value: Government participation
Alaska:			
Earl R. Pilgrim	4th Jud. Division	$62,000.00	$46,500.00
Tillicum Mining Co	Cleveland Peninsula	24,695.00	18,521.25
Arkansas: Ashley J. Gold	Sevier County	16,913.00	12,684.75
California: Melvin M. Ford and Oscar Lipnitz.	Kern County	7,500.00	5,625.00
Idaho:			
Bradley Mining Co	Valley County	175,368.00	131,526.00
Do	do	53,000.00	39,750.00
Hermada Mining Co	Elmore County	44,100.00	33,075.00
Oscar V. Svensson	do	2,445.00	1,833.75
Nevada: E. S. Perry and Robert B. McPherson.	Nye County	2,640.00	1,980.00
Oregon: (E. E. Stauffer) assigned to Paul W. Wise.	Malheur County	34,727.00	26,045.25
Washington: G. O. P. Antimony, Inc.	Okanogan County	23,200.00	17,400.00
Do	do	16,080.00	12,060.00

Government Regulations.—Effective May 15, 1952, the National Production Authority revoked Order M–39 (antimony) restricting consumption and stocks. However, monthly reporting on the production, receipts, consumption, shipments, and inventories of antimony (in excess of 1,999 pounds of contained antimony) was retained on a mandatory basis.

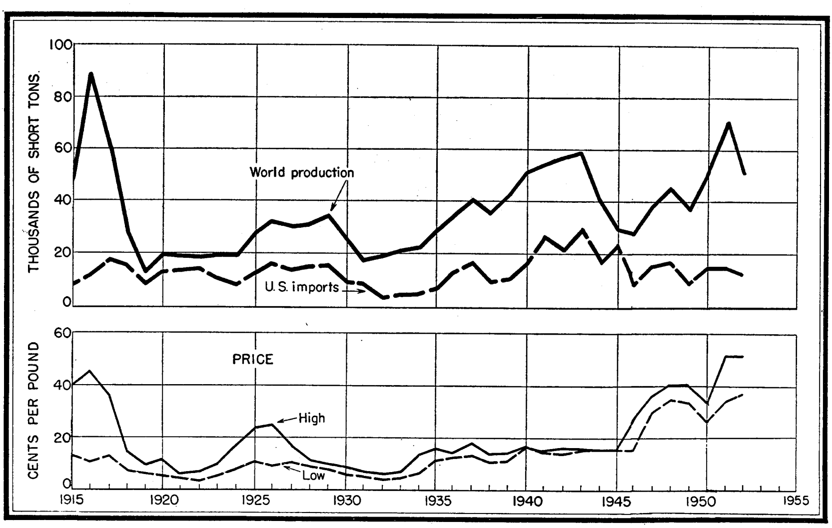

FIGURE 1.—World production, United States imports, and New York price of antimony, 1915–52.

TABLE 1.—Salient statistics of antimony in the United States, 1943–47 (average) and 1948–52, in short tons (antimony content)

	1943–47 (average)	1948	1949	1950	1951	1952
Production:						
Primary:						
Mine (shipments)	4,008	6,489	1,636	2,497	3,472	2,160
Smelter, from domestic and foreign ores	17,566	14,308	8,099	9,471	12,228	11,860
Secondary	18,123	21,592	18,061	21,862	23,943	23,089
Imports for consumption	18,796	17,038	9,429	15,354	15,673	12,789
Ore and concentrates	16,728	13,464	7,473	9,746	[1] 11,746	7,945
Sulfide	3	373	57	13	4	24
Metal	2,065	3,201	1,853	4,632	2,231	3,354
Oxide	(2)		46	963	1,692	1,466
Exports of ore and metal [3]	528	327	485	154	168	161
Consumption of primary antimony [4]	20,637	15,455	[1] 11,266	[1] 15,167	[1] 17,370	14,255
Average price of antimony at New York [5]—cents per pound	19.67	36.67	38.73	29.41	44.17	44.02
World production [6]	39,700	49,600	40,800	48,500	[1] 68,300	50,700

[1] Revised figure.
[2] Figures not available 1943. None imported 1944–48.
[3] Gross weight.
[4] Does not include antimony contained in domestic and foreign silver and lead ores, recovered at primary lead refineries, and marketed in antimonial lead.
[5] American Metal Market.
[6] Exclusive of U. S. S. R.

DOMESTIC PRODUCTION

MINE PRODUCTION

During 1952 domestic production (shipments) of antimony ores and concentrates totaled 4,900 short tons containing 2,200 tons of antimony of which 2,000 tons were estimated as recoverable. In addition 2,800 tons of antimony in the form of antimonial lead were recovered from silver and lead ores at primary lead refineries. Compared with 1951, the 1952 output from antimony ores and concentrates decreased 38 percent and from silver and lead ores increased 17 percent.

As a result of slackening demand and reduced prices, Bradley Mining Co., Stibnite, Idaho, discontinued mine production of antimony in June 1952, and the smelter was shut down in August. Before suspending operations the company produced 4,000 tons of concentrate containing 1,900 short tons of antimony, 86 percent of the total domestic mine production. The smaller producers were as follows:

Alaska—Stampede mine; Sawtooth Mining Co.
California—Kern County, Bingo Mine, and the Antimony Queen mine.
Nevada—Nye County, Last Chance mine.
Washington—Okanogan County, Lucky Knock and Bales mines.

TABLE 2.—Antimony-bearing ores and concentrates produced (shipments) in the United States,[1] 1943–47 (average) and 1948–52, in short tons

Year	Gross weight	Antimony content		Year	Gross weight	Antimony content	
		Quantity	Average percent			Quantity	Average percent
1943–47 (average)	15,847	4,008	25.3	1950	6,888	2,497	36.3
1948	16,239	6,489	40.0	1951	9,401	3,472	37.0
1949	5,260	1,636	31.1	1952	4,854	2,160	44.5

[1] Includes Alaska.

TABLE 3.—Domestic mine production (shipments) and consumption of primary antimony, 1943–52, in short tons, antimony content

Year	Domestic mine production [1]	Industrial consumption	Year	Domestic mine production [1]	Industrial consumption
1943	5,112	19,508	1950	2,297	15,167
1944	4,356	23,756	1951	3,194	17,370
1945	1,776	25,761	1952	1,987	14,255
1946	2,305	17,515			
1947	4,891	16,647	Total	33,393	176,700
1948	5,970	15,455			
1949	1,505	11,266	Average (10 years)	3,339	17,670

[1] In terms of recoverable metal content (92 percent of gross metal content).

SMELTER PRODUCTION

Primary.—Antimony smelters in the United States produced 11,800 short tons of antimony, comprising 2,500 tons of metal, 6,800 tons of oxide, 100 tons of sulfide, and 2,400 tons of residues. Total production decreased 3 percent from the 12,200 tons produced in 1951.

In 1952, 2,800 short tons of antimony was recovered as antimonial lead by primary lead refineries from domestic and foreign silver and lead ores. This was a 17-percent increase over the 2,400 tons recovered in 1951. (See Lead chapter of this volume for detailed discussion of antimonial lead production.)

TABLE 4.—Smelter production of antimony, 1948–52, by type of material, in short tons, antimony content

Year	Metal	Oxide	Sulfide	Residues	Total
1948 [1]					14,308
1949	3,242	4,786	71	(2)	8,099
1950	2,899	6,492	80	(2)	9,471
1951	3,870	7,475	100	783	12,228
1952	2,533	6,805	108	2,414	11,860

[1] Figures compiled by Office of Materials Distribution, U. S. Department of Commerce. Breakdown by type of material not available.
[2] Not reported separately.

TABLE 5.—Antimony metal, alloys, and compounds produced in the United States, 1943–47 (average) and 1948–52, in short tons

Year	Primary metal, oxide, sulfide and residues (antimony content)	Antimonial lead produced at primary lead refineries: Gross weight	Antimony content: From domestic ores [1]	Antimony content: From foreign ores [2]	Antimony content: From scrap	Total: Quantity	Total: Percent	Total secondary antimony (content of alloys [3])
1943–47 (average)	17,566	62,893	1,609	475	1,997	4,081	6.6	18,123
1948	14,308	100,764	2,190	1,031	2,539	5,760	5.7	21,592
1949	8,099	41,402	1,214	396	1,775	3,385	8.2	18,061
1950	9,471	61,912	2,253	597	1,654	4,504	7.3	21,862
1951	12,228	65,309	1,663	693	2,060	4,416	6.8	23,943
1952	11,860	58,203	2,210	567	1,615	4,392	7.5	23,089

[1] Includes primary residues and small quantity of antimony ore.
[2] Includes foreign base bullion and small quantity of foreign antimony ore.
[3] Includes antimony content of antimonial lead produced at primary lead refineries from scrap.

Secondary.—Antimony produced at secondary metal plants in 1952 was 21,400 short tons, plus 1,600 tons recovered from scrap at primary lead refineries, accounting for a total production of 23,000 tons of secondary antimony, a decrease of 4 percent from the 24,000 tons produced in 1951. (See Secondary Metals—Nonferrous chapter of this volume for detailed review.)

CONSUMPTION AND USES

The total consumption of antimony in the United States in 1952 was 40,100 short tons, an 8-percent decrease from the 43,700 tons consumed in 1951. Primary antimony used totaled 14,300 short tons

TABLE 6.—Industrial consumption of primary antimony 1948–52, by type of material, in short tons (antimony content)

Year	Ore and concentrates	Metal	Oxide	Sulfide	Residues	Total
1948 [1]						15,455
1949	2,472	4,163	4,492	139	(2)	[3] 11,266
1950	3,065	6,330	5,600	172	(2)	[3] 15,167
1951	3,007	4,645	8,872	162	684	[3] 17,370
1952	1,776	4,321	7,465	117	576	14,255

1 Figures compiled by Office of Materials Distribution, U. S. Department of Commerce. Breakdown by type of material not available.
2 Not reported separately.
3 Revised figure.

TABLE 7.—Industrial consumption of primary antimony, 1948–52, in short tons

Product	1948 [1]	1949	1950 [2]	1951 [2]	1952 [2]
Metal products:					
Ammunition	21	6	9	4	3
Antimonial lead	6,024	2,588	4,440	2,282	1,612
Battery metal	(3)	1,521	1,738	2,774	2,104
Bearing metal and bearings	1,803	873	1,518	1,308	1,119
Cable covering	62	172	72	95	43
Castings	81	49	126	79	80
Collapsible tubes and foil	31	14	23	18	32
Sheet and pipe	195	306	300	180	70
Solder	145	155	162	123	145
Type metal	1,019	587	766	709	624
Other	(3)	364	145	52	61
Total metal products	9,381	[4] 6,635	[4] 9,299	[4] 7,624	5,893
Nonmetal products:					
Ammunition primers	6	9	9	18	24
Antimony sulfide (precipitated)	(5)	(5)	(5)	68	67
Fireworks	(6)	(6)	(6)	20	36
Flameproofed coatings and compounds	(6)	(6)	(6)	463	980
Flameproofed textiles	388	273	369	2,590	2,059
Frits and ceramic enamels	1,561	1,155	1,462	1,476	959
Glass and pottery	352	296	579	570	579
Matches	37	28	56	31	22
Paints and lacquers	1,288	874	267	962	853
Pigments	(6)	(6)	(6)	705	766
Plastics	228	498	737	747	632
Rubber products	41	55	103	19	66
Other [7]	2,173	1,443	2,286	2,077	1,319
Total nonmetal products	6,074	4,631	5,868	9,746	8,362
Grand total	15,455	[4] 11,266	[4] 15,167	[4] 17,370	14,255

1 Data for 1948 compiled from monthly applications filed with the Office of Materials Distribution, U. S. Department of Commerce.
2 Data include certain intermediate smelting losses, which have been deducted for earlier years.
3 Included with "Antimonial lead."
4 Revised figure.
5 Not reported as an end-use product.
6 Included with "Other nonmetal products."
7 Antimony trichloride and sodium antimonate included to avoid disclosure of individual company operations.

(17,400 in 1951); antimony content of lead-silver ore consumed in the manufacture of antimonial lead by primary lead refineries, 2,800 short tons (2,400 in 1951); and secondary, 23,100 short tons (24,000 in 1951).

Consumption of primary antimony in the manufacture of finished products decreased 18 percent from 1951. Of the quantity consumed 59 percent was used in the manufacture of nonmetallic products and 41 percent in the manufacture of metallic products.

Consumption of secondary antimony, chiefly in metallic products, decreased 4 percent from 1951.

STOCKS

At the close of 1952 mine and industry stocks totaled 7,700 short tons, a 14-percent decrease from the 9,000 tons reported on hand at the end of 1951. Mine stocks at the beginning and end of 1952 were 480 and 180 tons, respectively. Industry stocks were 8,500 tons at the end of 1951 and 7,500 tons on December 31, 1952.

In addition to the stocks shown in table 8, noteworthy quantities of antimony are held in the National Stockpile. The Munitions Board Stockpile Report to the Congress on February 15, 1953, stated that antimony was one of the 18 commodities for which the stockpile objective had been met as of December 31, 1952.

TABLE 8.—Industry stocks of antimony in the United States at end of year, 1951–52, in short tons of contained antimony

Raw material	December 31, 1951			December 31, 1952		
	Mine [1]	Other [2]	Total [2]	Mine [1]	Other	Total
Ore and concentrates	479	3,015	3,494	179	1,565	1,744
Metallic antimony		2,347	2,347		2,041	2,041
Antimony oxide		2,681	2,681		3,114	3,114
Antimony sulfide (needle)		107	107		142	142
Primary antimony residues and slag		323	323		632	632
Total	479	8,473	8,952	179	7,494	7,673

[1] Includes Alaska.
[2] Revised figures.

PRICES

The price of antimony metal, RMM brand, in bulk, f. o. b. Laredo, Tex., averaged 42.09 cents per pound; ranging from a high of 50.00 cents at the beginning of the year to a low of 34.50 cents at the end of the year. The New York price for antimony metal, RMM brand, in bulk carlots, averaged 44.02 cents a pound in 1952, according to the American Metal Market. A review of the 1952 prices of antimony metal (National Lead Co.), carload lots, placed New York, follows:

	RMM brand, cents per pound	*Lone Star brand, cents per pound*
Jan. 1, 1952	51.85	52.35
Apr. 25, 1952	45.85	46.35
May 20, 1952	40.97	41.47
Nov. 4, 1952	36.47	36.97
Dec. 29, 1952	36.47	36.97

According to E&MJ Metal and Mineral Markets, opening and subsequent changes in nominal quotations for antimony ore during 1952, per unit (20 pounds) of antimony contained, were as follows:

	50–55 percent	*55–60 percent*	*60–65 percent*
Jan. 3, 1952	$5.50–$5.75	$5.75–$6.00	$6.75–$7.00
Feb. 7, 1952	5.00– 5.25	5.25– 5.50	6.50– 6.75
Mar. 13, 1952	4.50– 4.75	4.50– 4.75	6.50– 6.60
Apr. 24, 1952	4.25– 4.50	4.50– 4.75	6.00– 6.25
May 15, 1952	3.75– 4.00	4.00– 4.25	5.25– 5.50
June 12, 1952	3.25– 3.50	3.35– 3.60	4.50– 5.00
Aug. 7, 1952	3.00– 3.25	3.25– 3.50	3.50– 3.75
Sept. 18, 1952	2.50– 2.75	2.75– 2.85	3.00– 3.25
Nov. 20, 1952	2.50– 2.60	2.60– 2.70	3.25
Dec. 25, 1952	2.50– 2.70	2.60– 2.80	3.50– 3.75

FOREIGN TRADE [4]

Tariff.—There is a duty of 2 cents a pound on imports of antimony metal (unchanged since December 11, 1950); 1 cent a pound on antimony oxide (unchanged since May 22, 1948); and ½ cent per pound, plus 12 percent of the foreign value, on antimony sulfide (unchanged since January 1, 1948). There is no duty on imports of antimony contained in ore.

Imports.—In 1952 the United States imported for consumption 12,200 tons of contained antimony, a 17-percent decrease from the 14,700 short tons imported in 1951. Imports of ore (in terms of recoverable metal), principally from Bolivia and Mexico, decreased 32 percent, the grade of ore averaging 44 percent; imports of metal, chiefly from Mexico, Yugoslavia, Belgium-Luxembourg, and Czechoslovakia, increased 50 percent; imports of antimony oxide, 86 percent of which came from the United Kingdom, decreased 13 percent; and imports of antimony sulfide increased from 4 tons in 1951 to 24 tons in 1952 and were supplied principally by Yugoslavia.

TABLE 9.—Antimony imported for consumption in the United States, 1943–47 (average) and 1948–52 [1]

[U. S. Department of Commerce]

Year	Antimony ore			Needle or liquated antimony		Antimony metal		Type metal and antimonial lead [2] (short tons)	Antimony oxide	
	Short tons (gross weight)	Antimony content		Short tons (gross weight)	Value	Short tons	Value		Short tons (gross weight)	Value
		Short tons	Value							
1943–47 (average)	40,533	16,728	$3,344,711	4	$1,617	2,065	$973,393	496	(3)	(3)
1948	41,610	13,464	4,312,431	533	314,809	3,201	2,022,676	1,569	----	----
1949	17,855	7,473	2,488,271	81	42,537	1,853	1,242,582	654	56	$27,290
1950	22,307	9,746	1,850,162	19	8,895	4,632	2,204,091	1,936	1,160	428,386
1951	[4] 26,698	[4] 11,746	[4] 4,571,974	6	5,936	2,231	1,780,576	[4] 465	2,039	1,525,016
1952	18,246	7,945	3,200,889	34	20,719	3,354	2,338,938	1,494	1,766	1,056,286

[1] Does not include antimony contained in lead-silver ore.
[2] Estimated antimony content; for gross weight and value, *see* Lead chapter of this volume.
[3] Data not available 1943. None imported 1944–48.
[4] Revised figure.

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 10.—Antimony imported into the United States, 1943–47 (average), 1948–50 (totals), and 1951–52, by countries [1]

[U. S. Department of Commerce]

Country	Antimony ore			Needle or liquated antimony		Antimony metal		Antimony oxide	
	Short tons (gross weight)	Antimony content		Short tons (gross weight)	Value	Short tons	Value	Short tons (gross weight)	Value
		Short tons	Value						
1943–47 (average)	40,535	16,759	$3,333,285	3	$1,583	2,069	$975,957	([2])	([2])
1948	41,610	13,464	4,312,431	533	314,809	3,317	2,096,573		
1949	17,855	7,473	2,488,271	81	42,537	2,065	1,357,634	56	$27,290
1950	24,095	10,367	1,957,699	19	8,895	4,488	2,121,499	1,160	428,386
1951									
Belgium-Luxembourg				6	5,936	320	267,890	192	127,858
Bolivia [3]	[4] 7,249	[4] 4,626	[4] 2,160,000						
Canada	([5])	([5])	([5])			23	22,081		
Chile [3]	760	492	207,583						
China				2	1,096				
Czechoslovakia						17	7,275		
France	187	49	18,505			217	139,159	11	7,145
French Morocco	164	90	45,810						
Greece	18	7	2,565						
Honduras	10	5	2,286						
Italy						19	17,610		
Mexico	14,086	4,003	978,490			1,094	833,635		
Mozambique	150	90	40,136						
Netherlands						22	21,292		
Peru [3]	522	[4] 251	108,804			103	85,967		
Spain						11	9,870		
Union of South Africa	3,174	1,904	995,523						
United Kingdom						134	125,004	1,836	1,390,013
Yugoslavia						271	250,605		
Total	[4] 26,320	[4] 11,517	[4] 4,559,702	8	7,032	2,231	1,780,388	2,039	1,525,016
1952									
Belgium-Luxembourg				11	9,273	536	370,173	245	131,837
Bolivia [3]	7,505	4,967	2,281,717						
Chile [3]	133	86	55,899						
Czechoslovakia						356	126,707		
France	5	2	645			6	2,912		
Germany, West						77	32,723		
Greece	43	15	3,231						
Italy						17	13,151		
Mexico	9,564	2,272	556,759			1,055	926,948		
Netherlands						56	47,887		
Peru [3]	409	251	107,180			25	20,935		
Turkey						143	115,873		
Union of South Africa	580	348	192,166						
United Kingdom	7	4	3,292			320	212,601	1,521	924,449
Yugoslavia				23	11,446	798	489,615		
Total	18,246	7,945	3,200,889	34	20,719	3,389	2,359,525	1,766	1,056,286

[1] Data are general imports, that is, include antimony imported for immediate consumption, plus material entering the country under bond. Table does not include imported antimony contained in lead-silver ores.
[2] Data not available 1943. None imported 1944–48.
[3] Imports shown from Chile probably were mined in Bolivia or Peru and shipped from a port in Chile.
[4] Revised figure.
[5] Revised to none.

Exports.—Exports of antimony ore and concentrates (gross weight) in 1952 were 25 tons valued at $13,300; and of metal and alloys, 136 tons valued at $124,400. During 1951 exports (gross weight) included 5 tons of antimony ore and concentrates valued at $5,100 and 163 tons of metal and alloys valued at $146,000.

Reexports of ore and concentrates in 1952 were 5 tons valued at $3,400; and of metal and alloys, 1 ton valued at $1,000.

TECHNOLOGY

The flameproofing of textiles with titanium-antimony was the subject of an article.[5] The article provides an example—

$TiCl_4$ is dissolved in cold water to a concentration of 210 g. TiO_2 and 382 g. HCl per liter. Sb_2O_3 is dissolved in this liquid to a concentration of 100 g./1. This final solution contains 48% Sb_2O_3 (calculated of the weight of TiO_2) or 26% of the HCl. A clear yellow complex solution results that does not decompose in this concentration while an equivalent $SbCl_3$ solution containing no Ti ions decomposes quickly and is hydrolyzed. The complex character can be scientifically proven by spectrophoto-metric comparison of this solution with solutions of the single components.

The Antimony volume of the Materials Survey series, prepared by the Bureau of Mines for the National Security Resources Board, was published in 1952.[6] It describes the occurrence, mining, milling, and smelting of antimony, and gives considerable statistical information on the industry in the United States and abroad.

A review of the Broken Hill (Australia) lead-silver-zinc industry includes a short description of the extraction of arsenic and antimony from lead bullion and the production of antimonial lead.[7]

The use of sacks made of "Dynel" to collect antimony oxide at the Bradley Mining Co. Yellow Pine mine and smelter, Stibnite, Idaho, was the subject of an article.[8]

WORLD REVIEW

Canada.—A test shipment of 7,232 long tons of antimony sulfide ore from the Bridge River district, British Columbia, property of Gray Rock Mining Co., Ltd., returned a gross value of $2,043, or $282.49 per long ton. This material, hand-cobbed from an open cut on the No. 2 vein, assayed 50.2 percent antimony and 0.19 percent arsenic, with traces of lead, zinc, copper, selenium, and tellurium.[9]

India.—The Star Metal Refinery in Bombay, India's only producer of antimony, suspended operations in May.[10]

Mexico.—Output of antimony in Mexico during 1952 totaled 5,500 metric tons, a 19-percent decrease from 1951. A comparison of production and exports of antimony is shown in the following table:[11]

[5] American Dyestuff Reporter, The Flameproofing of Textiles With Titanium-Antimony: Vol. 41, No. 3, Feb. 4, 1952, pp. 87-88.
[6] Materials Survey—Antimony: Compiled for the NSRB by the Bureau of Mines, in cooperation with the Geological Survey, Washington, D. C., March 1951.
[7] Woodward, O. H., A Review of the Broken Hill Lead-Silver-Zinc Industry; Australasian Inst. Min. and Met., Inc., Melbourne, Australia, 1952.
[8] Engineering and Mining Journal, New Fiber Gives Excellent Service in Dust-Fume Bags: Vol. 154, No. 1, January 1953, p. 121.
[9] Northern Miner, vol. 153, No. 49, Feb. 28, 1952, p. 24.
[10] Metal Bulletin (London), No. 3712, July 25, 1952, p. 21.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 1, July 1952, pp. 3-5.

Production and exports of antimony, Mexico, metric tons (metal content)

	Production	Exports		Production	Exports
1941	11, 138	10, 241	1947	6, 926	6, 058
1942	11, 695	11, 283	1948	7, 380	6, 515
1943	13, 682	12, 567	1949	5, 753	4, 106
1944	10, 930	10, 277	1950	5, 868	3, 494
1945	8, 752	8, 005	1951	6, 824	4, 809
1946	6, 571	5, 906			

Philippines.—In Batangas Province, on the island of Luzon, a deposit of antimony was discovered.[12]

United Kingdom.—In 1952 total consumption of antimony in the United Kingdom declined to 3,168 long tons compared with 6,272 tons in 1951.[13]

Union of South Africa.—Large reserves of antimony have placed the Union of South Africa in the fore as one of the world's leading producers. Consolidated Murchison (Transvaal) Goldfields & Development Co., Ltd., the only antimony producer in 1951, produced 27,503 short tons of cobbed ore and concentrates averaging 61.9+ percent antimony and 1.224 dwt. gold, from the treatment of 160,392 tons assaying 11.59 percent antimony and 3.298 dwt. gold.[14]

Production in 1952 totaled 8,000 short tons of contained antimony, a 54-percent decrease from 1951, resulting from the restricted scale of operations caused by depressed world market prices for antimony.

Yugoslavia.—According to a recent report,[15] Europe's most important antimony deposits are located in Yugoslavia. An abstract of the report follows:

> Before World War II, Yugoslavia was Europe's largest producer of antimony. The Germans denuded the country of her known antimony reserves, so that in 1944 new reserves had to be created before mining could be restarted. All those now known are the result of post-war prospecting and efforts are being made to find additional occurrences. Europe's first plant to treat antimony ores by the flotation process was constructed at Zajaca, where an antimony smelter is also in operation. In addition to a number of small flotation plants in the vicinity, a large unit is under construction. The capacity of the existing plant at Zajaca is 1,500 tons of metal annually.

Production of antimony ore is estimated at 74,600 metric tons in 1952, a 35-percent increase from 1951.[16]

---

12 Mining Journal (London), Annual Review: May 1952, p. 35.
13 Mining Journal (London), Antimony: Ann. Rev., May 1953, p. 35.
14 South African Mining and Engineering Journal, vol. 63, No. 3128, Jan. 24, 1953, p. 863.
15 Work cited in footnote 9, p. 159.
16 Mining World, vol. 15, No. 5, Apr. 15, 1952, p. 131.

TABLE 11.—World production of antimony (content of ore),[1] by countries, 1943–47 (average) and 1948–52, in metric tons [2]

[Compiled by Pauline Roberts]

Country	1943–47 (average)	1948	1949	1950	1951	1952
North America:						
Canada [3]	591	141	72	292	591	1,134
Honduras	43	6	9	(4)	(4)	----------
Mexico [3]	9,373	7,380	5,753	5,868	6,824	5,531
United States	3,636	5,887	1,484	2,265	3,150	1,960
South America:						
Argentina	40	(5)	(5)	(5)	(5)	(5)
Bolivia (exports)	9,755	12,260	10,275	8,781	11,816	9,806
Peru	1,602	1,556	729	971	1,107	505
Europe:						
Austria [6]	326	269	379	409	498	389
Czechoslovakia	2,449	4,100	(5)	[7] 2,000	(5)	(5)
France	176	275	338	407	611	(5)
Greece	----------	----------	49	350	500	350
Hungary	[7 8] 660	(5)	(5)	(5)	(5)	(5)
Italy	460	553	503	671	794	779
Portugal	25	41	21	15	19	(5)
Spain	195	219	259	200	117	[9] 665
Yugoslavia	[7] 1,200	2,250	2,789	3,205	1,973	[7] 2,700
Asia:						
British Borneo: Sarawak	----------	4	1	2	----------	(5)
Burma [7]	515	121	70	40	200	(5)
China	607	3,251	[7] 4,000	[7] 6,000	[7] 8,000	[7] 8,000
Indochina	8	----------	----------	----------	----------	(5)
Iran	5	----------	[10] 175	[10] 230	[7 10] 230	160
Japan	256	135	172	161	221	209
Thailand (Siam)	48	92	265	87	65	70
Turkey (Asia Minor)	66	600	460	1,288	3,360	1,400
Africa:						
Algeria	351	746	1,326	1,250	1,462	1,321
French Morocco	328	520	700	689	957	839
Southern Rhodesia	87	9	41	24	62	100
Spanish Morocco	112	272	150	353	213	(11)
Union of South Africa	2,554	4,106	4,461	8,311	15,858	7,211
Oceania:						
Australia	394	188	198	227	310	[7] 170
New Zealand	----------	5	3	----------	----------	(5)
Total (except U. S. S. R.)	36,000	45,000	37,000	44,000	62,000	46,000

[1] Approximate metal content of ore produced, exclusive of antimonial lead ores.
[2] This table incorporates a number of revisions of data published in previous tables.
[3] Includes antimony content of antimonial lead.
[4] Negligible.
[5] Data not available; estimate by author of chapter included in total.
[6] Excludes Soviet zone, data for which are not available, but estimates for which are included in the totals.
[7] Estimate.
[8] Trianon Hungary after October 1944.
[9] Including Spanish Morocco.
[10] Fiscal year ended March 20 of year following that stated.
[11] Included with Spain.

Arsenic

By Abbott Renick [1]

PRODUCTION of white arsenic in the United States decreased 3 percent in 1952 under that in 1951 and was virtually unchanged from the 1947–51 average (16,000 short tons).

Producers' stocks of white arsenic reached the highest point on record, increasing from 4,800 tons to 11,300 in the course of the year. Imports for consumption in 1952 decreased 69 percent.

Of the total white arsenic newly available in the United States in 1952, domestic production (from domestic and foreign ores) constituted 78 percent and imports 22 percent. Apparent consumption was 6,400 tons less than supply.

The strong trend in consumer preference for organic chemicals over arsenicals continued unabated in 1952 and, coupled with extended droughts and the generally hot and dry weather which prevailed in the cotton belts, further decreased the use of arsenic in insecticides.

The price of white arsenic (arsenic trioxide) in 1952 held at 6½ cents a pound in barrels, carlots, delivered, until June 16, when it was reduced to 5½ cents.

TABLE 1.—Salient statistics of the white arsenic industry in the United States, 1943–47 (average) and 1948–52, in short tons [1]

Year	Production	Sales	Imports	Exports [2]	Apparent consumption [3]	Producers' stocks	Price per pound [4]
1943–47 (average)	24, 122	24, 386	13, 398	1, 447	36, 337	1, 541	$0. 048
1948	18, 639	14, 965	9, 336		24, 301	4, 712	. 06–. 06¼
1949	12, 795	10, 181	4, 696		14, 877	7, 326	. 06–. 05¼
1950	13, 273	17, 330	14, 774		32, 104	2, 479	. 05–. 06½
1951	16, 190	14, 351	14, 518		28, 869	[5] 4, 834	. 065
1952	15, 673	9, 244	4, 483		13, 727	11, 263	. 065–. 055

[1] For data for earlier years (1910–47), *see* Arsenic chapter, Minerals Yearbook 1949.
[2] Figures for 1943–45 from U. S. Department of Commerce; figures for other years reported by producers to Bureau of Mines.
[3] Producers' shipments plus imports minus exports.
[4] Refined white arsenic, carlots, as quoted by E&MJ Metal and Mineral Markets.
[5] Revised.

[1] Commodity-industry analyst.

DOMESTIC PRODUCTION

Reports from producers indicate that the output of crude and refined white arsenic in the United States totaled 15,700 tons in 1952, 500 tons less than in 1951.

Crude and refined white arsenic was produced in 1952 by the Anaconda Copper Mining Co. at Anaconda, Mont. (copper smelter); United States Smelting, Refining & Mining Co. at Midvale, Utah (lead smelter); and American Smelting & Refining Co. in plants at Tacoma, Wash. (copper smelter), and Murray, Utah (lead smelter). Arsenic metal was not produced during 1952.

TABLE 2.—Production and shipments of white arsenic by United States producers, 1943–47 (average) and 1948–52

Year	Crude			Refined			Total		
	Production (short tons) [1]	Shipments		Production (short tons)	Shipments		Production (short tons)	Shipments	
		Short tons	Value		Short tons	Value		Short tons	Value
1943–47 (average)	21,085	21,299	$1,129,262	3,037	3,087	$191,222	24,122	24,386	$1,320,484
1948	17,213	13,749	1,141,213	1,426	1,216	119,054	18,639	14,965	1,260,267
1949	12,289	9,597	713,984	506	584	50,527	12,795	10,181	764,511
1950	11,903	15,778	955,739	1,370	1,552	113,240	13,273	17,330	1,068,979
1951	15,485	13,656	972,832	705	695	69,242	16,190	14,351	1,042,074
1952	15,046	8,719	563,719	627	525	46,751	15,673	9,244	610,470

[1] Excludes crude consumed in making refined.

CONSUMPTION AND USES

During 1952 apparent consumption of white arsenic was 13,700 short tons, a 52-percent decline below 1951. The major portion of white arsenic produced is employed in manufacturing lead and calcium arsenate insecticides.

The reduced consumption was due largely to the generally hot and dry climatic conditions, which discouraged serious insect infestations, and to the greatly expanded use of organic insecticides, such as DDT, benzene hexachloride, chlordane, and toxaphene. The uptrend in the use of organic insecticides has been reported.[2]

> Only a decade ago, the combined output of organic insecticides was a paltry few million pounds a year. Now the annual production capacity is in the neighborhood of 350 million. Production has grown over 250 percent.

Arsenic is also consumed in glass manufacture, sheep dip, poisoned baits, pharmaceuticals, acid-resistant copper, and antimonial lead alloys. Sodium arsenate is used as a weed killer. Wolman salts or tanalite (25 percent sodium arsenate) is used as a wood preservative. Arsenical sprays have been employed since the end of the last century to protect growing tobacco.

[2] Chemical Engineering, Agricultural Chemicals: March 1953, p. 199.

STOCKS

Year-end producers' stocks of white arsenic reached 11,300 short tons compared with 4,800 at the end of 1951 and were the highest since 1939, the first year for which the Bureau of Mines compiled such data. Data are not available on stocks of calcium and lead arsenate held by producers.

TABLE 3.—Production of arsenical insecticides and consumption of arsenical wood preservatives in the United States, 1943–47 (average) and 1948–52

	Production of insecticides (short tons)[1]		Consumption of wood preservatives (pounds)[2]
	Lead arsenate (acid and basic)	Calcium arsenate (100 percent $Ca_3(AsO_4)_2$)	Wolman salts (25 percent sodium arsenate)
1943–47 (average)	32,204	22,743	1,022,092
1948	12,316	13,618	1,286,302
1949	8,434	8,003	1,003,992
1950	19,750	23,750	1,197,617
1951 [3]	12,708	20,450	1,544,181
1952 [4]	7,156	4,079	1,658,426

[1] Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce.
[2] Forest Service, U. S. Department of Agriculture.
[3] Revised figures.
[4] Preliminary figures.

PRICES

The carlot quotation for refined white arsenic held at 6½ cents per pound the first 5½ months of 1952; effective June 16, the price was reduced to 5½ cents per pound and after that date remained unchanged. The London price of white arsenic, per long ton, 99–100 percent, opened in January at £55¼–£57¼ and in the latter part of December was quoted at £59½.

FOREIGN TRADE [3]

Imports.—White arsenic imported totaled 4,500 short tons in 1952 compared with 14,500 tons in 1951, 14,800 tons in 1950, and an average of 9,300 tons in 1947–49.

Imports of metallic arsenic totaled 60,200 pounds, Sweden supplying 52, United Kingdom 37 and Germany 11 percent. In 1952 there were no transactions in arsenic sulfide; arsenical sheep dips came exclusively from United Kingdom.

[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 4.—White arsenic (As_2O_3 content) imported for consumption in the United States, 1943–47 (average) and 1948–52, by countries

[U. S. Department of Commerce]

	1943–47 (average)		1948		1949		1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Belgium-Luxembourg			5	$961	30	$1,997	952	$43,544				
Bolivia	2	$208										
Canada	85	7,402	83	6,278	96	11,816	179	16,194	742	$69,036	121	$14,470
France	11	1,246					497	39,397	1,919	247,443	110	12,992
Germany							11	755				
Italy			337	57,479								
Japan									276	39,180		
Mexico	10,862	634,642	7,132	598,989	4,511	544,895	12,659	1,290,712	10,899	1,147,395	4,252	520,112
Peru	1,677	79,194	98	8,860					61	6,468		
Poland Danzig	36	4,985			48	4,866	39	2,950				
Portugal	11	1,642	28	4,409			50	3,204				
Sweden	374	41,322	1,204	157,233	11	1,261	387	29,427	621	72,317		
U. S. S. R.	339	35,058	449	49,320								
Total	13,397	805,699	9,336	883,529	4,696	564,835	14,774	1,426,183	14,518	1,581,839	4,483	547,574

Exports.—Producers of white arsenic reported no direct foreign sales in 1952. Exports of calcium arsenate increased 5 percent from those of 1951, whereas exports of lead arsenate decreased 59 percent. Mexico was the principal recipient of calcium arsenate; Colombia, Peru, Nicaragua, Cuba, Canada, and others followed in order. Their respective proportions of the total were 41, 33, 13, 6, 2, 2, and 3 percent. Canada was the principal recipient of lead arsenate; Cuba, Taiwan, Venezuela, and others followed in order. Their respective proportions of the total were 28, 26, 17, 11, and 18 percent.

TABLE 5.—Arsenicals imported into and exported from the United States by classes, 1943–47 (average) and 1948–52, in pounds

[U. S. Department of Commerce]

Class	1943–47 (average)	1948	1949	1950	1951	1952
Imports for consumption:						
White arsenic (As_2O_3 content)	26,794,836	18,671,621	9,392,699	29,547,402	29,036,555	8,966,906
Metallic arsenic	38,146	36,587	45,369	137,533	220,668	60,220
Sulfide	471,767	88,608	44,092	147,055	148,299	
Sheep dip	88,505	38,275	55,830	77,219	62,050	102,415
Lead arsenate	24,110				13,669	161,316
Arsenic acid			200	2,000	5,600	
Calcium arsenate	103			228,000	1,554,207	192,205
Sodium arsenate	26,649			110,152	180,040	65,221
Paris green				88,640		41,255
Exports:						
Calcium arsenate	4,827,975	4,569,346	4,047,406	3,857,107	5,356,867	5,606,613
Lead arsenate	3,911,602	2,037,645	860,530	1,040,100	626,184	255,268

TECHNOLOGY

Research by the Bureau of Mines on the occurrence of thallium in ores, concentrates, and metallurgical products found that one of the most promising sources was the byproduct "white arsenic" from a lead smelter in Utah.[4]

From a white arsenic containing 96 percent arsenic trioxide and 0.21 percent thallium, 98 percent of the arsenic was volatilized and more than 99 percent of the thallium was retained in the residue by fuming with 5 percent sulfuric acid and 5 percent lime at 430° C. for 0.5 hour. The physical properties of the residues were satisfactory.

The thallium was recovered satisfactorily from the residue by volatilization with sodium chloride at 800° C.

WORLD REVIEW

Canada.—Although arsenical ores are widely distributed in Canada, the production of arsenic is limited to a few localities where it is recovered as a byproduct in treating gold or silver-cobalt ores. About 750 short tons of white arsenic was produced in 1952 compared with 1,200 in 1951. Canada's output of crude white arsenic continued to come from the O'Brien Gold Mines Co., and consolidated Beattie Mines, Ltd., in Cadillac and Duparquet Townships, Quebec.

Finland.—Output of arsenic concentrates from the Ylojarvi mine was 496 metric tons in 1952 compared with 726 tons in 1951.[5]

Mexico.—Byproduct white arsenic was recovered by Cia. Metalurgica Peñoles, S. A. (subsidiary of American Metal Co.), at its Torreon, Coahuila, lead smelter. The American Smelting & Refining Co. produced white arsenic at its San Luis Potosi copper smelter.

Portugal.—Mina de Pintor produced 940 metric tons of white arsenic in 1951 compared with 801 tons in 1950. Domestic sales were 71 tons in 1951 compared with 35 tons in 1950. Most of the arsenic consumed in Portugal is used by the glass industry; the remainder is consumed in insecticides.

Exports decreased from 1,277 tons in 1950 to 865 in 1951; stocks were reported at a minimum at the end of the year. Total anticipated 1952 production has been sold in advance.

The company plans to build a plant at Pintor to calcine and refine arsenic in the near future. Eighty percent of the equipment will come from West Germany, and 20 percent will be manufactured in Portugal from German designs.[6]

---

[4] Prater, John D., Schlain, David, and Ravitz, S. F., Recovery of Thallium From Smelter Products: Bureau of Mines Rept. of Investigations 4900, 1952, 9 pp.

[5] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 6, June 1953, p. 3.

[6] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 4, October 1952, pp. 3–4.

TABLE 6.—World production of white arsenic, by countries,[1] 1946–52, in metric tons [2]

[Compiled by Pauline Roberts]

Country [1]	1946	1947	1948	1949	1950	1951	1952
Australia	1,651	1,210	520	257	163	122	--------
Belgium-Luxembourg (exports)	[3]	[3]	151	527	1,909	325	1,003
Brazil	829	1,001	984	959	1,067	1,321	[4] 850
Canada	338	357	527	239	360	1,068	694
France	3,140	2,510	2,256	1,964	2,454	[3]	[3]
Germany, West (exports)	[3]	[3]	37	1,081	1,124	3,504	[3]
Greece	8	14	18	20	33	56	[3]
Iran [5]	[3]	[3]	[3]	[4] 80	[4] 25	[3]	[3]
Italy	436	1,620	1,730	1,440	726	1,769	2,144
Japan	1,092	1,407	1,765	2,489	1,627	1,300	[3]
Mexico	9,648	9,685	7,571	3,576	8,987	12,766	[3]
New Zealand	18	8	8	19	10	--------	[3]
Peru	753	608	1,011	--------	--------	[3]	[3]
Portugal	508	1,005	1,616	975	608	747	[3]
Southern Rhodesia	216	416	283	148	114	76	515
Spain	440	484	573	124	159	375	[3]
Sweden	10,109	16,088	16,979	8,967	14,512	[3]	[3]
Union of South Africa	12	3	13	--------	--------	--------	--------
United Kingdom [6]	147	91	[3]	[3]	[3]	[3]	[3]
United States	9,263	17,014	16,909	11,607	12,041	14,687	14,218
Total (estimate)	42,000	56,000	54,000	36,000	47,000	57,000	46,000

[1] Arsenic is also believed to be produced in Argentina, Austria, China, Czechoslovakia, East Germany, Hungary, Korea, and U. S. S. R., but data are not available. Estimates by the author for Austria and East Germany have been included in the total. There is too little information for estimating the other countries.
[2] This table incorporates a number of revisions of data published in previous white arsenic chapters.
[3] Data not available; estimate by author of chapter included in total.
[4] Estimate.
[5] Year ended Mar. 20 of year following that stated.
[6] White arsenic, including arsenic soot.

Asbestos

By Oliver Bowles[1] and Flora B. Mentch[2]

ALTHOUGH total production of asbestos in Canada, principal source for the United States, was somewhat smaller in 1952 than in 1951, the decline was confined largely to the shorts. Production of the better grades of mill fibers was higher than in 1951. The demand for groups 3 to 5 generally exceeded supply. During the first half of the year the demand for shorts was considerably lower than in 1951, but later in the year it increased until it equaled or exceeded supply.

Domestic sales exceeded those of 1951 by 4 percent and reached an alltime high. Arizona sales, which were a little higher than in 1951, were chiefly of the nonspinning grades. Amphibole asbestos sales, which were unusually small, were confined to Georgia.

Imports and apparent consumption were smaller than in 1951, but the decline was confined to the shorter grades. Imports of low-iron chrysotile, of spinning grades, from Southern Rhodesia continued to decline. As a great deal of interest is centered in fiber of this type, table 5 has been introduced into this chapter to show imports from Southern Rhodesia by grades.

As the demand for high-grade spinning fibers continues to exceed the supply, prices continued the upward trend that characterized recent years.

TABLE 1.—Salient statistics of the asbestos industry in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Domestic asbestos:						
Produced short tons	12,932	37,237	42,918	41,358	51,730	53,888
Sold or used do	12,603	37,092	43,387	42,434	51,645	53,864
Value	$516,903	$1,806,261	$2,614,416	$2,925,050	$3,912,500	$4,713,032
Imports (unmanufactured) short tons	449,632	647,881	509,366	705,458	761,873	709,419
Value	$21,301,310	$37,974,092	$33,939,582	$47,284,205	$58,521,046	$61,595,900
Exports (unmanufactured)[1] short tons	4,617	9,227	20,045	20,890	16,526	10,724
Value	$552,936	$1,804,611	$4,152,344	$4,084,384	$3,662,270	$2,670,970
Apparent consumption short tons	457,619	675,746	532,708	727,002	796,992	752,559
Exports of asbestos products[1,2]	$7,413,083	$9,326,705	$9,667,847	$8,147,141	$14,321,278	$13,028,857

[1] 1947–52 figures include material that has been imported and subsequently exported without change.
[2] 1943–45 figures include value of "Magnesia and manufactures."

DOMESTIC PRODUCTION

As indicated in table 1, domestic sales were 4 percent higher in 1952 than in 1951. Chrysotile was produced in Vermont and Arizona and

[1] Commodity specialist.
[2] Statistical assistant.

amphibole in Georgia. So few companies have produced amphibole during recent years that separate figures cannot be published.

Production in Arizona was a little higher in 1952 than in the previous year. The following firms and individuals were active: American Asbestos Cement Corp., 115 West Oak St., Globe; Apache Asbestos Mines, Inc., Globe; Bear Canyon Mining Co., P. O. Box 1730, Globe; Ned H. Brown, P. O. Box 1797, Clifton; Arthur Enders, P. O. Box 362, Globe; Jaquays Mining Corp., 1219 South 19th Ave., Phoenix (on June 1, 1952, took over the Regal mine, formerly operated by Arizona Chrysotile Asbestos Co.), also operated the Asbestos King mine; George W. Kohl, P. O. Box 1593, Globe; Kyle Asbestos Mines of Arizona, P. O. Box 302, Globe; Metate Asbestos Corp., P. O. Box 1506, Globe; Phillips Asbestos Mines, Drawer 71, Globe.

In 1952 a majority of the Arizona producers established The Arizona Asbestos Producers' Association, with headquarters in Globe, for the purpose of reviewing marketing problems, securing better transportation facilities in the district, and taking other steps to improve conditions in the industry.

Measures were under way late in 1952 to establish at Globe, Ariz., an asbestos mill and purchasing facilities under Defense Materials Procurement Agency sponsorship, but little progress had been made by the end of the year except the purchase and warehousing of some unmilled asbestos. The purpose of this project is to make available a mill for the production of low-iron asbestos now in strong demand for stockpiling and current consumption.

According to press reports, a carlot of an unusual, platy form of asbestos known as antigorite has been shipped from a deposit near Jamestown, Tuolumne County, Calif., to the Powhatan Mining Co. at Baltimore, Md., for experimental purposes. No commercial production of either amphibole or chrysotile was reported in 1952, but some exploratory work was conducted under Defense Minerals Exploration Administration loans.

The Powhatan Mining Co., Woodlawn, Baltimore, Md., reported a small production of amphibole asbestos in Georgia from deposits at Gay, Meriwether County, and Dillard, Rabun County.

Some interest has appeared in an asbestos deposit in Warren County, N. Y., consisting of crossfiber veins of chrysotile in limestone. Only small outcrops of fiber-bearing rock appear.

Mining & Milling Corp. of America, 441 Lexington Ave., New York 17, N. Y., has equipped a mill at Spruce Pine, N. C., for processing anthophyllite obtained chiefly at the Bluerock deposit, which was worked some years ago by Industrial Minerals Corp. The mill, which was nearing completion in 1952, is designed to prepare group 7 fibers to be used in conjunction with Canadian 7R chrysotile in asphalt- and vinyl-tile manufacture. Other actual or proposed uses include welding-rod coatings, molded compounds, paints, insulating cements, filtration materials, and underbody coatings.[3]

The Vermont Asbestos Mines Division of the Ruberoid Co., 500 Fifth Ave., New York 18, N. Y., produced chrysotile on an enlarged scale during 1952 near Hyde Park, Vt. Exploratory work, including diamond drilling, was continued partly under DMEA loans.

[3] Rukeyser, Walter A., Mining & Milling Corp. of America to Begin Production in November 1952: Asbestos, vol. 34, No. 5, November 1952, pp. 26–29.

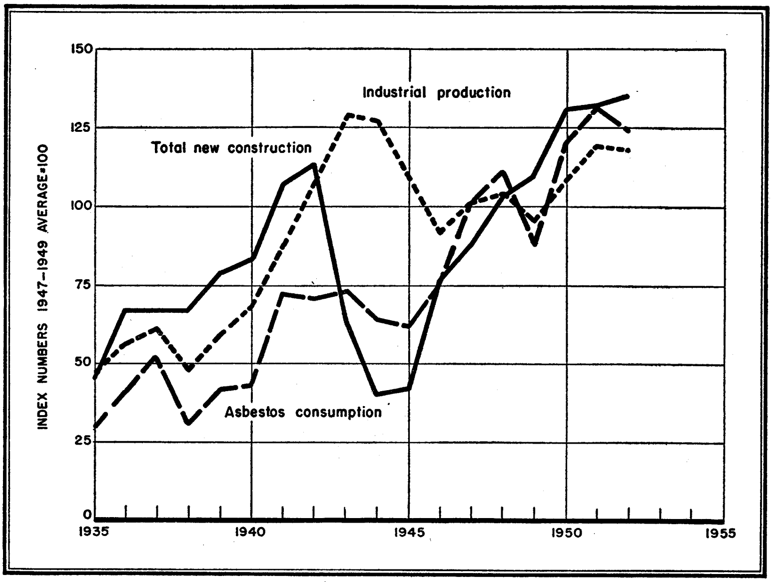

FIGURE 1.—Consumption of asbestos compared with total new construction and industrial production, 1935–52. Statistics on value of construction from Bureau of Foreign and Domestic Commerce and on industrial production from Federal Reserve Board.

CONSUMPTION AND USES

As indicated in table 2, consumption of raw asbestos in the United States was about 6 percent lower in 1952 than in 1951. However, the decline was in the shorter grades, whereas consumption of the longer fibers increased. This condition is reflected in the alltime high value of consumption in 1952 of more than 64 million dollars. As asbestos has a multitude of industrial uses, its consumption moves in consonance with the trend of industrial production. It is also used extensively as a constituent of asbestos-cement building materials and in various heat-insulating products; therefore its consumption is influenced by the volume of building construction. These trends are shown graphically in figure 1.

TABLE 2.—Apparent consumption of raw asbestos in the United States, 1943–47 (average) and 1948–52

Year	Short tons	Value	Year	Short tons	Value
1943–47 (average)	457, 619	$21, 265, 277	1950	727, 002	$46, 124, 871
1948	675, 746	37, 975, 742	1951	796, 992	58, 771, 276
1949	532, 708	32, 401, 654	1952	752, 559	63, 637, 962

PRICES

Prices of asbestos continued the periodic advances that have characterized recent years. The substantial increases in Canadian asbestos prices, as of January 15, 1951, continued in effect through January 1952; but, as quoted in short tons, f. o. b. mines, in the magazine Asbestos, they were advanced in February 1952, as follows: Group 1 (Crude No. 1) remained at $1,100–$1,500. Group 2 (Crude No. 2, Crude Run-of-Mine, and Sundry) was increased from a range of $485–$900 to $500–$1,000; group 3 (Spinning Fiber) from $275–$450 to $300–$525; group 4 (Shingle Fiber) from $135–$151 to $150–$200; group 5 (Paper Fiber) from $95–$119 to $100–$140; group 6 (Waste, Stucco, or Plaster) from $70 to $77; and group 7 (Refuse or Shorts) from $32–$63 to $35–$70.

Vermont prices, quoted in short tons f. o. b. Hyde Park or Morrisville, Vt., which were advanced in October 1951, continued at that level until February 1952, when they were increased as follows: Group 3 (Spinning and Filtering) from $279.50–$302 to $321–$348; group 4 (Shingle Fiber) from $135–$162 to $156–$173; group 5 (Paper Fiber) from $81.50–$115 to $110–$132; group 6 (Waste, Stucco, or Plaster) from $71.40 to $78; and group 7 (Refuse or Shorts) from

TABLE 3.—Asbestos (unmanufactured) imported for consumption in the United States, 1948–52, by countries and classes

[U. S. Department of Commerce]

Country	Crude (including blue fiber)		Mill fibers		Short fibers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948	38,088	$5,420,600	176,908	$18,028,161	432,885	$14,525,331	647,881	$37,974,092
1949	39,272	6,741,789	127,504	14,476,260	342,590	12,721,533	509,366	33,939,582
1950	27,803	5,857,687	177,951	21,381,704	499,704	20,044,814	705,458	47,284,205
1951								
Australia	311	76,225	-	-	-	-	311	76,225
Bolivia [1]	324	121,085	-	-	-	-	324	121,085
British East Africa	160	35,409	-	-	-	-	160	35,409
Canada	736	362,075	224,770	28,780,021	501,264	23,052,818	726,770	52,194,914
France [2]	-	-	11	1,632	-	-	11	1,632
Italy	1	3,074	22	20,554	-	-	23	23,628
Southern British Africa	712	162,891	-	-	-	-	712	162,891
Southern Rhodesia	7,700	2,237,654	25	6,344	-	-	7,725	2,243,998
Union of South Africa [3]	23,448	3,448,373	109	18,299	26	5,428	23,583	3,472,100
U. S. S. R.	1,897	171,354	330	16,500	10	175	2,237	188,029
Yugoslavia	-	-	17	1,135	-	-	17	1,135
Total	35,289	6,618,140	225,284	28,844,485	501,300	23,058,421	761,873	58,521,046
1952								
Australia	274	83,353	-	-	-	-	274	83,353
Bolivia	413	157,289	-	-	-	-	413	157,289
Canada	555	393,398	210,293	30,852,323	458,012	22,243,941	668,860	53,489,662
Italy	-	-	11	12,721	-	-	11	12,721
Portugal	16	1,323	-	-	32	3,584	48	4,907
Southern British Africa	607	164,368	-	-	-	-	607	164,368
Southern Rhodesia	10,121	3,385,933	422	178,763	-	-	10,543	3,564,696
Union of South Africa	26,640	3,861,619	152	33,611	100	12,699	26,892	3,907,929
U. S. S. R.	-	-	1,761	206,926	-	-	1,761	206,926
United Kingdom	-	-	-	-	5	1,815	5	1,815
Venezuela	-	-	5	2,234	-	-	5	2,234
Total	38,626	8,047,283	212,644	31,286,578	458,149	22,262,039	709,419	61,595,900

[1] Includes 28 tons ($12,545) of blue (crocidolite) crudes credited by U. S. Department of Commerce to Chile.
[2] Classified by U. S. Department of Commerce as amosite crude, re-classified by Bureau of Mines as mill fibers.
[3] Includes 100 tons ($9,400) amosite crude credited by U. S. Department of Commerce to French West Africa; 512 tons ($52,065) credited to Mozambique; 140 tons ($34,115) credited to Southern Rhodesia; also 6 tons ($2,002) blue (crocidolite) crudes credited to United Kingdom.

342070—55——12

$34–$63 to $37–$68.50. The above prices of both Canadian and Vermont fibers remained in effect for the balance of the year.

There are no market quotations for African asbestos. It is sold by negotiation with individual purchasers.

FOREIGN TRADE [4]

Imports.—The United States consumed about one-half of the asbestos produced in the world in 1952 but produced only 7 percent of its requirements. Accordingly, foreign supplies are essential to the domestic asbestos-products industries. In 1952 imports were 7 percent lower than in 1951. About 94 percent of total imports originated in Canada, 4 percent in the Union of South Africa, and 1 percent in Southern Rhodesia. On a value basis, however, African imports approached 12 percent of the total.

As there is a growing interest in the types and grades of asbestos imported from the principal sources, tables 4 and 5 have been introduced into this chapter showing importations by grades from Canada and Southern Rhodesia.

Exports.—Exports of unmanufactured asbestos were smaller in 1952 than in any year since 1948. Export controls which were in effect since late in 1951 evidently effected a decline in the volume of asbestos shipped out of the United States.

TABLE 4.—Asbestos (chrysotile) imported for consumption in the United States from Canada, by grades, 1951–52, in short tons

[U. S. Department of Commerce]

Grades	1951	1952
Crude No. 1	126	144
Crude No. 2	226	332
Other crudes	384	79
Spinning and Textile Fiber	22,463	24,072
Shingle Fiber	104,419	98,577
Paper Fiber	97,888	87,644
Short Fiber	501,264	458,012
Total	726,770	668,860

TABLE 5.—Asbestos (chrysotile) imported for consumption in the United States from Southern Rhodesia, by grades, 1951–52, in short tons

[U. S. Department of Commerce]

Grades	1951	1952
Crude No. 1	678	462
Crude No. 2	1,239	1,363
Other crudes	5,783	8,296
Spinning and Textile Fiber	25	177
Shingle Fiber	----------	245
Total	7,725	10,543

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 6.—Asbestos and asbestos products exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Unmanufactured asbestos				Asbestos products	
	Domestic [1]		Foreign [2]		Domestic [1]	Foreign [2]
	Short tons	Value	Short tons	Value	Value	Value
1948	6,530	$1,173,259	2,697	$631,352	$9,321,351	$5,354
1949	17,621	3,618,703	2,424	533,641	9,666,560	1,287
1950	18,980	3,646,828	1,910	437,556	8,097,192	49,949
1951	14,298	3,216,810	2,228	445,460	14,320,389	889
1952	10,265	2,550,065	459	120,905	13,027,739	1,118

[1] Material of domestic origin, or foreign material that has been milled, blended or otherwise processed in the United States.
[2] Material that has been imported and subsequently exported without change.

TABLE 7.—Asbestos and asbestos products exported from the United States 1951–52, by kinds

[U. S. Department of Commerce]

Product	1951		1952	
	Quantity	Value	Quantity	Value
Unmanufactured asbestos:				
Crude and spinning fibers ... short tons	1,306	$479,228	1,419	$551,686
Nonspinning fibers ... do	11,449	2,567,289	7,610	1,845,154
Waste and refuse ... do	1,543	170,293	1,236	153,225
Total unmanufactured ... do	14,298	3,216,810	10,265	2,550,065
Asbestos products:				
Brake blocks ... do	363	680,989	195	454,537
Brake lining:				
Molded and semimolded ... do	3,472	6,017,473	2,365	4,657,696
Not molded ... linear feet	1,034,930	661,474	530,906	424,838
Clutch facing ... number	1,452,270	935,913	1,550,644	996,080
Construction materials ... short tons	14,757	2,526,784	16,692	2,822,802
Pipe covering and cement ... do	2,026	453,367	2,324	655,254
Textiles, yarn, and packing ... do	1,176	2,391,982	1,254	2,428,123
Manufactures, n. e. s.	(1)	652,407	(1)	588,409
Total	------	14,320,389	------	13,027,739

[1] Quantity not recorded.

NEW DEVELOPMENTS

Research was continued on methods of removing iron from the ferrous types of chrysotile to make them suitable for electric insulation uses. Experiments conducted by the Naval Research Laboratory included treatment of bulk samples of Canadian chrysotile with a commercial-size Vortrap at the National Bureau of Standards, but the results were unsatisfactory. Only one-third of the iron content had been removed after three passages through the machine. Considerable research remains to be done on fiberization before the effectiveness of the Vortrap as a means of removing iron from asbestos can be determined.

Much progress has been made in the manufacture of glass and related fibers, some of which may be used as substitutes for asbestos in certain applications. The manufacture of an aluminum silicate fiber known as "Fiberfrax" has been announced by the Carborundum Co It is blown by steam or compressed air after fusion with an electric arc. The fibers will withstand temperatures as high as 2,300° F.[5]

Keasbey & Mattison Co., which has operated an asbestos-products plant at Ambler, Pa., for many years, has expanded its facilities by establishing an asbestos-cement-pipe plant at Santa Clara, Calif., and an asbestos-textile plant at Meredith, N. H.

DMEA loan applications were approved for exploratory work on asbestos deposits in Gila County, Ariz.; Siskiyou, Nevada, Trinity, and Inyo Counties, Calif.; Madison County, Mont.; Grant County, Oreg.; Marinette County, Wis.; and Natrona County, Wyo. No noteworthy discoveries were recorded in 1952.

Several publications on various phases of the asbestos industry appeared during the year. Becker & Haag issued a second edition of Asbest.[6] The first section of the book describes the physical and chemical properties of asbestos. Research in this field was assisted greatly by the electron microscope and electronic apparatus. Following sections deal with the asbestos deposits of the world, the processing of asbestos, and the manufacture of asbestos products.

The Bureau of Mines, in cooperation with the National Security Resources Board, prepared a report[7] covering primarily problems relating to acquisition of adequate supplies of the essential grades of asbestos. It describes the varieties and composition of asbestos, the principal world deposits, mining and milling methods, grading and classification, world production and reserves, international trade, uses, substitutes, and various other aspects of the industry.

The Department of Geography of the University of Maryland has prepared, in cooperation with the Bureau of Mines, a comprehensive atlas of the mineral resources of the world; one chapter is devoted to asbestos.[8]

Asbestos floats have been discussed in some detail by Badollet.[9] Floats are airborne particles collected at various places in asbestos-processing mills. Their properties, classification, and uses are described. They are useful constituents of automobile-body coatings, adhesives, caulking compounds, joint fillers, paints, plastics, and many other products.

The United States Tariff Commission has published a short report on asbestos.[10]

Processes and equipment used in asbestos milling, particularly those employed in Africa, are described in detail in a recent series of articles.[11]

To conserve supplies of the spinning grades of chrysotile asbestos adequate for the manufacture of products essential to the defense program, the National Production Authority issued Order M-96, effective February 1, 1952. On and after that date, the use of some grades of spinning fiber was prohibited for any other than certain

[5] Chemical Engineering, Ceramic Fiber Resists 2,300° F.: Vol. 59, No. 9, September 1952, p. 198.
[6] Frank, Karl, Asbest (in German): Becker & Haag, Hamburg, Germany, 1952, 234 pp.
[7] Bowles, Oliver, Materials Survey—Asbestos: Bureau of Mines, prepared for National Security Resources Board, 1952, 146 pp.
[8] Van Royen, William, and Bowles, Oliver, Asbestos: chapter in Atlas of the World's Resources, The Mineral Resources of the World, Prentice-Hall, New York, 1952, pp. 166-169.
[9] Badollet, M. S., Asbestos Floats: Canadian Min. and Met. Bull., vol. 55, May 1952, pp. 185-189.
[10] U. S. Tariff Commission, Asbestos: Industrial Mineral Series Rept. M-3, 1951, 46 pp.
[11] Sinclair, W. E., Milling Asbestos Ore: Asbestos, vol. 33, No. 9, March, 1952, pp. 8-18; No. 10, April, 1952, pp. 4-12; No. 11, May, 1952, pp. 4-10; No. 12, June 1952, pp. 2-10.

specified end uses. Limitations were placed on the use of the material for production of certain other end-use products.

A new although small use for blue asbestos is its employment in cigarette filters.

WORLD REVIEW

Official statistics of world production for 1952 are far from complete, but estimates for unreported countries are included in the total shown in table 8. Revisions for previous years have been made in the light of new information that has become available. World output was virtually the same in 1952 as in 1951.

TABLE 8.—World production of asbestos by countries,[1] 1948–52, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
North America:					
Canada (sales)[3]	650,239	521,543	794,095	882,866	843,078
United States (sold or used by producers)	33,649	39,360	38,495	46,851	48,864
South America:					
Bolivia (exports)	147	182	166	316	465
Brazil	1,499	1,415	844	1,321	(4)
Chile	150	291	172	(4)	(4)
Venezuela	192	192	190	260	394
Europe:					
Finland [5]	10,818	10,486	10,949	11,850	5,801
France	1,309	1,090	6,080	6,940	6,300
Greece	9	9	30	34	25
Italy	13,044	15,877	21,433	22,612	23,938
Portugal	414	101	257	312	(4)
Spain	35	40	41	41	(4)
Yugoslavia	752	1,138	958	1,523	2,506
Asia:					
Cyprus	8,106	12,556	14,989	17,180	[6] 18,479
India	83	148	211	440	(4)
Japan	4,809	5,456	5,664	6,139	3,564
Taiwan (Formosa)	652	410	216	35	24
Turkey	203	250	245	80	---------
Africa:					
Egypt	1,625	117	260	1,247	(4)
French Morocco	399	402	511	604	576
Kenya	510	716	229	379	354
Madagascar	(7)	2	1	17	3
Southern Rhodesia	62,502	72,246	64,888	70,454	76,960
Swaziland	29,421	30,814	29,635	31,719	31,542
Union of South Africa	41,490	64,334	79,300	97,402	121,416
Oceania:					
Australia	1,348	1,671	1,643	2,599	4,124
New Zealand	---------	---------	42	826	(4)
Total (estimate)	1,025,000	975,000	1,300,000	1,425,000	1,425,000

[1] In addition to countries listed, asbestos is produced in Argentina, China, Czechoslovakia, Korea, and U. S. S. R. Estimates by authors of the chapter are included in the total.
[2] This table incorporates a number of revisions of data published in previous asbestos chapters.
[3] Exclusive of sand, gravel, and stone (waste rock only), production of which is reported as follows: 1948, 40,066 tons; 1949, 32,015 tons; 1950, 43,551 tons; 1951, 30,628 tons; 1952, 35,982 tons.
[4] Data not available; estimate by authors of chapter included in total.
[5] Includes asbestos flour.
[6] Exports.
[7] Less than 0.5 ton.

CANADA

Shipments of Canadian asbestos declined 5 percent from the 1951 level, but the value of sales increased 9 percent. As indicated in table 9, the recession in sales was confined primarily to the shorter, low-priced grades. Asbestos-producing companies in Canada in 1952 were, in order of size of output: Canadian Johns-Manville Corp., Ltd.; Asbestos Corp., Ltd.; Johnson's Co.; Quebec Asbestos Corp.; Bell

Asbestos Mines; Nicolet Asbestos Mines, Ltd.; and Flintkote Mines, Ltd.

The American Smelting & Refining Co. conducted, under option, large-scale milling tests of asbestos-bearing rock from the property of United Asbestos Corp. Ltd., under Black Lake, Quebec. Preliminary mining and milling are being conducted by Lake Asbestos of Quebec, Ltd., a subsidiary of American Smelting & Refining Co. The results of the tests have not yet been announced. The Quebec Legislature has amended the Quebec Mining Act to permit drainage of the lake.

An extensive modernization program of Canadian Johns-Manville Corp., Ltd., at the Jeffrey mine and mill, Asbestos, Quebec, is well advanced. Over 16,000 tons a day of fiber-bearing rock is now being milled.

The new mill of Dominion Asbestos Co., with a capacity of 2,200 tons of rock a day, was nearing completion at the end of 1952. The property is near St. Adrien about 15 miles from Asbestos, Quebec.

A new mill, the Normandie, of the Asbestos Corp., Ltd., with a capacity of 5,000 tons of rock a day was under construction in 1952.

Lafayette Asbestos Co., Ltd., has purchased the mineral rights, machinery, and equipment of the St. Lawrence Asbestos Co., Ltd. The property is situated in Cranbourne Township, Dorchester County, Quebec. Plans are being made for constructing a mill with a capacity of 2,000 tons of rock a day.

The complex block-caving system of mining in the Quebec area has been described in some detail by Lindell.[12] He also described the haulage systems employed at Canadian mines.[13]

The McDame Creek asbestos deposit in northern British Columbia is being developed by Cassiar Asbestos Corp., a subsidiary of Conwest Exploration Co. A mill having a capacity of 250 tons of rock a day was completed in 1952. It was designed primarily to process fiber from surface exposures. It was expected that the mill would be in operation by midsummer 1953. A larger mill to handle rock from underground workings is contemplated. Samples of the asbestos tested in the

TABLE 9.—Sales of asbestos in Canada, 1951–52, by grade
[Dominion Bureau of Statistics]

	1951			1952		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Grade:						
Crudes	748	C $568, 725	C $760. 33	741	C $726, 827	C $980. 87
Fibers	333, 001	49, 399, 632	148. 35	351, 644	58, 822, 472	167. 28
Shorts	639, 449	31, 615, 988	49. 44	576, 954	29, 705, 614	51. 49
Total	973, 198	81, 584, 345	83. 83	929, 339	89, 254, 913	96. 04
Rock mined	12, 623, 529			12, 992, 252		
Rock milled	10, 219, 658			10, 918, 989		

[12] Lindell, Karl V., World's Largest Asbestos Producer Uses Block Caving and Concreted Slusher Drifts: Min. Eng., vol. 4, No. 3, March 1952, pp. 265–272.

[13] Lindell, Karl V., Rail and Truck Haulage at Canadian Asbestos Open Pit: Min. Eng., vol. 4, No. 4, April 1952, pp. 364–368.

United States were found to be of good quality for textile use. It is reported that the iron content of the processed fiber will be low enough to pass specifications for nonferrous fiber. Exploratory work indicates the presence of a large body of asbestos-bearing rock having a relatively high fiber content. The deposit is the most promising occurrence of spinning fiber noted during recent years.

SOUTHERN AFRICA

Southern Rhodesia.—As indicated in table 10, the output of asbestos in Southern Rhodesia in 1952 increased 9 percent in quantity and 22 percent in value. Principal production was from the Shabani mines and in the Mashaba and Filabusi districts, controlled by Turner & Newall, Ltd., of Manchester, England. Rhodesia Monteleo Asbestos, Ltd., has completed its new mill at its property in the Vukwe Hills, 15 miles southeast of Shabani. Fiber shipments on a substantial scale are expected in 1953.

The Johns-Manville Corp., in association with several other companies, is developing two asbestos deposits at Mashaba in the Victoria district. One mill will handle the product of both deposits.

TABLE 10.—Asbestos produced in Southern Rhodesia, 1948–52

Year	Short tons	Value	Year	Short tons	Value
1948	68, 897	£2,604, 623	1951	77, 663	£5, 452, 108
1949	79, 638	3,986, 703	1952	84, 834	6, 651, 975
1950	71, 527	4,615, 490			

Union of South Africa.—Production in the Union continued the remarkable expansion that has characterized recent years. Total production was 25 percent higher than in 1951. Gains were registered in every category. Amosite production increased 17 percent, chrysotile 28 percent, Transvaal blue 30 percent, and Cape blue 35 percent. For the first time in the history of the industry, exports passed the 100,000-ton mark. The new Riley Bridge over the Orange River at Koegas, completed in 1952, has greatly facilitated transportation and tends to stimulate increasing production of blue asbestos.

TABLE 11.—Asbestos produced in and exported from the Union of South Africa, 1948–52

Year	Production (short tons)			Exports	
	Transvaal	Cape Province	Total	Short tons	Value
1948	37, 434	8, 301	45, 735	38, 550	£1, 138, 792
1949	58, 918	11, 999	70, 917	63, 428	2, 600, 323
1950	72, 203	15, 211	87, 414	70, 609	3, 475, 200
1951	89, 290	18, 078	107, 368	89, 735	5, 056, 143
1952	109, 398	24, 441	133, 839	106, 576	6, 899, 086

TABLE 12.—Asbestos produced in the Union of South Africa, 1948–52, by varieties and sources, in short tons

Variety and source	1948	1949	1950	1951	1952
Amosite (Transvaal)	30,372	41,974	42,393	54,053	63,280
Chrysotile (Transvaal)	4,441	7,609	14,334	19,509	24,970
Blue (Transvaal)	2,608	9,181	15,387	15,581	20,294
Blue (Cape)	8,301	11,999	15,211	18,078	24,441
Anthophyllite (Transvaal)	13	154	89	147	854
Total	45,735	70,917	87,414	107,368	133,839

OTHER COUNTRIES

Australia.—The blue asbestos deposits of western Australia are discussed in a recent publication.[14]

Colombia.—The Johns-Manville Corp. is developing a chrysotile asbestos deposit at Antioquia in cooperation with Sociedad Colombiana de Asbestos, Ltda., and the Institute de Fomento Industrial, a Colombian Government organization devoted to promoting the industrial development of the country.

Kenya.—A deposit of anthophyllite was discovered in 1949 in the Teita Hills about 120 miles from the Port of Mombasa. A mill has been built, and some progress has been made in developing uses in such products as chemical filters, compound packings, and thermal and acoustical insulation.[15]

Spain.—An output of 30 tons a month of asbestos from a deposit at Ronda in southern Spain was reported in the press in 1952.

Yugoslavia.—Several widely scattered chrysotile asbestos deposits occur in Yugoslavia. At least four of the properties have been developed, and mills are in operation or are under construction. Most of the fiber is of the shorter grades, but one deposit furnishes hand-cobbed Crudes Nos. 1 and 2. The properties have been described in some detail by Millar.[16]

---

[14] The Mining Journal (London), The Asbestos Deposits of Western Australia: Vol. 238, No. 6095, June 15, 1952, p. 623.

[15] Asbestos, The Makinyambu Asbestos Deposits, Kenya, British East Africa: Vol. 34, No. 1, July 1952, pp. 2–8.

[16] Millar, W. B., Asbestos in Yugoslavia: Asbestos, vol. 34, No. 2, August, pp. 2–10; No. 3, September, pp. 2–10; No. 4, October, pp. 2–6, 1952.

Barite

By Joseph C. Arundale [1] and Flora B. Mentch [2]

THE UNITED STATES has been the world's leading producer of barite since the beginning of World War II. This lead was lengthened in 1952, when a record tonnage was produced. Imports also increased.

New grinding facilities were being built to supply the growing need for barite in oil-well drilling mud.

TABLE 1.—Salient statistics of the barite and barium-chemical industries in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Barite:						
Primary:						
Produced.............short tons..	649,241	777,841	731,308	693,424	845,579	1,012,811
Sold or used by producers:						
Short tons....................	638,693	799,848	717,313	695,414	860,669	941,825
Value....................	$4,623,603	$6,693,413	$5,642,226	$6,193,906	$7,968,023	$8,797,944
Imports for consumption:						
Short tons....................	44,533	53,204	26,178	58,381	52,755	107,918
Value....................	$298,427	$443,515	$192,567	$431,879	$419,494	$923,336
Consumption........short tons..	665,620	894,309	719,543	[1] 786,131	[1] 950,893	[1] 1,033,843
Ground and crushed sold by producers:						
Short tons....................	405,431	631,424	554,028	573,359	703,014	839,428
Value....................	$6,581,421	$11,195,365	$10,156,590	$11,305,209	$14,590,000	$16,608,546
Barium chemicals sold by producers:						
Short tons....................	74,758	71,717	57,012	73,689	86,032	83,156
Value....................	$7,323,683	$7,028,058	$5,646,403	$7,885,586	$11,656,497	$12,101,474
Lithopone sold or used by producers:						
Short tons....................	145,363	140,033	78,335	105,650	102,837	61,832
Value....................	$12,364,540	$16,135,976	$8,977,178	$13,129,363	$14,470,742	$8,475,200

[1] Includes some witherite.

DOMESTIC PRODUCTION

Domestic production of barite in 1952 surpassed that in any previous year and for the first time exceeded 1 million tons. Arkansas remained the leading producer, but output increased from most of the other producing States.

August 1, 1952, the Defense Production Administration established an expansion goal for barite at an annual capacity of 1,360,000 net tons by 1955. This includes a requirement of about 1 million tons of drilling-grade barite, the remainder being largely chemical grade. The 1955 goal, therefore, represents an increase of about 420,000 tons over 1951 production, of which 405,000 tons is drilling-grade barite.

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.

In anticipation of increasing demand, two firms applied for certificates of necessity from the Defense Materials Procurement Agency to construct additional grinding facilities. The Magnet Cove Barium Corp. was building a grinding plant at New Orleans, La., and the Baroid Sales Division of National Lead Co. was building a plant at Corpus Christi, Tex. This latter company also was reported to be planning expansion of its Malvern, Ark., plant. The Superbar Co. was reported to be doubling the capacity of its fine-grinding facilities near Potosi, Mo., for processing local barite.

TABLE 2.—Domestic barite sold or used by producers in the United States, 1950–52, by States

State	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Arkansas [1]	343,168	$3,088,512	407,085	$3,765,536	428,522	$3,963,828
Georgia, South Carolina, Tennessee	72,888	766,711	73,117	841,440	97,540	1,162,249
Missouri	212,736	1,924,520	281,895	2,697,200	304,080	2,919,795
Nevada	47,608	268,874	63,201	387,026	68,062	391,242
Other States [2]	19,014	145,289	35,371	276,821	43,621	360,830
Total	695,414	6,193,906	860,669	7,968,023	941,825	8,797,944

[1] Value estimated.
[2] Arizona, California, Idaho, Montana (except 1950), and New Mexico.

TABLE 3.—Ground (and crushed) barite produced and sold by producers in the United States, 1943–47 (average) and 1948–52

Year	Plants	Production (short tons)	Sales	
			Short tons	Value
1943–47 (average)	21	408,429	405,431	$6,581,421
1948	23	630,808	631,424	11,195,365
1949	24	561,258	554,028	10,156,590
1950	26	569,129	573,359	11,305,209
1951	24	704,709	703,014	14,590,000
1952	24	839,457	839,428	16,608,546

The Arizona Barite Co. began to strip overburden from a deposit of barite about 20 miles south of Aguila, which was being developed as an open-pit operation. This firm also operates an underground barite mine east of Mesa, Ariz.[3]

The Nevada Barium Co. was reported to have begun constructing a crushing and screening plant at Beowawe that will custom-mill barite from that area. Meanwhile, the company was producing mine-run barite.[4]

Westvaco Chemical Division, Food Machinery & Chemical Co., was reported to have acquired 8 claims about 45 miles south of Battle Mountain, Nev. Drilling operations were said to be underway to determine the extent and grade of the barite deposit.[5]

[3] Mining World, vol. 14, No. 6, May 1952, p. 81.
[4] Mining World, vol. 14, No. 7, June 1952, p. 90.
[5] Mining World, vol. 14, No. 2, February 1952, p. 90.

The history of the rare-earth and barite deposit at Mountain Pass, Calif., and the operations of Molybdenum Corp. in this area were reviewed.[6]

Several thousand pounds of barium metal is produced annually in the United States by Kemet Laboratories Co., Inc. (unit of Union Carbide and Carbon Corp.), Cleveland, Ohio, and King Laboratories, Inc., Syracuse, N. Y.

CONSUMPTION AND USES

The petroleum industry completed 45,840 new wells in the United States in 1952 to set a new record.[7] The average depth of these wells also continued to increase. Another new record has been forecast for 1953 on the basis of wells scheduled.[8] This activity was responsible for a record consumption of barite as the weighting agent in drilling muds. More than three-quarters of a million tons of ground barite were consumed for this purpose.

The use of barite for most other purposes was less than in the previous year. Shipments of lithopone decreased sharply to a figure 40 percent below 1951 and the lowest since 1921. This was attributed in part to a decreased volume of business in industries that are important consumers and in part to increased use of substitutes. Most of the decrease was in the use of lithopone in paints, varnishes, and lacquers. This, in turn, was reflected in a somewhat decreased production of black ash, one of the steps in the manufacture of lithopone. Most other barium chemicals also were produced in substantially smaller quantities. However, barium oxide and barium hydroxide, as in 1951, were produced at rates substantially above those for 1950 and previous years. This was attributed largely to increased requirements for the compounds by the lubricating-oil industry.

TABLE 4.—Crude barite (domestic and imported) used in the manufacture of ground barite and barium chemicals in the United States, 1943–47 (average) and 1948–52, in short tons

Year	In manufacture of—			Total	Year	In manufacture of—			Total
	Ground barite [1]	Lithopone	Barium chemicals			Ground barite [1]	Lithopone	Barium chemicals	
1943–47 (average)	418,868	144,973	101,779	665,620	1950	578,078	99,703	[2] 108,350	786,131
1948	640,284	153,987	100,038	894,309	1951	711,531	107,094	[2] 132,268	950,893
1949	567,249	71,710	80,584	719,543	1952	849,246	61,000	[2] 123,597	1,033,843

[1] Includes some crushed barite.
[2] Includes some witherite.

[6] California State Division of Mines, Mineral Information Service: Vol. 5, No. 7, July 1952, p. 9. Engineering and Mining Journal, A Visit to the Mountain Pass Rare-Earth Enterprise: Vol. 153, No. 10, October 1952, p. 87.

[7] McCaslin, John C., Operators Completed 45,840 Wells in 1952: Oil and Gas Jour., vol. 51, No. 38, Jan. 26, 1953, pp. 192–195.

[8] Casper, John C., 46,230 Wells Scheduled for This Year: Oil and Gas Jour., vol. 51, No. 38, Jan. 26, 1953, pp. 190–191.

TABLE 5.—Ground (and crushed) barite sold by producers, 1950–52, by consuming industries

Industry	1950		1951		1952	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Well drilling	483,519	84	594,668	85	758,240	90
Glass	24,638	4	25,779	4	24,604	3
Paint	28,000	5	28,000	4	25,000	3
Rubber	19,000	3	15,000	2	18,000	2
Concrete aggregates	15,784	3	38,143	5	12,000	2
Undistributed	2,418	1	1,424	(1)	1,584	(1)
Total	573,359	100	703,014	100	839,428	100

[1] Less than 0.5 percent.

TABLE 6.—Lithopone sold or used by producers in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Plants	8	8	8	7	6	5
Short tons	145,363	140,033	78,335	105,650	102,837	61,832
Value	$12,364,540	$16,135,976	$8,977,178	$13,129,363	$14,470,742	$8,475,200

TABLE 7.—Distribution of lithopone shipments, by consuming industries, 1950–52, in short tons

Industry	1950		1951		1952	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Paints, varnishes, and lacquers	78,177	74	76,614	75	45,267	73
Floor coverings	5,297	5	4,620	4	3,009	5
Coated fabrics and textiles	7,945	8	4,814	5	5,698	9
Paper	2,290	2	6,462	6	3,089	5
Rubber	4,092	4	3,295	3	1,523	3
Other	7,849	7	7,032	7	3,246	5
Total	105,650	100	102,837	100	61,832	100

The principal use for barium metal is as a "getter." In this application, the pure metal or an alloy with other alkaline-earth metals or magnesium or aluminum is introduced into an electronic tube to absorb residual gases and thus improve the vacuum on which the efficiency of the tube depends.

TABLE 8.—Barium chemicals produced and used or sold by producers in the United States, 1948–52, in short tons

Chemical	Plants	Produced	Used by producers [1] in other barium chemicals [2]	Sold by producers [3]	
				Short tons	Value
Black ash: [4]					
1948	16	152,383	151,509	459	$31,442
1949	15	97,693	97,753	246	16,464
1950	12	130,967	130,305	499	33,084
1951	12	152,792	150,434	455	28,361
1952	12	121,061	120,562	649	42,475
Carbonate (synthetic):					
1948	5	43,227	16,588	27,482	1,927,599
1949	4	36,122	10,077	27,010	1,942,845
1950	4	49,299	13,063	36,266	2,746,628
1951	4	60,181	18,541	40,568	3,322,276
1952	4	57,935	21,591	37,214	3,175,080
Chloride (100 percent $BaCl_2$):					
1948	4	13,008	3,534	8,998	964,311
1949	3	10,513	2,872	7,679	848,637
1950	3	12,285	3,324	8,874	992,722
1951	4	17,959	4,911	12,364	1,830,070
1952	4	14,157	3,979	10,409	1,407,986
Hydroxide:					
1948	4	5,030	92	4,849	809,589
1949	4	3,849	140	3,737	694,097
1950	4	7,927	82	7,888	1,540,046
1951	5	13,483	231	12,757	3,185,405
1952	5	11,759	585	10,848	2,211,998
Oxide:					
1948	3	7,247	6,449	577	127,716
1949	3	5,795	4,899	1,118	233,733
1950	3	8,129	6,021	2,162	451,277
1951	3	9,347	6,334	3,073	729,379
1952	3	9,843	6,081	3,818	907,762
Sulfate (synthetic):					
1948	7	22,733	(5)	17,134	1,601,497
1949	7	15,182	----------	15,371	1,436,557
1950	6	15,821	----------	15,676	1,505,628
1951	6	14,237	----------	13,426	1,448,628
1952	7	13,035	----------	13,274	1,492,324
Other barium chemicals: [6]					
1948	(7)	13,469	[8] 8,994	12,218	1,565,904
1949	(7)	5,320	2,890	1,851	474,070
1950	(7)	5,049	2,878	2,324	616,201
1951	(7)	6,999	2,545	3,389	1,112,378
1952	(7)	8,893	1,669	6,944	2,863,849
Total: [9]					
1948	20	----------	----------	71,717	7,028,058
1949	20	----------	----------	57,012	5,646,403
1950	17	----------	----------	73,689	7,885,586
1951	18	----------	----------	86,032	11,656,497
1952	19	----------	----------	83,156	12,101,474

[1] Of any barium chemical.
[2] Includes purchased material.
[3] Exclusive of purchased material and exclusive of sales by one producer to another.
[4] Black-ash data include lithopone plants.
[5] Included with "Other barium chemicals."
[6] Includes barium acetate, chromate, nitrate, perchlorate, peroxide, and sulfide. Specific chemicals may not be revealed by specific years. In 1948 consists mostly of titanium dioxide-barium sulfate pigments.
[7] Plants included in above figures.
[8] Also includes barium sulfate (synthetic).
[9] A plant producing more than 1 product is counted but once in arriving at grand totals.

PRICES

According to E&MJ Metal and Mineral Markets, the following prices for barite prevailed throughout 1952: Barytes—f. o. b. mines: Georgia: Barytes ore, crude, jig and lump, \$13–\$13.50 per long ton; beneficiated, \$16–\$18 per net ton, in paper bags; Missouri: Per ton, water-ground and floated, bleached, \$37.60, carlots, f. o. b. works; crude ore, minimum 94 percent $BaSO_4$, \$10.15 f. o. b. mines.

Prices on barium metal are not quoted in the trade journals but may be obtained directly from the producers. The price varies with the quantity and purity desired.

TABLE 9.—Range of quotations on barium chemicals in 1952

[Oil, Paint and Drug Reporter]

Barium carbonate, precipitated, bags, 10 tons and up, works....short ton..	[1] $82.50 –$87.50
Barium chlorate, kegs, works....pound..	.30 – .38
Barium chloride, technical, bags, carlots, works, freight equaled....short ton..	[2] 152.00
Barium chromate, bags, freight equaled....pound..	.30 – .32
Barium dioxide (peroxide), drums, carlots, works....do....	.15 – .16
Barium hydrate, crystals, bags....short ton..	[2] 190.00 –200.00
Barium nitrate, barrels, carlots, works....pound..	.12½
Barium oxide, ground, drums, carlots, works....short ton..	[2] 250.00
Blanc fixe (dry):	
Direct process, bags, carlots, works....do....	90.00
Byproduct, bags, carlots, works....do....	100.00
Lithopone:	
Ordinary, bags, carlots, delivered....pound..	.07½– .079
Less carlots, same basis....do....	.08¼– .0890
Titanated (high-strength), bags, carlots, delivered....do....	.10
Smaller lots....do....	.11

[1] As quoted in January and February. Method of reporting was changed in March to carlots. $85.50 was reported for rest of year.
[2] As quoted March through December.

FOREIGN TRADE [9]

Imports of crude barite into the United States reached an alltime high of 107,918 short tons in 1952. New grinding facilities on the gulf coast created additional requirements for foreign barite. Shipments from Canada (Nova Scotia) and Mexico reached new highs. Shipments from Yugoslavia resumed after being suspended in 1951. For the first time a significant tonnage of crude was received from Brazil and ground barite from Canada.

TABLE 10.—Barite imported for consumption in the United States, 1948–52, by countries

[U. S. Department of Commerce]

	1948		1949		1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Crude barite:										
Algeria					(1)	$2				
Brazil									3,180	$14,425
Canada	39,877	$359,161	8,813	$60,429	44,501	328,689	51,447	$409,506	67,854	571,196
Italy	5,601	51,257	5,712	65,024						
Mexico	7,726	33,097	3,589	9,516	3,296	4,213	1,308	9,988	12,188	97,347
Yugoslavia			8,064	57,598	10,584	98,975			24,696	240,368
Total crude barite	53,204	443,515	26,178	192,567	58,381	431,879	52,755	419,494	107,918	923,336
Ground barite:										
Algeria							84	2,870	179	5,900
Canada									6,440	112,265
Greece	(1)	11	211	2,241	478	5,363	31	337		
India							28	925		
Italy					200	4,535	17	435	1	25
Total ground barite	(1)	11	211	2,241	678	9,898	160	4,567	6,620	118,190

[1] Less than 1 ton.

[9] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

As domestic requirements and production of most barium chemicals declined, there was a corresponding decrease in imports.

TABLE 11.—Barium chemicals imported for consumption in the United States, 1948–52

[U. S. Department of Commerce]

Year	Lithopone		Blanc fixe (precipitated barium sulfate)		Barium chloride		Barium hydroxide	
	Pounds	Value	Short tons	Value	Pounds	Value	Short tons	Value
1948								
1949	24,003	$2,053	1	$54	8	$8		
1950	2,402,572	179,197	53	6,174				
1951	1,587,900	151,165	12	1,616	1,712,756	99,453	279	$55,344
1952	20,950	2,308	32	6,481	167,964	11,065	193	46,979

Year	Barium nitrate		Barium carbonate precipitated		Other barium compounds	
	Short tons	Value	Short tons	Value	Short tons	Value
1948	141	$17,492			11	$3,771
1949	84	7,819			11	5,651
1950	149	21,083	286	$28,222	35	11,669
1951	368	62,277	794	72,977	32	12,503
1952	456	80,654	499	30,427	82	35,944

TABLE 12.—Lithopone exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1948	21,015	$2,972,912	$141.47	1951	20,473	$3,615,915	$176.62
1949	14,460	1,918,913	132.70	1952	9,985	1,632,106	163.46
1950	9,357	1,248,538	133.43				

Imports of witherite from United Kingdom, the only known commercial source, reached a record tonnage. The brick industry, which uses witherite for de-scumming, and the steel industry, which uses it for carburizing, were operating at record levels. No witherite is produced in the United States, except as it may be mined mixed with barite.

TABLE 13.—Witherite, crude, unground, imported for consumption in the United States, 1948–52

[U. S. Department of Commerce]

Year	Short tons	Value [1]	Year	Short tons	Value [1]
1948	2,470	$94,809	1951	2,016	$51,673
1949	2,113	63,369	1952	5,174	184,003
1950	2,089	51,381			

[1] Valued at port of shipment.

TECHNOLOGY

The development of a new material for permanent magnets was reported; it was said to be an oxide containing iron and barium and was developed by the Philips Research Laboratories at Eindhoven in the Netherlands. The new magnet is claimed to be suitable for use in dynamos, motors, and some special kinds of transformers.[10]

Baroid Sales Division of National Lead Co. completed moving its main offices from Los Angeles, Calif., to Houston, Tex., consolidated its research facilities in this location, and enlarged both its research and service laboratories. The research facilities emphasize work on drilling fluids.[11]

Engineers at the Nova Scotia Technical College, Halifax, are reported to have tested concrete made with a barite aggregate in a search for a low-cost material with high resistance to gamma-ray penetration. The aggregate used contained 80 percent barite and 10 percent iron oxide. Concrete was made with a weight of 190 to 200 pounds per cubic foot. It was found that a wall 12 inches thick allowed a penetration of 1 percent of the rays and a wall 1.5 inches thick allowed 50-percent transmission. Ordinary concrete with a weight of 145 to 150 pounds let 50 percent of the gamma rays through a 2-inch wall.[12]

The Bureau of Mines conducted a series of investigations to develop an economic and feasible treatment for two types of barite ore. One of these ores from Montgomery County, Ark., consisted of an intimate mixture of barite and quartz. Fine grinding and fatty acid flotation were utilized to effect a good recovery of a drilling-grade product. The other test was made on a sphalerite-barite ore from Morgan County, Mo. In the test the sphalerite responded to activation with copper sulphate and floated with xanthate or Aerofloat promoters. Separation of barite from the dolomite gangue proved more difficult. The problem was solved by using petroleum sulfonate promoters for the barite. By this treatment a chemical-grade barite was produced in the laboratory.[13]

A patent was issued on a pulverulent asphaltic composition composed of powdered asphalt and finely divided barium sulfate. This material was said to be stable in storage.[14]

Barium acetate is a widely used electrolyte in the process for depositing phosphor powder on the inside faces of television and other type tubes. An accurate control of the barium acetate solution strength is necessary and rapid analysis is desirable. A new rapid, accurate volumetric method for determining the strength of such barium acetate solutions was described.[15]

---

[10] Mining Journal (London), vol. 238, No. 6077, Feb. 8, 1952, p. 142.

[11] Chemical and Engineering News, Old Mud Compounds Being Taught New Tricks in Baroid Lab.: Vol. 30, No. 23, June 9, 1952, pp. 2400–2401.

[12] Shellstad, K. A., Vaughan, V. E., and Cameron, E. L., Barite Aggergate Concrete for Gamma-Ray Shielding: Canadian Jour. Technol., December 1952, p. 334; abs. Engr. News Record, vol. 150, No. 14, Apr. 2, 1953, p. 64.

[13] Frommer, D. W., and Fine, M. M., Experimental Treatment of Barite Ores From Montgomery County, Ark., and Morgan County, Mo.: Bureau of Mines Rept. of Investigations 4881, 1952, 11 pp.

[14] Puller, H. B. (assigned to Berry Asphalt Co.), Pulverulent Asphaltic Composition, U. S. Patent 2,584,919, Feb. 5, 1952.

[15] Manns, Thomas J., Reschovsky, Margaret U., and Certa, Anthony J., Volumetric Determination of Barium: Anal. Chem., vol. 24, No. 5, May 1952, pp. 908–909.

WORLD REVIEW

Australia.—S. A. Barytes, Ltd., was said to be planning to double the output of barite from its mine at Araparinna near Howker in South Australia. This would bring output to 7,000 tons per year.[16]

Belgian Congo.—Veins of barite are reported to have been located at Moyen Congo (at Madimba) on the Bangu (in the Mayumbe) and in Southern Katanga.[17]

Canada (Nova Scotia).—The deposit of barite at Walton, Nova Scotia, was discovered about 1893; but exploration and development of the deposit were not begun until early in World War II, when supplies of barite from Germany were no longer available. At that time Canadian Industrial Minerals, Ltd., began exploration in the area. Diamond drilling indicated that the ore body was of considerable size, and it was decided to proceed, using a combination of open-pit and glory-hole mining. The history of this operation and the mining and milling methods used were described in an article.[18]

TABLE 14.—World production of barite, by countries,[1] 1948–52, in metric tons[2]

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
Algeria	16,681	16,874	22,890	21,021	[3] 12,000
Argentina	(4)	(4)	(4)	(4)	[3] 13,000
Australia	3,831	5,552	6,028	6,277	4,700
Austria	3,842	8,260	10,119	9,645	[3] 7,000
Brazil	[3] 10,000	6,010	6,860	50	(4)
Canada	86,860	42,763	70,013	89,006	108,257
Chile	2,141	1,461	1,360	1,095	(4)
Colombia	120	58	(4)	(4)	(4)
Egypt		30		41	30
France	56,722	30,295	33,349	26,519	28,800
French Morocco		305	4,912	3,256	3,111
Germany:					
East	(4)	[3] 55,500	(4)	(4)	(4)
West	[5] 60,068	181,467	310,896	417,479	345,840
Greece	18,706	15,604	20,799	29,399	21,679
India	23,514	21,457	12,155	8,356	7,621
Ireland	7,035	5,968	4,821	8,230	(4)
Italy	65,662	51,583	54,426	76,541	55,256
Japan	3,404	9,840	14,460	16,704	14,112
Korea, Republic of					[3] 1,300
Peru	1,787	6,350	3,031	23,015	9,104
Portugal	406	427	128	719	(4)
South-West Africa		48			
Southern Rhodesia	51	488	261	85	271
Spain	14,153	7,665	7,147	12,449	14,040
Swaziland	98	104	441	477	403
Sweden	1,914	923	50	(4)	(4)
Tunisia	230	630	25	10	25
Union of South Africa	1,734	2,222	2,268	2,038	1,718
United Kingdom [6]	123,719	119,216	98,160	89,981	(4)
United States	705,642	663,428	629,060	767,092	918,802
Yugoslavia	28,648	36,445	29,730	24,822	34,819
Total (estimate)	1,375,000	1,400,000	1,525,000	1,825,000	1,900,000

1 In addition to countries listed, barite is produced in China, Cuba, Czechoslovakia, Mexico, North Korea and U. S. S. R., but data on production are not available. Estimates by authors are included in total.
2 This table incorporates a number of revisions of data published in previous Barite chapters.
3 Estimate.
4 Data not available: estimate included in total.
5 Excludes British zone.
6 Includes witherite.

16 Mining World, vol. 39, No. 3, March 1952, p. 74.
17 Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, p. 47.
18 Campbell, G. G., Recovery of Barytes at Walton, Nova Scotia: Canadian Min. and Met. Bull. 485, September 1952, pp. 532–535.

French Morocco.—The only producer of barite in French Morocco in 1952 was the Compagnie Minière et Industrielle du Maroc, which mines a deposit at Djebel Irhoud about 40 miles southeast of Safi. The company has done considerable prospecting in another area approximately 60 miles southeast of Marrakech near the Tichka Pass. Although the mineral is said to be of good quality, transport problems and operating difficulties due to the location of the deposit have prevented exploitation.[19]

Peru.—Expansion of the oil-drilling industry in Peru has brought an increase in requirements for barite. In an effort to develop sources of barite within the country a new mine was opened near Chiclayo near the Sechura Desert where extensive exploration for oil was expected to begin.[20]

United Kingdom.—A temporary setback was reported in barite mining in the United Kingdom; stocks were said to be high, with many mines unable to dispose of their output. At the Devonshire Baryta Co. mine, Bridford, Devonshire, operations had been cut back. In the north of England the Silverband mine was closed down and at Cow Green operations had been slowed down.[21]

Athole G. Allen, Ltd., announced suspension of development and production operations at the barite mines at Closehouse and Lunehead, Middletown-in-Teesdale.[22]

---

[19] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 1, July 1953, pp. 35–36.
[20] Abs. from information received from B. A. Bramson, United States minerals attaché, Lima, Peru.
[21] Mining World, vol. 14, No. 12, November 1952, p. 66.
[22] Metal Bulletin (London), No. 3718, Aug. 19, 1952, p. 23.

Bauxite

By Horace F. Kurtz[1]

LARGE-SCALE expansion of bauxite mining and processing facilities was proceeding in the West Indies, the Guianas, west Africa, and south-central Europe during 1952. The demand that led to the new developments resulted from a phenomenal expansion of the aluminum industry, particularly in the United States, Canada, Germany, and the U. S. S. R. These major aluminum producers depended on foreign bauxite reserves for important quantities of ore. Investigations of substitutes for bauxite continued in 1952, but none had been proved competitive by commercial production.

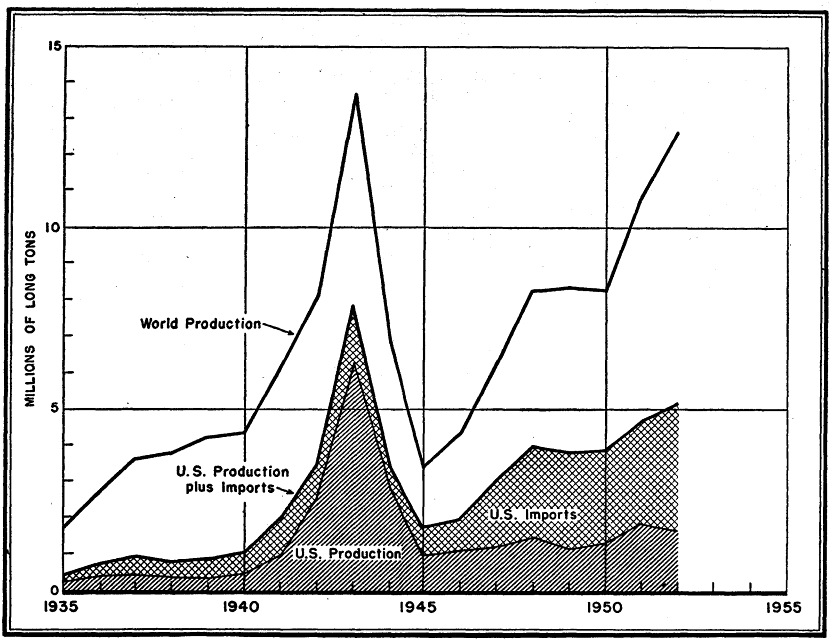

FIGURE 1.—United States supply and world production of bauxite, 1935–52.

[1] Commodity-industry analyst.

TABLE 1.—Salient statistics of the bauxite industry in the United States, 1943–47 (average) and 1948–52, in long tons

	1943–47 (average)	1948	1949	1950	1951	1952
Crude-ore production (dry equivalent)	2,468,745	1,457,148	1,148,792	1,334,527	1,848,676	1,667,047
Imports (as shipped)	1,104,296	2,488,915	2,688,164	2,516,247	[1] 2,819,676	3,497,939
Exports (as shipped)	176,412	54,113	34,902	45,406	89,948	41,330
Consumption	3,021,524	2,725,140	2,677,733	3,325,304	3,945,667	4,240,891
World production	[1] 6,897,000	[1] 8,227,000	[1] 8,344,000	[1] 8,238,000	[1] 10,811,000	[1] 12,634,000

[1] Revised figure.

Bauxite consumption in the United States had risen steadily and rapidly since 1949. Domestic production since World War II had shown only a slightly increasing trend, whereas imports had increased over fourfold. Although the United States had been neither an international supplier nor a self-sufficient nation in regard to bauxite in recent years, it continued to have all of the alumina-production capacity it required. All four alumina plants that were operated since the war were expanded under the aluminum expansion program. One new alumina plant began production in 1952, and a sixth plant was under construction. Aluminum is discussed in the Aluminum chapter of this volume.

DOMESTIC PRODUCTION

Mine production of domestic bauxite declined 10 percent from 1951 to 1952. Arkansas produced 96 percent of the 1952 total, and the remainder was produced in Alabama and Georgia. Despite the reduced mine output, total shipments of crude and processed bauxite to consumers increased. The quantity of crude ore that was dried, calcined, or activated before shipment to consuming plants was only slightly more than half that of the preceding year. Alcoa Mining Co.'s change in operations from shipping dried bauxite to the East St. Louis, Ill., alumina plant to sending crude ore directly to the new alumina plant at Bauxite, Ark., was the principal cause of the decline in processing activity, although the quantity of ore calcined for the abrasive industry was substantially reduced also.

TABLE 2.—Production of bauxite in the United States, 1948–52, by quarter years, in long tons [1]

[Dried-bauxite equivalent]

Quarter ended—	1948	1949	1950	1951	1952
March 31	295,488	320,157	322,006	378,031	426,269
June 30	359,284	294,023	368,256	502,088	458,612
September 30	437,457	208,926	293,724	453,564	312,370
December 31	364,919	325,686	350,541	514,993	469,796
Total	1,457,148	1,148,792	1,334,527	1,848,676	1,667,047

[1] Quarterly figures adjusted to final annual totals.

A review of the bauxite industry in Arkansas was published in 1952.[2] All of the production came from an area near Little Rock, Ark., in Saline and Pulaski Counties. About 84 percent of the output was mined by open-pit methods.

The Alcoa Mining Co., the largest producer in 1952, mined bauxite principally for its affiliated alumina company but also shipped dried and calcined ore from its two plants in Arkansas to nearly all industries that use bauxite. The second largest producer, Reynolds Mining Corp., shipped its entire output in crude form to the Reynolds Metals Co. The Dulin Bauxite Co. and the Riffe Construction Co., associated companies, were the only producers in Arkansas not directly afliated with a company that consumes bauxite. The Dulin crushing, drying, and calcining plant near Sweet Home, Ark., served both companies, and bauxite was sold to most bauxite-consuming industries. The American Cyanamid Co. and Consolidated Chemical Industries, Inc., mined chemical-grade bauxite in Arkansas during 1952, and the American Cyanamid Co. also shipped dried bauxite to the oil-refining industry. Both chemical companies operated plants near the mines. The Norton Co. and the Crouch Mining Co. mined and calcined bauxite exclusively for the abrasive plants affiliated with each company. The Campbell Bauxite Co. purchased crude ore from Arkansas producers and produced dried bauxite for the chemical industry and activated bauxite for desiccating and oil-filtering pur-

TABLE 3.—Mine production of bauxite and shipments from mines and processing plants to consumers, in the United States, 1948–52, by States, in long tons

State and year	Mine production			Shipments from mines and processing plants to consumers		
	Crude	Dried-bauxite equivalent	Value [1]	As shipped	Dried-bauxite equivalent	Value [1]
Alabama, Florida, and Georgia:[2]						
1948	74, 511	61, 807	$397, 222	59, 520	59, 474	$504, 556
1949	65, 137	53, 868	344, 217	45, 792	46, 407	425, 532
1950	32, 706	27, 192	161, 274	35, 741	35, 473	272, 320
1951	38, 807	33, 402	217, 774	39. 122	38, 123	363, 602
1952	76, 582	63, 214	541, 000	50, 670	48, 463	520, 550
Arkansas:						
1948	1, 649, 926	1, 395, 341,	8, 299, 486	1, 430, 688	1, 314. 069	9, 458, 476
1949	1, 287, 358	1, 094, 924	6, 433, 964	1, 232, 883	1, 132, 330	8, 119, 574
1950	1, 552, 047	1, 307, 335	7, 531, 535	1, 416, 724	1, 301, 374	9, 277, 076
1951	2, 153, 786	1, 815, 274	12, 259, 742	1, 583, 320	1, 493, 557	11, 994, 882
1952	1, 903, 101	1, 603, 833	10, 235, 254	2, 067, 241	1, 849, 287	14, 084, 274
Total United States:						
1948	1, 724, 437	1, 457, 148	8, 696, 708	1, 490, 208	1, 373, 543	9, 963, 032
1949	1, 352, 495	1, 148, 792	6, 778, 181	1, 278, 675	1, 178, 737	8, 545, 106
1950	1, 584, 753	1, 334, 527	7, 692, 809	1, 452, 465	1, 336, 847	9, 549, 396
1951	2, 192, 593	1, 848, 676	12, 477, 516	1, 622, 442	1, 531, 680	12, 358, 484
1952	1, 979, 683	1, 667, 047	10, 776, 254	2, 117, 911	1, 897, 750	14, 604, 824

[1] Computed from selling prices and values assigned by producers.
[2] Bauxite was processed in Florida in 1948–49.

[2] Buskett, E. W., Mining Bauxite in Arkansas: Mine and Quarry Eng., vol. 18, No. 1 January 1952, pp. 15–19.

poses. Activated bauxite was also produced from purchased crude and dried ore by the Porocel Corp.

TABLE 4.—Recovery of processed bauxite in the United States, 1943–47 (average) and 1948–52, in long tons

Year	Crude ore treated	Processed bauxite recovered			
		Dried	Calcined or activated	Total	
				As recovered	Dried-bauxite equivalent
1943–47 (average)	1,238,808	845,764	168,562	1,014,326	1,094,605
1948	688,898	476,921	68,800	545,721	584,856
1949	597,536	431,158	55,544	486,702	517,412
1950	657,798	480,623	63,713	544,336	579,884
1951	1,059,645	756,060	103,588	859,648	914,433
1952	576,430	397,067	56,191	453,258	481,705

Bauxite production in both Alabama and Georgia increased in 1952. The Alcoa Mining Co. produced chemical- and refractory-grade bauxite and operated a drying plant in the Eufaula district of Alabama, and the D. M. Wilson Bauxite Co. mined refractory-grade ore in the same area. The American Cyanamid Co. mined bauxite in central and northwestern Georgia for use in the chemical industry and operated a drying plant near Adairsville, Ga. Bauxite from the southeastern States averaged about 53 percent Al_2O_3, 15 percent SiO_2, and 1.3 percent Fe_2O_3.

CONSUMPTION

Bauxite consumption increased 7 percent to 4¼ million long tons (dry basis) in 1952, an annual level surpassed only by the peak war year 1943. Most of the increase resulted from a greater demand for alumina to meet requirements of the expanding aluminum industry. Production of primary aluminum rose 12 percent from 1951–52, despite a severe decrease in the power available for reducing alumina to metal during the last 4 months of 1952.

Reports from consumers showed that 1,130,000 tons of crude bauxite, 2,996,000 tons of dried bauxite, and 197,000 tons of calcined and activated bauxite were used during 1952. Imported bauxite comprised 63 percent of the total bauxite consumed in 1952, compared with 53 percent in 1951. All major consuming industries used greater quantities of foreign ore.

The geographical distribution of bauxite consumption was largely determined by the location of alumina plants, which used 88 percent of the ore. Two of the alumina plants were located in the bauxite-producing area of central Arkansas, and the others were at Mobile, Ala., Baton Rouge, La., and East St. Louis, Ill. Virtually all bauxite used by the abrasive industry was consumed in the Niagara Falls

TABLE 5.—Bauxite consumed in the United States, 1951–52, by industries, in long tons

[Dried-bauxite equivalent]

Industry	1951			1952		
	Domestic	Foreign	Total	Domestic	Foreign	Total
Alumina	1,563,663	1,801,260	3,364,923	1,382,041	2,339,588	3,721.629
Abrasive [1]	122,644	181,792	304,436	60,546	194,269	254,815
Chemical	90,568	78,954	169,522	75,670	82,119	157,789
Refractory	14,886	33,687	48,573	13,518	39,861	53,379
Others	53,749	4,464	58,213	52,439	840	53,279
Total	1,845,510	2,100,157	3,945,667	1,584,214	2,656,677	4,240,891

[1] Includes consumption by Canadian abrasives industry.

area of Canada and the United States. Data on calcined bauxite fused and crushed by the abrasive industry in Canada were included with the consumption figures, since most of this material was returned to the United States for manufacture into abrasive wheels and coated products. The decline in production of abrasives from bauxite during 1952 was attributed to the general decline in metal fabrication resulting from a nationwide steel strike, which began on June 3 and lasted about 2 months. The production of abrasives is discussed more thoroughly in the Abrasives Materials chapter of this volume. Georgia, Louisiana, Alabama, Tennessee, and South Carolina consumed two-fifths of the bauxite used directly in the production of aluminum chemicals. Plants in Delaware, New Jersey, Ohio, and Maryland used another two-fifths. About 84 percent of the refractory-grade bauxite consumed in 1952 was used at plants in Missouri, Kentucky, and Illinois. Although most plants producing aluminous refractories were situated near refractory-clay deposits, the rising demand for high-alumina refractories in recent years and the depletion of suitable raw materials, such as Missouri diaspore, have forced the industry to use increasing quantities of bauxite.

The 5 alumina plants of the aluminum producers had a total output of 1,863,000 short tons of calcined alumina and 123,000 tons of alumina in other forms in 1952. It was calculated that an average of 1.91 long tons (dry basis) of bauxite was required to yield 1 short ton of calcined alumina. An average of 3.65 long tons of bauxite was used to produce 1 short ton of aluminum.

Much of the construction involved in increasing the alumina capacity of the United States to approximately 3.5 million tons per year was completed during 1952. In October the Aluminum Ore Co. new plant at Bauxite, Ark., began production. The annual capacity of this plant was rated at 400,000 short tons of alumina using the combination Bayer-sinter process for treating Arkansas bauxite. During 1952 the Reynolds Metals Co. began constructing a new plant designed to produce 365,000 tons of alumina per year from Jamaican bauxite. The plant site was at LaQuinta, Tex., adjacent to the aluminum plant near Corpus Christi, Tex.

The 15 primary aluminum plants that operated during 1952 used an estimated 97 percent of the calcined alumina and 91 percent of the total alumina consumed. The other consumers of calcined alumina have been classified into three groups: Producers of ceramic products, including refractories, spark plugs, glass, and porcelain; producers of aluminum chemicals and fluxes and users of alumina for its catalytic and adsorbent properties; and abrasives producers. The chemical group used most of the commercial alumina trihydrate and activated alumina, and nearly all of the tabular alumina was used for refractories and spark plugs.

TABLE 6.—Production and shipments of selected aluminum salts in the United States, 1951–52

Type of salt	1951				1952			
	Production (short tons)	Shipped or used			Production (short tons)	Shipped or used		
		Shippers [1]	Short tons	Value		Shippers [1]	Short tons	Value
Aluminum sulfate:								
Ammonium	4,582	3	4,566	$404,231	5,823	4	5,548	$505,104
Potassium	18,837	3	18,784	1,574,134	17,296	4	17,666	1,498,298
Sodium		1				1		
General:								
Commercial	721,620	15	719,184	22,090,751	673,420	16	671,071	20,985,609
Municipal	14,425	6	14,287	348,525	15,501	6	15,501	394,642
Iron-free	50,124	8	47,776	2,514,897	38,236	8	35,559	1,836,753
Sodium aluminate	10,178	8	9,456	955,431	11,390	7	11,652	1,158,033
Aluminum chloride:								
Liquid	11,464	4	11,158	656,695	12,704	5	12,474	669,806
Crystal	[2] 37,617	[2] 1	[2] 36,752	[2] 10,167,442	25,482	1	25,812	6,563,227
Anhydrous		7				6		
Total	[2] 868,847	37	[2] 861,963	[2] 38,712,106	799,852	38	795,283	33,611,472

[1] Producing companies reporting aluminum salts shipped or used. A company shipping more than one kind of salt is counted but once in arriving at total.
[2] Revised figure.

Although bauxite was the principal raw-material source of aluminum for the aluminum salts production shown in table 6, clay, alumina, aluminum, and alunite were used also. The overall decline in production of aluminum salts from 1951 to 1952 was largely a reflection of lower demand for commercial-grade aluminum sulfate, iron-free aluminum sulfate, and anhydrous aluminum chloride.

STOCKS

Inventories at the close of 1952, excluding bauxite in transit, were 17 percent greater than stocks on December 31, 1951. Stocks of processed ore (dried, calcined, and activated) nearly doubled during 1952. The increase largely reflected additions of dried ore to serve the expanded operations at alumina plants. From January to October 1952 the Reynolds Metals Co. exercised its option to purchase crude bauxite from the Government-held nonstrategic stockpiles in Arkansas. A total of 150,000 long tons (dry equivalent) was withdrawn during 1952, which brought the total since the first purchase in 1950 to approximately 700,000 tons.

TABLE 7.—Stocks of bauxite in the United States Dec. 31, 1948–52, in long tons

Year	Producers and processors		Consumers		Government	Total [1]	
	Crude	Processed [2]	Crude	Processed [2]	Crude [1]	Crude and processed [2]	Dried-bauxite equivalent
1948	654,601	7,441	57,191	590,124	3,277,090	4,586,447	4,023,300
1949	574,983	8,467	34,183	832,083	3,277,090	4,726,806	4,184,786
1950	543,284	17,392	42,150	723,103	3,061,034	4,386,963	3,809,765
1951	890,336	18,552	44,169	1,008,767	2,630,792	4,592,616	4,069,796
1952	755,536	35,440	45,840	1,946,651	2,454,584	5,238,051	4,744,817

[1] Excludes National Stockpile.
[2] Dried, calcined, activated, and sintered.

All inventory data in this chapter exclude the National Stockpile. During 1952 both metal-grade and refractory-grade bauxite were on the Government's purchase list of strategic materials for this stockpile.

PRICES

The average book values per long ton of bauxite mined and processed in the United States, as calculated from company reports for 1952, were as follows: Crude, \$5.44; dried, \$8.54; calcined, \$19.92; and activated, \$67.06. The average prices of bauxite shipped to consumers, f. o. b. mines or processing plants, were \$5.70 for crude, \$8.78 for dried, \$19.91 for calcined, and \$67.06 for activated.

Price quotations published in E&MJ Metal and Mineral Markets in 1952, per long ton, were as follows: Domestic ore, chemical, crushed and dried, 55 to 58 percent Al_2O_3, 1.5 to 2.5 percent Fe_2O_3, \$8 to \$8.50 f. o. b. Alabama and Arkansas mines; other grades, 56 to 59 percent Al_2O_3, 5 to 8 percent SiO_2, \$8 to \$8.50, f. o. b. Arkansas mines; pulverized and dried, 56 to 59 percent Al_2O_3, 8 to 12 percent SiO_2, \$14 to \$16, f. o. b. Arkansas mines; abrasive grade, crushed and calcined, 80 to 84 percent Al_2O_3, \$17, f. o. b. Arkansas mines; crude (not dried) 50 to 52 percent (Al_2O_3 on a dry basis), \$4.50 to 5.50, f. o. b. Arkansas mines. Beginning December 18, 1952, crude bauxite was quoted at \$5 to \$5.50 per ton. Also in December, the following quotations, per long ton, were added: Imported bauxite, calcined, crushed (abrasive grade) 83 to 86 percent Al_2O_3, \$19.75 f. o. b. port of shipment, British Guiana; refractory grade bauxite (calcined), \$24.20.

The average value of imported crude and dried bauxite (virtually all dried ore), f. o. b. foreign port of shipment on dock, as reported by the United States Department of Commerce, was \$6.63 per long ton in 1952. By countries, the average values were \$6.57 from Surinam, \$7.37 from Jamaica, \$6.83 from British Guiana, and \$4.75 from Indonesia. The average value of imported calcined refractory-grade bauxite, at British Guiana ports, was \$22.45 per ton. Exports from the United States, largely calcined abrasive-grade bauxite, had an average value of $18.26 per ton.

The General Services Administration sold crude bauxite to the Reynolds Metals Co. in 1952 at an average price of $6.63 per weight equivalent of 1 long dry ton. The average analysis on a dry basis was 50.6 percent Al_2O_3, 11.3 percent SiO_2, and 3.4 percent FeO.

Market prices for alumina and aluminum salts were published in Oil, Paint and Drug Reporter. Throughout 1952 the following quotations remained unchanged: Alumina, calcined, bags, car lots, f. o. b. works, 3.85 cents per pound; hydrate, heavy, bags, car lots, freight equalized, $60 per ton; and aluminum sulfate, commercial, bulk, car lots, f. o. b. works, $1.65 per 100 pounds.

FOREIGN TRADE [3]

During 1952 United States imports of bauxite, classified by the United States Department of Commerce as crude, but including mostly dried ore, were approximately 3.5 million long tons, the largest quantity in history. An increasing dependence on foreign sources of bauxite became evident as imports comprised 68 percent of the total supply, as determined by adding imports to domestic production, contrasted with 60 percent in 1951; moreover, the 1952 data reflected only the initial phases of the domestic aluminum producers' plans to expand mining operations abroad.

TABLE 8.—Bauxite and aluminum compounds imported for consumption in the United States, 1948–52

[U. S. Department of Commerce]

Year	Bauxite (crude and dried) [1]		Alumina		Other aluminum compounds	
	As imported (long tons)	Value	Short tons	Value	Short tons	Value
1948	2,488,915	$15,820,743	6	$3,547	5,559	$124,167
1949	2,688,164	16,353,298	[2] 176	19,192	1,472	46,736
1950	2,516,247	15,729,855	[2] 217	20,038	3,113	126,715
1951	[2] 2,819,676	[2] 17,794,192	965	88,135	5,334	275,238
1952	3,497,939	23,193,991	654	67,310	8,050	682,932

[1] Only small quantities of undried bauxite were imported. Complete data on imports of calcined bauxite were not available. Beginning September 1950, calcined bauxite for refractory uses only was imported as follows: 1950, 9 tons ($329); 1951, 18,642 tons ($405,438); 1952, 31,412 tons ($705,166).
[2] Revised figure.

Surinam, the principal foreign supplier since 1928, provided 3,023,145 tons during 1952. The first shipments of Jamaican bauxite for commercial use began in June 1952 and totaled 264,988 tons for the entire year. All of the Jamaican ore was shipped, partly dried, from the new operations of Reynolds Jamaica Mines, Ltd., to Mobile, Ala., for use at the Hurricane Creek, Ark., plant of the parent Reynolds Metals Co. Receipts of dried bauxite from British Guiana were 178,379 tons. In addition, all imports of refractory-grade calcined bauxite in 1952 came from British Guiana. No shipments of bauxite from Indonesia were reported following 19,425 tons received

[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

in January. Indonesia was the second largest foreign source of bauxite for the United States from 1948 through 1951. Trinidad and Tobago (probably all South American ore) accounted for the remainder (12,002 tons). Nearly all alumina imported in 1952 came from Canada, and most of the other aluminum compounds came from France and Canada.

About 54 percent of the total bauxite imports entered the United States through the Mobile (Ala.) customs district and 44 percent through the New Orleans (La.) customs district. The following duties on imports remained unchanged throughout 1952: Crude and dried bauxite, 50 cents per long ton; calcined bauxite for use in the manufacture of refractories, $1 per long ton; other calcined bauxite, 15 percent ad valorem; alumina and refined aluminum hydroxide, ¼ cent per pound.

Bauxite exports, classified as aluminum ores and concentrates, declined in 1952 to less than half the preceding year. Canada received about 40,000 tons, largely calcined bauxite, and the remaining 3 percent was divided among 12 other countries. Canada, Colombia, and the Philippines were the chief recipients of the aluminum sulfate exported, and Mexico and Canada were the most important foreign markets for the other aluminum compounds.

TABLE 9.—Bauxite[1] and aluminum compounds exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Bauxite (including bauxite concentrates), long tons			Aluminum sulfate		Other aluminum compounds	
	As exported	Dried-bauxite equivalent[2]	Value	Short tons	Value	Short tons	Value
1948	54,113	86,284	$1,202,036	14,342	$467,622	3,539	$599,210
1949	34,902	57,628	512,779	14,706	554,710	4,155	664,018
1950	45,406	72,014	1,155,673	13,010	461,653	4,393	742,941
1951	89,948	138,916	2,217,426	19,865	755,897	4,601	1,067,050
1952	41,330	62,979	845,452	19,743	706,265	4,152	736,332

[1] Classified as Aluminum ores and concentrates by the Department of Commerce.
[2] Calculated by Bureau of Mines.

TECHNOLOGY

Papers and discussion from the 1951 clay symposium of the American Institute of Mining and Metallurgical Engineers, published in 1952, included information on the origin of bauxite deposits.[4] A report on clays and bauxite in northeastern Mississippi, including drill records compiled during World War II and a map showing the occurrences of alumina resources in the Columbia River Basin, were published by the United States Department of the Interior during 1952.[5]

Research on beneficiation and desilication of low-grade Arkansas

[4] American Institute of Mining and Metallurgical Engineers, Problems of Clay and Laterite Genesis: Symposium, 1952, 244 pp.

[5] Reed, Donald F., Investigation of High-Alumina Clays and Bauxite of Northeastern Mississippi: Bureau of Mines Rept. of Investigations 4827, 1952, 84 pp.
Sohn, I. G., Geologic Environment Map of Alumina Resources of the Columbia Basin: Geol. Survey Mineral Investigations, Resource Appraisals Map MR 1, 1952.

bauxite was continued at the Bureau of Mines laboratories at Bauxite, Ark. A report was released describing a method for treating high-iron bauxite to recover both abrasive- and metal-grade bauxite and an iron concentrate.[6]

Extraction of alumina from Jamaican bauxite on a commercial scale was begun at the end of 1952. Although little had been published on the technology of using these ores, the available data indicated that Jamaican bauxite is low in silica, usually less than 3 percent, and frequently less than 1 percent.[7] Analyses showed that the Jamaican ore contained 17 to 23 percent iron as Fe_2O_3, which was considerably greater than most other commercial bauxites in the Western Hemisphere. Alumina occurred predominantly as the alumina trihydrate mineral, gibbsite, although the monohydrate, boehmite, was present in significant proportions in most deposits.

On August 19, 1952, the Munitions Board issued a set of specifications that would be used if the Government purchased metal-grade Jamaican bauxite for the National Stockpile. The chemical requirements for the mixed boehmite-gibbsite bauxite from Jamaica compared with the trihydrate ore specifications in use during 1952 as follows:

Constituent		*Trihydrate, percent*	*Mixed, percent*
Alumina (Al_2O_3)	Minimum	55.0	47.0
Silica (SiO_2)	Maximum	5.0	4.0
Total alkalies (as oxides)	do	1.0	1.0
Ferrous iron (as FeO)	do	3.0	3.0
Phosphorus (as P_2O_5)	do	1.0	1.0
Manganese, chromium, and vanadium (as $MnO_2+Cr_2O_3+V_2O_5$).	do	2.0	2.0
Loss on ignition	Minimum	(1)	(2)

1 50 percent of actual Al_2O_3.
2 40 percent of actual Al_2O_3.

The first Jamaican bauxite used was largely gibbsitic. Considerably more starch was needed to flocculate the muds from the digestion operation in producing alumina from these ores than was required for Guiana and Arkansas bauxites; however, rapid settling and a tendency not to deflocculate on washing resulted. The sludges from the Jamaican ore required more wash water and evaporating capacity than would have been needed for Guiana bauxites but less than that for high-silica Arkansas ores. Although the sludges from Jamaican bauxite contained large quantities of iron, there was a low proportion of silica, usually present as sodium-aluminum silicates. The low silica content of the ores also had the effect of reducing alumina and soda losses. Inasmuch as higher temperatures and caustic concentrations have had to be applied to dissolve European monohydrate bauxites, the efficient use of Jamaican bauxite containing a large proportion of its alumina as boehmite was expected to require more

6 Calhoun, W. A., Powell, H. E., and Hodshire, J. F., Beneficiation of High-Iron Arkansas Bauxite Ore: Bureau of Mines Rept. of Investigations 4841, 1952, 12 pp.
7 Zans, V. A. Economic Geology and Mineral Resources of Jamaica: Geol. Survey Dept., Jamaica, British West Indies, Bull. 1, 1951, pp. 19–22.
Schmedeman, O. C., First Carribbean Bauxite Development: Eng. and Min. Jour., vol. 151, No. 11, November 1950, pp. 98–100.

soda in-process and different autoclaves from those previously used to treat gibbsitic ore.[8]

During 1952 the Bureau of Mines virtually completed modifications and additions to an experimental alumina plant at Laramie, Wyo. Construction of the plant was begun in December 1943, but the project was terminated at the close of World War II before the plant was completed or operated. The project was reactivated to test the feasibility of producing alumina from anorthosite occurring in the vicinity in virtually inexhaustible quantities.[9] The broader objective was to gather information on technology, equipment, product and byproduct purities, and costs that would aid in evaluating the use of clays and other aluminum silicates that have been considered potential sources of alumina. Although the plant did not have a capacity comparable to commercial-size plants, the operation should be large enough to permit translation of the data for industrial applications. Essentially, the process was to consist of leaching a sinter produced from anorthosite, limestone, and soda ash. The liquor was to be autoclaved, carbonated, and calcined to recover alumina; the residue may have potentialities in cement manufacture.

Several studies of titanium and the minor elements occurring in Arkansas bauxite were made during 1952.[10] The Bureau of Mines investigated procedures to concentrate the columbium-titanium minerals from black sands removed as waste material from the red muds at alumina plants treating Arkansas bauxite.

WORLD REVIEW

The development of bauxite-production schemes in the three countries with the largest reserves highlighted the international aspects of the bauxite industry during 1952. In Jamaica, Reynolds Jamaica Mines, Ltd., Kaiser Bauxite Co., and Alumina Jamaica, Ltd., all subsidiaries of North American aluminum producers, virtually completed installations for mining and processing bauxite. Reports from Hungary indicated that it had regained the prominence as a bauxite producer that it achieved during World War II. Bauxite output from Gold Coast declined in 1952, but a proposed aluminum production project based on Volta River hydroelectric power promised greatly expanded bauxite-mining operations on completion.

Bauxite discoveries were made in regions of Australia, India, and Venezuela where bauxite deposits had never been identified before. Exploration continued in most of the other areas where reserves had been known, particularly throughout South America and southeastern Asia.

---

[8] Tiemann, T. D., Extraction of Alumina From Haiti and Jamaica Bauxites: Jour. Metals, vol. 3, No. 5, May 1951, pp. 389–393.

[9] Hagner, A. F., Anorthosite of the Laramie Range, Albany County, Wyo., as a Possible Source of Alumina: Geol. Survey Wyoming, Bull. 43, April 1952, 15 pp.

[10] Fleischer, M., Murata, K. J., Fletcher, J. D., and Narten, P. F., Geochemical Association of Niobium (Columbium) and Titanium and its Geological and Economic Significance: Geol. Survey Circ. 225, 1952, 13 pp.
Gordon, M., Jr., and Murata, K. J., Minor Elements in Arkansas Bauxite: Econ. Geol., vol. 47, No. 2, March–April 1952, pp. 169–179.

TABLE 10.—World production of bauxite, by countries, 1947–52, in metric tons [1]

[Compiled by Lee S. Petersen]

Country	1947	1948	1949	1950	1951	1952
Australia	4,956	5,736	5,377	3,523	5,166	7,344
Austria		5,324	6,526	616	7,795	15,180
Brazil	6,735	14,772	16,213	18,570	19,033	(2)
British Guiana	1,318,190	1,903,230	1,785,860	1,608,831	2,034,888	2,426,264
France	680,123	803,535	785,321	805,228	1,124,400	1,115,000
French West Africa				[3] 10,125		109,750
Germany, West	18,000	[4] 10,000	2,439	4,166	(2)	
Gold Coast (exports)	97,437	133,055	147,340	116,793	131,404	75,562
Greece	22,420	44,238	48,852	77,448	197,060	348,591
Hungary [4]	340,000	450,000	550,000	570,000	(2)	(2)
India	18,835	22,512	43,224	65,433	68,123	(2)
Indonesia	24,559	437,822	678,138	531,143	642,316	560,671
Italy	171,083	153,711	104,852	153,384	174,014	281,458
Jamaica						[4] 350,000
Malaya, Federation of						22,146
Mozambique	2,960	857	1,369	4,336	3,329	(2)
Rumania [4]	600	800	1,000	1,000	(2)	(2)
Spain	5,822	6,805	11,962	12,186	10,581	5,952
Surinam	1,798,588	2,149,906	2,126,654	2,080,657	2,671,330	3,153,790
Taiwan (Formosa)					[4] 10,000	(2)
U. S. S. R. [4]	500,000	600,000	650,000	750,000	(2)	(2)
United States (dried equivalent of crude ore)	1,221,348	1,480,535	1,167,230	1,355,946	1,878,347	1,693,803
Yugoslavia	87,629	136,476	345,953	200,892	453,357	577,196
Total	6,319,000	8,359,000	8,478,000	8,370,000	10,984,000	12,837,000

[1] This table incorporates a number of revisions of data published in previous bauxite chapters.
[2] Data not available; estimate by author of chapter included in total.
[3] Exports.
[4] Estimate.

Expanded bauxite production in Surinam, Hungary, British Guiana, and Jamaica provided most of the 17-percent world increase from 1951 to 1952. An estimated 59 percent of the total output was mined in the 5 producing countries of the Western Hemisphere (Surinam, British Guiana, United States, Jamaica, and Brazil), 16 percent in the U. S. S. R. and 2 satellite countries (Hungary and Rumania), and 25 percent in 13 other countries.

Of the world production of bauxite, 55 percent was mined in countries that produced no primary aluminum, and only 31 percent was mined in countries that produced 98 percent of the world's aluminum. The largest international movement of bauxite during 1952 was the 3 million tons supplied the United States by Surinam. Among the other major shipments, outside of the U. S. S. R. and its satellites, British Guiana sent approximately 2 million tons of ore to Canada. The United States received about one-tenth of the output of this British colony. All Jamaica's exports in 1952 came to the United States. West Germany, the largest bauxite importer in the Eastern Hemisphere, received about ½ million tons from Yugoslavia, ¼ million from Greece, and lesser quantities from France and Indonesia. Complete data on the flow of bauxite between other countries in 1952 were not published, but where available, have been presented in the following discussion, by countries.

Australia.—Investigations of bauxite deposits on Marchinbar Island, Wessel Islands group, Northern Territory, during 1952 proved reserves of about 10 million tons. Analysis of these deposits averaged from 48 to 53 percent Al_2O_3, 4 to 9 percent SiO_2, excluding quartz, and 6 to 17 percent Fe_2O_3. Two other large bauxite occurrences were discovered on the mainland near Cape Arnhem, but their size and content were not measured.

Austria.—The only known bauxite deposit in Austria was at Unterlaussa, Upper Austria. Production increased in both 1951 and 1952, but nearly half of the ore was unsuitable for making alumina. Since there were no alumina plants in Austria, the metal-grade ore that was produced was shipped to Schwandorf, West Germany.

British Guiana.—The Demarara Bauxite Co., a subsidiary of Aluminium, Ltd., of Canada, exported 1,968,000 long tons of dried bauxite and 145,000 tons of calcined bauxite in 1952. The company installed a new calcining kiln of 100,000 tons annual capacity. Another bauxite calciner, reported to be the largest in the world, was under construction.

The smaller Berbice Co., a subsidiary of the American Cyanamid Co., ceased mining from its deposits near Kwakwani on the Berbice River in 1952. The operation, which had begun 10 years earlier, was intended to provide chemical-grade bauxite, but much of the ore developed was a lower grade. In December it was announced that the Berbice Co. had been sold to the Reynolds Metals Co. The new owners acquired all assets, including mining leases, exploration rights, mining machinery, washing and drying plants, transportation equipment, housing facilities, and a stockpile of ore.

Dominican Republic.—During 1952 the Aluminum Co. of America was constructing facilities to mine bauxite from its concession near Pedernales, Barahona Province. The building of 14 miles of road and a new port at Cabo Rojo on the southwestern coast were among the major projects that remained to be completed. Shipments of ore were not expected before the latter part of 1953.

France.—France, which historically has been the leading bauxite producer in the Eastern Hemisphere, mined over 1.1 million metric tons in 1952, for the second consecutive year. The following six companies provided nearly all of the production: Société des Bauxites de France, Union des Bauxites, Société Péchiney, Société des Bauxites du Midi, Électro-Chimie d'Ugine, and Comptoir d'Extraction et de Vente des Bauxites. French exports during 1952 included 339,000 tons of bauxite and 65,000 tons of alumina. Alumina production capacity was estimated at 270,000 tons per year.

French West Africa.[11]—Aluminium, Ltd., through its wholly owned French subsidiary, Bauxites du Midi, began large-scale mining on the island of Kassa (Los Archipelago), near Conakry on the mainland, in 1952. Mine production from this bauxite operation, the largest in Africa, exceeded 100,000 metric tons during 1952. Shipments were begun in October, and by the end of 1952 nearly 50,000 tons had been delivered at Port Alfred, Canada. Facilities on Kassa included plants for crushing, washing, and drying the bauxite, with a capacity of about ¼ million tons per year.

Germany.—In 1952 West Germany's receipts of bauxite included 489,000 metric tons from Yugoslavia, 281,000 tons from Greece, 117,000 tons from France, 114,000 tons from Indonesia, 10,000 tons from Surinam, 9,000 tons from Austria, 7,000 tons from British

[11] American Metal Market, Aluminium, Ltd., Opens New Bauxite Mines in French West Africa: Vol. 59, No. 197, Oct. 10, 1952, pp. 1, 9.

Guiana, 6,000 tons from United Kingdom (probably Gold Coast ore), and 3,000 tons from India. No bauxite production in West Germany was reported. In addition to the alumina produced for domestic consumption, West Germany exported 50,000 metric tons of alumina, including 27,000 tons to Austria, 11,000 tons to Switzerland, 7,000 tons to Sweden, 2,000 tons to Spain, and 1,000 tons to Indonesia.

Gold Coast.[12]—Representatives of the United Kingdom and Gold Coast Governments, Aluminium, Ltd., and the British Aluminium Co. met in the Gold Coast during 1952 to discuss the feasibility of developing a fully integrated aluminum ingot industry in the Gold Coast. The proposed scheme would utilize the bauxite reserves at Yenahin and Mpraeso, estimated to exceed 200 million tons, and the large hydroelectric potential of the Volta River. The first phase of the project would include an alumina plant and a reduction plant of 80,000 metric tons annual capacity. An eventual smelter capacity of 210,000 tons annually was envisioned.

Greece.—The output of bauxite in Greece during 1952 was nearly double the 1951 production. Most of the ore was converted to aluminum in Germany for the United States, under agreements made with the Mutual Security Agency. United Kingdom and Norway received most of the remainder of the bauxite exports, and consumption in Greece was negligible. The average price of Greek bauxite was $6.17 (U. S.).

Hungary.—Bauxite production in Hungary, which had the largest known reserves in Europe, was probably more than a million metric tons in 1952. An unknown quantity of ore was exported to the U. S. S. R. and its satellite countries, but Hungary also consumed bauxite in the production of alumina at the Almasfuzitö plant and a smaller plant at Magyarovar. These were the only alumina plants reported to be in operation.

India.—The discovery of several new bauxite deposits in India was reported during 1952. The largest was in the Surguja district of Madhya Pradesh and was estimated to contain 8 million tons. The following companies had bauxite mines in India: The Aluminium Corp. of India and the Indian Aluminium Co., in the Ranchi district, Bihar; G. P. Sonawala, Thana district, Bombay; Sevalia Cement Works, Kaira district, Bombay; Shevaroy Bauxite Product Co., Salem district, Madras; Pandit Chakorilal Pathak and Sons, Associated Cement Co., K. P. Pandey, N. Venkat Ramara and Sons, Macpherson and Co., and G. H. Cook & Sons, all in the Jubbulpore district, Central Provinces. Two alumina plants, one at Muri, Bihar and the other near Asansol, West Bengal, were owned by the Indian Aluminium Co. and the Aluminium Corp of India, respectively.

Indonesia.—Inventories of bauxite on Bintan Island rose to approximately 200,000 metric tons by the end of 1952, as shipments during the year were considerably less than production and consumption was nil. Japan and West Germany were the principal recipients of bauxite from Indonesia. Exports to the United States ceased at the beginning of 1952.

---

[12] Her Majesty's Stationery Office (London), Volta River Aluminium Scheme: Cmd 8702, November 1952, 22 pp.

Italy.—Bauxite production in Italy increased over 100,000 metric tons from 1951 to 1952. The central Apennines, the Gargano peninsula, and Southern Apulia were the principal mining areas. The remaining bauxite requirements were met by imports, largely from Yugoslavia and France. Italy exported about 17,000 tons of alumina to Switzerland and 8,000 tons to Austria.

Jamaica.—The first commercial production of bauxite in Jamaica occurred in 1952. Reynolds Jamaica Mines, Ltd., made its initial shipment to the United States in June and by December was exporting at the rate of over 50,000 long tons per month. Ore was mined in St. Ann Parish, about 6 miles from the new company port on Ocho Rios Bay. A drying plant near the mines removed most of the free moisture before it was carried by aerial tramway to the dock.[13] Reynolds was reported to have purchased or acquired options on 40,000 to 50,000 acres in Jamaica.

The Kaiser Bauxite Co. was almost ready to begin shipments of bauxite from Jamaica by the close of 1952. Its project had been delayed because of landslides, which damaged the railroad and other facilities. It was planned to mine the first ore in St. Elizabeth Parish and transport it over the new 13-mile private railroad to the drying and shipping facilities at Port Kaiser on Little Pedro Point.

The Aluminium, Ltd., subsidiary, Alumina Jamaica, Ltd. (formerly Jamaica Bauxites, Ltd.), was the first company to produce alumina in the Caribbean area. The alumina plant, near Mandeville, Manchester Parish, began production, using a modified Bayer process, about the end of 1952. The company planned to use the shipping facilities at Kingston until it could use its own new pier at Old Harbor Bay on the southern coast. Bauxite production for 1952 was estimated at 100,000 long tons. The total investment of Aluminium, Ltd., for all facilities was expected to reach $40 million, the largest single capital investment in the history of Jamaica.

Japan.—It was reported that the capacity of Japanese alumina plants was being expanded from 90,000 metric tons in 1951 to 112,000 tons in 1952.[14] Capacities for 1951 were given as follows: Nippon Keikinzoku K. K. (Nippon Light Metals Co.), Shimizu plant, 45,000 tons; Showa Denko K. K., Yokohama plant, 25,000 tons; and Nisshin Kagaku Kogyo (Nisshin Chemical Industry, Ltd.), Niihama plant, 20,000 tons. A proposed agreement between the Nippon Keikinzoku K. K. and Aluminium, Ltd., whereby the Canadian company would purchase stock in the Japanese company, supply additional capital and technical assistance, and ship bauxite from its holdings in Malaya or India, was approved by the Japanese Government in 1952.

Malaya.—The Ramunia Bauxite Co., which began mining in July, was the only active bauxite producer in Malaya during1952. The mining operation was in southeast Johore on the Straits of Singapore. Ore produced in 1952 analyzed 57 to 58 percent Al_2O_3 and 4.5 to 4.7 percent SiO_2. Exports went to Taiwan (Formosa) and Japan. The Ramunia Bauxite Co. planned to increase its rate of production as soon as a satisfactory settlement could be made on a title dispute for an adjoining area, containing over 2 million tons of bauxite.

[13] Knoerr, Alvin W., Reynolds Jamaica Bauxite Project: Eng. and Min. Jour., vol. 153, No. 9, September 1952, pp. 108–112.

[14] Baudart, M. G.-A., The Prospects of the Japanese Aluminium Industry: Metal Bull. 3754, Dec. 23, 1952, pp. 14–16; trans. from Revue de l'aluminium.

Surinam.—Bauxite production in Surinam, the world's largest producer, increased 18 percent from 1951 to over 3 million long tons in 1952. Canada received about 41,000 tons, and virtually all of the remainder was shipped to the United States. The Surinam Bauxite Co., a subsidiary of the Aluminum Co. of America, announced that an estimated 7 million tons of bauxite reserves was blocked out on a new discovery near Ornoribo on the Para River.

The International Bank for Reconstruction and Development recommended a 10-year program, which would cost a minimum of $53 million, for the establishment of an aluminum production industry in Surinam. A World Bank mission, sent to Surinam at the requests of the Governments of the Netherlands and Surinam, reported that there appeared to be no technical reason why economical hydroelectric power could not be developed for this purpose at Brokopondo on the Surinam River. The Surinam Government was urged to investigate the business aspects further. Surinam's mining bureau continued to survey a bauxite deposit in the Nassau Mountains during 1952.

U. S. S. R.—Official U. S. S. R. information regarding the production of bauxite, as in the case of most other commodities, was not available. One of the few reports on the U. S. S. R. printed in the trade journals during 1952 briefly discussed the growth of the aluminum industries in all of the satellite countries.[15]

Venezuela.—Two new bauxite discoveries of undetermined size were reported from Venezuela during 1952. One deposit was at Cerro La Mesa in the Upata region of Estado Bolivar near the Cerro El Chorro deposit found in 1951. The other new discovery was in the Sierra de Perija region southwest of Maracaibo near the Colombian border.

Yugoslavia.—Croatia (Istria and Dalmatia) was the principal source of the large bauxite production in Yugoslavia during 1952; however, two new mines near Bosanka and Stolac in Bosnia and Hercegovina were opened. Most of the output was exported to Germany, with Italy the only other important recipient. The small alumina plants at Lozovac and Moste were operated, and construction of the 50,000-ton-per-year Strnisce plant in Slovenia was about 75 percent completed.

---

[15] Light Metals, The Industry in the World Today: Vol. 15, No. 168, March 1952, pp. 97-100.

Beryllium

By Robert F. Griffith [1]

BERYL supply, the only commercial source of beryllium, was the largest in history in 1952. The increase was from imports; domestic production remained at about its normal level. Record-high prices and the beryl expansion program, sponsored by the Defense Materials Procurement Agency, were largely responsible for the increased supply. Even though Government and industry stocks increased during the year, there was no complacency over future supply owing to the uncertainty of continued large imports. It has been estimated that the demand for beryl in the United States will increase by 1975 to about two and one-half times the quantity consumed in 1950.[2]

A program for the purchase of beryl from small domestic producers for the National Stockpile was announced by General Services Administration on October 7.

At the year end, construction of a beryllium-copper master-alloy plant at Elmore, Ohio, neared completion. The plant will again provide the country with a second producer of this strategic material.

TABLE 1.—Salient statistics on beryl [1] in the United States, 1943–47 (average) and 1948–52, in short tons

Year	Production [2]	Imports	Total supply	Exports		Consumption	Stocks		Average price per unit BeO	
				Beryl	Metal, alloys, and compounds [3]		Industry	Government	Domestic [4]	Foreign [5]
1943–47 (average)	206	2,222	2,428	2.7	66.4	1,944	517	3,400	$15.57	$10.36
1948	99	1,720	1,819	.1	13.0	1,970	1,042	198	26.87	17.41
1949	475	3,811	4,286	.3	94.0	1,029	2,322	1,076	32.10	22.52
1950	559	4,860	5,419	.1	110.5	3,007	2,621	(6)	30.51	25.43
1951	484	4,316	4,800	.3	94.8	3,388	1,417	(6)	33.34	31.67
1952	515	5,978	6,493	1.9	[7] 196.6	3,476	2,492	(6)	38.55	38.55

1 Estimated 10 percent BeO content.
2 Mine shipments.
3 Beryl equivalent.
4 F. o. b. mine, Colorado.
5 C. i. f. United States ports.
6 Restricted.
7 Does not include an undisclosed quantity of secondary material exported to United Kingdom.

1 Commodity-industry analyst.
2 Resources for Freedom, vol. II, The Outlook for Key Commodities: U. S. Government Printing Office, June 1952, pp. 59–61.

DOMESTIC PRODUCTION

Mine Production.—Mine shipments of beryl in the United States during 1952 were the second largest on record, totaling 515 short tons. However, nearly one-fourth of this quantity was of lower grade than the generally accepted average content of 10 percent BeO.

TABLE 2.—Beryl shipped from mines in the United States, 1943–47 (average) and 1948–52, by States, in short tons

State	1943–47 (average)	1948	1949	1950	1951	1952
Colorado	(1)	(1)	144	97	97	54
New Hampshire	(1)	(1)	(1)	106	50	(1)
New Mexico	(1)		8	(1)	141	101
South Dakota	149	45	139	96	138	334
Other [2]	56	54	184	260	58	26
Total: Short tons	205	99	475	559	484	515
Value	$29,935	$26,600	$152,485	$170,550	$161,361	$233,757
Average value per ton	$146.02	$268.69	$321.02	$305.10	$333.39	$453.90

[1] Included with "Other" to avoid disclosure of individual company operations.
[2] Arizona (1949–51); Connecticut (1944, 1947); Georgia (1952); Maine (1943–44, 1947–52); Massachusetts (1943–44); North Carolina (1943–44, 1949, 1951); Virginia (1943–44); and States indicated by footnote 1.

The largest shipments recorded from one property were from the Harding mine, near Dixon, N. Mex. Shipments from this mine totaled 100 tons; of this quantity, 40 tons was reported to be subgrade, 6 percent BeO, beryl concentrate. South Dakota was by far the largest producing State, followed by New Mexico, Colorado, New Hampshire, Georgia, and Maine. The Government purchase depot at Rapid City, S. Dak., was active in obtaining beryl for the National Stockpile. Shipments from South Dakota, which included 92 tons by George C. Bland (Beecher lode), containing 8 percent BeO, accounted for nearly two-thirds of the total domestic production. Beryl production was reported by Keystone Feldspar & Chemical Co., Consolidated Feldspar Corp., John Fisher, J. A. Johnson, and eight other producers. Consolidated Feldspar Corp. was acquired by International Minerals & Chemical Corp. in December 1952.[3] Principal Colorado producers were Consolidated Feldspar Corp., from unspecified properties, and from lessees of properties controlled by Michael D. Lyons. Beryl Ores Co., Arvada, Colo., was actively engaged as a dealer in beryl ore, and this company continued to beneficiate low-grade ores and to grind beryl for use in the ceramic industry. Beryl production was reported from the Hogg mine and from the Foley mine in Georgia. A program for exploration, development, and mining of pegmatites in the Newry Mountain district, near Andover, Maine, was initiated by Beryllium Development, Inc., a wholly owned subsidiary of Beryllium Corp., Reading, Pa.[4] A large production of beryl was reported by this company from the Scotty mine on Plumbago Mountain near Bethel, Maine; however, this production was not shipped and is not included in the 1952 totals. A Reconstruction

[3] Mining World, vol. 15, No. 4, April 1953, p. 84.
[4] American Metal Market, vol. 59, No. 102, May 27, 1952, p. 1.

Finance Corp. loan of $125,000 was granted Idaho Beryllium & Mica Corp. for the production of mica and beryl from the company property at Deary, Idaho.[5] A sample shipment of 125 pounds of beryl was reported from this property in 1952. In Utah 17 beryl-bearing claims in the Sheep Rock Range, Juab and Tooele Counties, were leased by Brush Beryllium Co.[6] The beryl occurs in a large, fine-grained, granitic formation in contrast to the usual pegmatite occurrences. Exploration by diamond drilling is planned. A large beryl-bearing pegmatite dike north of Chewelah, Wash., was explored during 1952 on a property controlled by Earl Cannon and associates [7] and on Merikay mines, managed by Arthur Collins.[8] No shipments were recorded from either property. No beryl production was recorded from Arizona, California, Connecticut, North Carolina, or Virginia in 1952. Tungsten ores from the Hillside mine, Hillside, Ariz., which were reported to contain 2 to 3 percent of beryl, were investigated.

Exploration under the DMEA program resulted in the following certifications of discovery on beryl in 1952: Lewis W. Collingwood and Campbell & Ventling Mining Co., both in Custer County, S. Dak.; Beryllium Development, Inc., Oxford County, Maine; and Georgia-Carolina Mica Mining Co., Inc., Troup County, Ga.

The Small Defense Plants Administration announced December 26, 1952, that small business would be urged to expand beryl-ore production by 2,100 tons a year in the next 3 years. Small mine plants desiring to expand will be granted rapid tax writeoffs on the expansion.

Refinery Production.—The principal processors of beryl and manufacturers of beryllium products are:

Producer and plant location:	*Products*
Beryllium Corp., Reading, Pa	Beryllium-copper master alloy; beryllium-copper casting ingots, sand castings, strip, rod, wire, bar, forgings, and safety tools; beryllium-aluminum master alloy; beryllium-magnesium-aluminum master alloy, beryllium-nickel casting ingots; beryllium metal and oxide.
Beryl Ores Co., Arvada, Colo	Ground beryl; beryllium oxide and ceramic frit.
Brush Beryllium Co., Cleveland, Luckey, and Elmore, Ohio.	Beryllium-copper master alloy; beryllium-copper casting alloy ingots; beryllium-aluminum master alloy; beryllium metal and metal shapes; beryllium oxide, oxide crucibles, chemicals, and compounds.
Champion Spark Plug Co., Detroit, Mich.	Ceramics.
Lapp Insulator Co., Inc., LeRoy, N. Y.	Do.
A. O. Smith Co., Milwaukee, Wis	Do.
Ampco Metal Co., Milwaukee, Wis.	Beryllium-copper mill products.
Wilber B. Driver Co., Newark, N. J.	Do.
Riverside Metal Co., Riverside, N. J.	Do.
Slagle Beryllium Co., Darby Pa	Do.

[5] Engineering and Mining Journal, vol. 153, No. 5, 1952, p. 142.
[6] Mining World, vol. 14, No. 9, 1952, p. 95.
[7] Metal News, vol. 20, No. 3, March 1952, p. 5.
[8] Engineering and Mining Journal, vol. 153, No. 11, November 1952, p. 165.

Brush Beryllium Co. operated a Government-owned plant at Luckey, Ohio, for the Atomic Energy Commission. The commercial production facilities of the company are in a new plant at Elmore, Ohio, and fabrication work is done at Cleveland.

On November 28, 1952, Defense Production Administration Goals 195 and 196 announced objectives for expansion of production facilities for beryllium-copper alloy mill products and beryllium-copper master alloy.

CONSUMPTION AND USES

Commercial consumption of beryl in 1952 exceeded the 1951 consumption by over 100 tons. Total consumption, government and industry, was the highest in history. Although the Government was active in obtaining beryl for the National Strategic Stockpile and for the Atomic Energy Commission, there was a marked increase in the supply of beryl ore available for commercial use. The Emergency Procurement Service of the General Services Administration served as purchasing agent for the National Stockpile, and Brush Beryllium Co., Cleveland, Ohio, purchased beryl for the Atomic Energy Commission.

Beryllium has important applications in the form of an alloying element with copper, aluminum, nickel, magnesium, and iron; as beryllium oxide in the manufacture of specialized high-temperature refractory material and high-quality electrical porcelains; and as a metal in the atomic energy field as a moderator and as a reflector of neutrons, in radium-beryllium neutron sources, and in X-ray tube windows. In terms of quantity, the largest use is in the manufacture of beryllium-copper alloys. These alloys are unsurpassed in their ability to withstand fatigue and wear and at the same time conduct electrical current under high-temperature conditions. They are unique among copper-base alloys in that they can be worked in a relatively soft state and then brought to their final level of strength and hardness by simple low-temperature heat treatment. Applications include springs and contacts in tabulating machines and other electrical and electronic equipment, and use in diaphragms, bellows, and springs for aircraft air-speed indicators and altimeters, weather instruments, pressure gages, and other instruments and controls. Beryllium-copper has applications in large machine parts,[9] and beryllium-copper wire is finding increased use in a wide range of industrial applications.[10] Beryllium-copper is readily adapted to sand casting and other foundry techniques. Its ability to reproduce fine detail accounts for the successful application in pressure cast molds for plastics and precision casting. In 1952 an estimated 65 percent of all beryllium products was utilized for defense.

Beryllium oxide has a high melting point, unusual resistance to thermal shock, and thermal conductivity equivalent to that of certain metals and is an excellent electrical insulator at high temperatures. High-quality porcelains containing beryllium oxide are used for aircraft spark plugs and ultra-high-frequency insulators. Beryl is sometimes used directly in the production of high-grade dielectrics.

---

[9] Richards, John T., Beryllium-Copper Useful for Large Machine Parts: Materials and Methods, vol. 35, No. 6, June 1952, pp. 97–99.

[10] Wire and Wire Products, vol. 27, No. 2, February 1952.

In the field of refractories, beryllium oxide is used as a liner in rocket combustion chambers and small, high-temperature electric furnaces and in the fabrication of laboratory ware. Although ceramics are usually thought of as heat-insulating materials, the thermal conductivity of beryllium oxide at high temperatures is about the same as nickel and considerably better than stainless steel. Because of its excellent heat transmission, very low neutron absorption, and refractory properties, beryllium oxide has potential applications in nuclear energy power-plant design.[11]

Beryllium metal has a density of 1.84 and a melting point of 1,284° C. It is the only stable light metal with a high melting point. It is also an excellent transmitter of sound, having a sound-velocity value twice that of aluminum or steel. Advances have been made recently in production of high-purity metal and in the fabrication of large and intricate parts. The metal finds numerous applications in the atomic energy field as a moderator and as a reflector of neutrons, similar to graphite and heavy water. As a construction material in a thermal (slow-velocity neutron) reactor, beryllium metal appears promising; however, this application and its use as a moderator are limited by the high price of reactor-grade material.[12]

A bibliography on the properties of beryllium is given; the physical, electrical, optical, magnetic, chemical, mechanical, and nuclear properties are reviewed; and methods of purification and fabrication are discussed.[13]

STOCKS

Beryl stocks in the hands of commercial consumers were the second largest in history at the end of 1952, having increased over 1,000 tons during the year. Government stocks increased substantially as a result of intensified efforts by the Emergency Procurement Service and Defense Materials Procurement Agency to meet National Stockpile objectives. Stocks of beryllium alloys and compounds held by producers were considerably above the 1951 level. Quantitative data on industry stocks of beryllium products or on Government stocks of beryl are not available for publication.

Although 1952 was a year of peak consumption and a year in which Government agencies were vigorously active in obtaining beryl for the National Stockpile, industry stocks increased substantially. These factors reflect the improved supply situation; principally from increased imports.

PRICES

A program for the purchase of beryl from small domestic producers was announced October 7, 1952, by General Services Administration. Government mica-purchase depots at Custer, S. Dak., Franklin, N. H., and Spruce Pine, N. C., were authorized to buy beryl under this program. Shipments up to 500 pounds of beryl, containing not less than 8 percent BeO, are purchased on the basis of visual inspection at a flat price of $400 per short dry ton. The beryl must be in

[11] Evans, George S., Wanted, Better Materials for Nuclear Reactors: Iron Age, vol. 169, No. 11, Mar. 13, 1952, pp. 93-97.
[12] See footnote 11.
[13] Udy, Murray C., Shaw, Homer L., and Baulger, Francis W., The Properties of Beryllium: Battelle Memorial Inst., AECD-3382; BMI-T-14, July 15, 1949, declassified with deletions May 20, 1952, 154 pp.

the form of clean crystals, cobbed free of waste. Shipments of 500 pounds or more are subjected to chemical analysis if the producer desires, but the producer is required to stand the cost of analysis. Shipments accepted by sampling and chemical analysis are purchased on the basis of short ton units (20 pounds) of contained BeO as follows: 8–8.9 percent, $40; 9–9.9 percent, $45; 10 percent and over, $50. Purchases of more than 25 tons of beryl a year from individual producers must be negotiated with DMPA through GSA. The program terminates June 30, 1958, or when deliveries under the program total 1,500 short dry tons, whichever occurs first. Quotations for beryl on the commercial market soon followed closely these record high prices. E&MJ Metal and Mineral Markets quoted domestic beryl in 1952, f. o. b. mine, per unit BeO, 10–12 percent BeO, as follows: January, $34–$37; December, $45–47.50. Prices quoted for imported ore, c. i. f. United States ports, were substantially the same. Even with these record high prices domestic production of beryl remained at about the same level. It is becoming increasingly evident that high prices for beryl will not alone greatly increase domestic production.

In addition to the principal consumers of beryl listed under Refinery Production, other markets include the following dealers and importers of beryl: Leonard J. Buck, Inc., New York City; C. G. Trading Corp., 122 E. 42d St., New York City; Derby & Co., Ltd., 285 Madison Avenue, New York City; Foote Mineral Co., 18 E. Chelten Ave., Philadelphia, Pa.; General Engineering and Supply Co., 1265 Dierks Bldg., Kansas City, Mo.; W. B. Groma, New York City; Metal Traders, Inc., 67 Wall St., New York City; Metallurg, Inc., New York City; Wm. H. Muller, New York City; Pewlew-Wilson Sons & Co., Inc., New York City; Philipp Bros., Inc., 70 Pine St., New York City; South American Minerals & Merchandise Corp., New York City; C. Tennant, Sons & Co., Empire State Bldg., New York City; Varlacoid Chemical Co., New York City; Wardell-Hatch & Co., Inc., New York City; and Watson, Geech & Co., Inc., 25 Broadway, New York City.

Beryllium-copper master alloy, 4 percent Be, remained steady throughout the year at $1.56 per pound of alloy ($32 per pound of contained Be plus the market price of the contained copper). Five percent Be beryllium-aluminum and beryllium-magnesium-aluminum master alloys were quoted at $70 and $60 per pound of contained beryllium, respectively, plus aluminum at market, with no charge for magnesium. Special "50–50" master alloys were quoted at $70 per pound of contained beryllium plus base metal at market. Beryllium metal was offered as follows: Lump or pebbles (technical) $65 per pound, (premium) $85 per pound; powder (technical) $95 per pound, (premium) $103 per pound. High-fired refractory-grade beryllium oxide was quoted at $18 per pound at the beginning of the year; however, in general, prices of oxide, other compounds, and alloys were nominal, depending upon quantity and quality.

Although beryl was exempted from price control the latter part of 1951, beryllium metal, alloys, and products remained under price control during 1952.

FOREIGN TRADE

United States imports of beryl in 1952 were the highest on record, exceeding by over 1,000 tons the previous high year, 1950. Imports were about equally divided between Western and Eastern Hemispheric sources. Shipments were received from Argentina, the first since 1948, and from India for the second consecutive year since 1946. Brazil, again the principal source of supply, accounted for 43 percent of the total imports, and an equal quantity was received from combined African sources. Since 1950 Portugal has become a small but consistent source of supply. Because of increased prices, the value of beryl imports was nearly double that in the previous high-value year, 1951. An appreciable production of beryl from Madagascar is shipped to France. United States Department of Commerce records indicate that no beryllium metal, oxide, carbonate, or other forms of beryllium were imported by the United States in 1952.

Exports of beryllium ore and concentrates, metal, scrap, primary forms, and alloys (except beryllium-copper) from the United States in 1952 totaled 20,014 pounds valued at $68,474. The principal recipients were: United Kingdom, Canada, West Germany, and France. Department of Commerce classification included beryllium-copper with copper alloys in 1952; export data were not shown separately. However, 376,838 pounds of primary beryllium-copper master alloy ingots were licensed for export; shipments were principally to United Kingdom. Including secondary forms, the total estimated value of beryllium-copper alloy exports for 1952 was $700,000. Canada was the only recipient of material classed as beryllium ore and concentrates. Shipments totaled 3,723 pounds, valued at $9,563.

TABLE 3.—Beryl imported for consumption in the United States, by countries, 1946–52, in short tons

[U. S. Department of Commerce]

Country	1946	1947	1948	1949	1950	1951	1952	Total (short tons)	Percent of total
Argentina	53		55				550	658	2.9
Australia	20	45						65	0.3
Brazil	996	722	1,545	3,264	2,703	1,094	2,590	12,914	57.0
British East Africa (principally Uganda)				11	11	47	18	87	0.4
French Morocco				22	77	23	118	240	1.1
India	119					449	196	764	3.4
Japan [1]				107	17	12		136	0.6
Mozambique			55	107	130	174	308	774	3.4
Portugal					28	97	105	230	1.0
Southern Rhodesia					464	692	931	2,087	9.2
Union of South Africa (includes South West Africa)			47	290	1,401	1,722	1,156	4,616	20.4
Other countries [2]			18	10	29	6	6	69	0.3
Total:									
Short tons	1,188	767	1,720	3,811	4,860	4,316	5,978	22,640	100.0
Value	$105,708	$114,667	$299,375	$858,308	$1,235,639	$1,366,772	$2,548,423		

[1] Country of export only; ore produced principally in Brazil and Argentina before, or during World War II.

[2] 1948, Chile less than 1 ton, Hong Kong (country of export only) 18 tons; 1949, Norway 10 tons; 1950, Canada 29 tons; 1951, Finland 6 tons; 1952, Finland 3 tons; Korea, Republic of, 3 tons.

Beryl is imported into the United States free of duty; a 25-percent duty is imposed on beryllium metal and compounds. Beryllium metal, compounds, alloys, scrap, ore, and concentrates remained on the positive list of products requiring export licenses to foreign destinations (excepting Canada).

Available data indicate only two small foreign producers of beryllium-copper, although there are several mills and foundries in a number of foreign countries that process beryllium-copper alloys. Other countries depend almost entirely on the United States for their primary supply of beryllium products.

TECHNOLOGY

The recovery of beryl, the only commercial source mineral of beryllium, has been entirely by hand-sorting (cobbing) methods. Probably not more than 30 percent of the beryl present in any one deposit is recovered because fragments and crystals of beryl less than 1-inch in diameter usually are not sorted from the gangue material. Government and industry were active in 1952 in investigations to recover beryl by modern milling methods. A flotation process for recovery of beryl was developed by the Bureau of Mines at Rapid City, S. Dak.; this process has been successful on a laboratory scale.[14] To span the hiatus between laboratory and commercial mill operation, pilot-plant studies will be conducted. Metallurgical development studies for recovering fine-grained byproduct beryl from the Kings Mountain, N. C., area were initiated by the Bureau of Mines under memorandum agreement with DMPA, dated September 29, 1952.

In processing beryl to BeO and master alloy, the efficiency or recovery of beryllium metal has been on the order of 67 percent. Efforts by industry to improve the recovery ratio have resulted in a reported 11-percent increase in the recovery of BeO and an 8-percent increase in the quantity of beryllium-copper master alloy yielded from a given quantity of BeO. Beryllium-bearing residues from past operations can be recycled for partial recovery of beryllium previously lost.

Considerable attention was directed toward developing substitutes for beryllium-copper in 1952; however, no entirely satisfactory substitute was developed. The most promising material investigated was a quaternary alloy of copper, nickel, aluminum, and silicon.[15] The improved beryl supply situation has resulted in industry directing its efforts toward finding new uses for beryllium-copper rather than developing substitutes.

Beryl is often difficult to identify in the field. Four methods were described in 1952 for the field identification of beryl.[16]

---

[14] Runke, S. M., Mullen, D. H., and Cunningham, J. B., Progress Report on Pegmatite Investigations in South Dakota: Bureau of Mines Rept. of Investigations 4928, 1952, pp. 30–31.

[15] Substitutes for Beryllium Alloys: Nat. Research Council, Div. of Eng. and Ind. Research, Min. and Metals Advisory Board, Library of Congress, Publication Board Project, September 1952, 35 pp.

[16] Spector, F. D., and Brown, D. F., Simple Field Tests for Beryl: New Mexico Miner, vol. 14, No. 5, May 1952, p. 5.

Barlow, N. E., Field Tests for Beryl: South African Min. and Eng. Jour., vol. 62, No. 3077, pt. 2, Feb. 2, 1952, p. 987.

Brush Beryllium Co., Quick Spot Test for Beryllium: South African Min. and Eng. Jour., vol. 63, No. 3090, pt. 1, May 3, 1952, p. 363.

Chemical Age, Chemical Test for Beryl: Vol. 66, No. 1699, Feb. 2, 1952, p. 214.

Depending on the type of material, the beryllium content, and the equipment available, one of the following analytical methods is used for beryllium assays: Gravimetric, colorimetric, fluorometric, and spectrochemical.

Normally, gravimetric methods are used in ore analyses where speed is not a factor, where a relatively high degree of accuracy is desired on medium- to high-grade ores, and where equipment is not available for one of the other methods.[17]

A colorimetric method is used by the Brush Beryllium Co. as a rapid and reliable means of determining the BeO content of prospectors' samples. Although this method does not give as accurate results as are obtainable by several of the gravimetric types of procedure, it is nevertheless usable where a rapid and foolproof method is mandatory.[18]

A fluorometric method is used by the Atomic Energy Commission for determining the beryllium content of air in relation to health problems where a high degree of sensitivity is required.[19]

Spectrochemical (spectrographic) procedures are used for both qualitative and quantitative analyses. Quantitative analyses by this method are applicable where a large number of determinations are being made to justify the cost of the necessary equipment and the preparation of standard curves.[20]

RESERVES

United States beryllium reserves in deposits of a grade of 1.0 percent or more equivalent beryl consist of an estimated 12,000 tons of beryl in pegmatites and 3,000 tons of equivalent beryl in nonpegmatitic rocks, a total of 15,000 tons. Over 50 percent of the 12,000-ton beryl reserve in pegmatites is in South Dakota, principally in the Southern Black Hills in Pennington and Custer Counties.[21] Indicated beryl reserves in New England were increased substantially as a result of a Bureau of Mines investigation.[22] There is an estimated 270,000 tons of beryl in pegmatite deposits in the United States containing less than 1.0 percent and over 0.1 percent beryl. Of this 270,000-ton reserve, 240,000 tons are in the tin-spodumene belt of the Carolinas. Of the total reserves in pegmatite deposits, only an estimated 7,000 tons can be recovered by cobbing. This comparatively small quantity emphasizes the necessity for developing a metallurgical process to successfully beneficiate low-grade beryl ores.

---

[17] Hillebrand, W. F., Lundrell, G. E. F., Bright, H. A., and Hoffman, J. I., Applied Inorganic Analysis: John Wiley & Sons, Inc., New York, 2d ed., 1953, pp. 516–523.
Liddell, Donald M., Beryllium: Handbook of Nonferrous Metallurgy. Recovery of the Metals: McGraw-Hill Book Co., Inc., New York, 2d ed., 1945, vol. 2, pp. 66–72.

[18] Brush Beryllium Co., Estimation of the Beryllium Oxide Content in Ores by the Colorimetric p-Nitrobenzeneazoorcinol Method: 4301 Perkins Ave., Cleveland 3, Ohio. 8 pp.

[19] Welford, George, and Harley, John, Fluorometric Determination of Trace Amounts of Beryllium: Am. Ind. Hygiene Quart., December 1952.
Fletcher, M. H., White, C. E., and Sheftel, M. S., Determination of Beryllium in Ores-Fluorometric Method: Ind. Eng. Chem., anal. ed., vol. 18. March 1946, p. 179.

[20] Marks, Graham W., and Jones, Betsy M., Method for the Spectrochemical Determination of Beryllium, Cadmium, Zinc, and Indium in Ore Samples: Bureau of Mines Rept. of Investigations 4363, 1948, 27 pp.

[21] Tullis, E. L., Beryl Resources of the Black Hills, S. Dak.: Bureau of Mines Rept. of Investigations 4855, 1952, 19 pp.

[22] Newman, G. L., Bumpus Pegmatite Deposit, Oxford County, Maine: Bureau of Mines Rept. of Investigations 4862, 1952, 15 pp.

TABLE 4.—Estimated United States beryl reserves, by States, in short tons

State	Pegmatite deposits			Nonpegmatite deposits	
	1.0 percent or more beryl	0.1 percent or more beryl	Cobbable beryl	1.0 percent or more equivalent beryl	0.1 percent or more equivalent beryl
Arizona				300	1,100
Colorado	1,400	3,500	1,300		100
Connecticut		2,100	50		
Idaho	100	400	100		
Maine	2,700	3,800	1,250		
Nevada		300			100
New Hampshire	600	1,100	500		
New Mexico	600	600	400	3,000	4,500
South Dakota	6,000	16,000	3,000		
Wyoming	100	200	50		
North and South Carolina (tin-spodumene belt)		240,000			
Total	11,500	268,000	6,650	3,300	5,800

The principal beryllium reserves in nonpegmatitic deposits are in tactite at Iron Mountain, N. Mex. Although these reserves are large, the beryllium industry is not adapted to the use of this type of ore. A large potential beryl reserve has been reported in the Sheeprock Mountains, Tooele County, Utah. The beryl occurs as small crystals disseminated throughout a granite stock over an area of about 1 square mile. The rock must be milled to recover the beryl. Insufficient data are available to include this deposit in reserves.

Reserves of beryl in foreign countries are not known with any degree of certainty. A value for world reserves has been calculated by assuming that the ratio between United States and world production should be the same as the ratio that exists between United States and world reserves. By using this factor, a world total of 210,000 tons of 1.0 percent ore and 3.8 million tons of 0.1 percent ore is obtained. The major sources of 1.0 percent ore are Brazil, 95,000 tons; Argentina, 31,000 tons; South Africa, 19,000 tons; Southern Rhodesia, 13,000 tons; India, 13,000 tons; Madagascar, 7,000 tons; and Australia, 6,000 tons. The principal sources of 0.1 percent ore are Brazil, 1.7 million tons; Argentina, 560,000 tons; South Africa, 350,000 tons; Southern Rhodesia, 230,000 tons; India, 230,000 tons; Madagascar, 120,000 tons; and Australia, 100,000 tons.

WORLD REVIEW

Argentina.—Five hundred metric tons of beryl was purchased from Argentina Trade Promotion Institute (IAPI) by Minerales & Metales Co. for shipment to the United States, the first exports to the United States since 1948. These exports came from an 8-year accumulation of beryl by IAPI, during which exports were not permitted; therefore, these shipments cannot be taken as a measure of production. The production rate is estimated to be about 30 metric tons per month.

TABLE 5.—World production of beryl, by countries,[1] 1946–52, in metric tons [2]

[Compiled by Lee S. Petersen]

County [1]	1946	1947	1948	1949	1950	1951	1952
Afghanistan					7	2	
Argentina	130	10	[3] 50				[3] 498
Australia	19	54	56	36	23	114	91
Brazil (exports)	1, 294	1, 027	1, 783	3, 078	2, 625	1, 533	2, 523
Canada					[3] 26		
Chile			([3] [4])				([5])
France			2	([5])	([5])	([5])	([5])
French Morocco			51	211	56	84	129
India	112	([5])	([5])	([5])	([5])	215	([5])
Korea, Republic of	([5])	([5])				([5])	([4])
Madagascar	([5])	([4])	9	27	486	530	395
Mozambique	22	81	16	136	264	230	140
Northern Rhodesia					5	4	8
Norway				[3] 9		([5])	([5])
Portugal	([5])		[6] 10	3	52	102	78
Southern Rhodesia				23	846	1, 007	1, 076
South-West Africa	5	52	90	239	659	753	536
Tanganyika			[7] 2	1			([5])
Uganda		18	44	34	71	2	3
Union of South Africa				223	844	593	375
United States (mine shipments)	91	132	90	431	507	439	467
Total (estimate)	1, 700	1, 430	2, 470	4, 587	6, 651	5, 720	6, 530

[1] In addition to the countries listed, beryl has been produced in a number of countries for which no production data are available; except for U. S. S. R., their aggregate output is not significant.
[2] This table incorporates a number of revisions of data published in previous beryl chapters.
[3] United States imports.
[4] Less than 0.5 ton.
[5] Data not available; estimates by author of the chapter included in total.
[6] Estimate.
[7] Exports.

Brazil.—Beryl-bearing pegmatites were discovered in the northern part of the State of São Paulo. Crystals about 1 foot in width were found in Bairro dos Pimentas, 3 miles from the city of São Luiz do Paraitinga.[23] A plant for producing beryllium oxide was scheduled to begin production in 1952. Located at Resende on the Paraiba River in the State of Rio de Janeiro, the plant is to be operated by Proberil, S. A., which was organized in São Paulo and financed by Brazilian and American capital. Initial annual production capacity is stated to be 90 tons of beryllium oxide. Beryl from the State of Minas Gerais will be processed. Deposits also are found in the States of Baia, Rio Grande do Norte, and Paraiba. Sulphuric acid used in the process is made at Barra Mansa in Minas.[24]

Canada.—Beryl-bearing pegmatites in Renfrew County, Ontario, were described,[25] and a beryl discovery in the Las La Hache district, British Columbia, was reported.[26]

France.—Pechiney (Compagnie de Produits Chemiques et Electrometallurgiques) processes beryl in France. The company has two ore-processing plants in the Province of Savoie—one at St. Jean de Maurienne, to produce beryllium-copper alloys; the other at Mauri-

[23] Mining World, vol. 14, No. 4, April 1952, p. 59.
[24] Metal Bulletin (London), No. 3683, Apr. 8, 1952, p. 21.
[25] Graham, A. D., Mineralogy, Internal Structure, and Genesis of Beryl Pegmatites, Renfrew County, Ontario: M. A. Thesis, 1952, Queen's University, Kingston, Ontario.
[26] Mining Record, vol. 63, No. 44, Oct. 30, 1952, p. 5.

enne, to produce beryllium metal. Beryl also, reportedly, has been stockpiled by the Government. Sources of ore are Madagascar, French Morocco, Brazil, and India. A small quantity of beryl has been produced from a mine near La Vedrenne, north of Minoges.

French Morocco.—The entire production of beryl came from the Angarf mine of Sociéte des Mines des Zenaga; 142 short tons were produced. Exports to the United States were 118 short tons and to France, 22 tons.[27]

Germany.—Heraeus-Vacuumschmelze, A. G., at Hanau a/Main processes beryl to master alloys. The capacity is reported to be small.

India.—Beryl is produced in Madras State from the mica mines at Saidapuram, from near Pattalai, or Padiyur, in the Coimbature district, and from the Nellore district.

Madagascar.—Exports of beryl in 1952 were 309 metric tons; France was the principal recipient. Production was largely by Marc Rollet from mines in the Malakialina area, near Fitampito.

Mozambique.—Beryl production was from Empresa Mineira do Alto Ligonha. A beryl discovery was reported from Mocuba, Zambesia Province.

Norway.—Beryl deposits occur in southern Norway; at Asedammen near the Swedish border; in the Evje-Iveland district; and in the Landbo-Gjerstad area. Some of the deposits have been worked; however, for the most part they can be developed economically only in conjunction with the sale of byproduct minerals.

Southern Rhodesia.—Beryl production has increased steadily since the initial production in 1949. Principal producing districts are Bikita tin fields, Salisbury Enterprise tin field, Miami mica field, and the Mtoko district.

Spain.—A beryl discovery in the La Coruna Province in northwestern Spain was reported.[28]

Surinam.—Exploration was conducted on beryl-bearing pegmatites near Rama, on the Surinam River, and in an area bordering the Marowijn River.

Union of South Africa (includes South-West Africa).—Since 1949, South Africa has become an important source of beryl. Production was at its peak in 1950 and 1951. The 1952 production declined approximately 35 percent, principally because of the depletion of known surface ores.

United Kingdom.—In England, Mallory Metallurgical Products, Ltd., (Wembley, Middlesex), Telegraph Construction & Maintenance Co., Ltd., (Greenwich), and the Beryllium Smelting Co., Ltd. (London) produced beryllium-alloy products from master alloys imported from the United States.

---

[27] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 3.
[28] Mining World, vol. 14, No. 4, April 1952, p. 52.

Bismuth

By Abbott Renick[1]

IN 1952 domestic refinery production of bismuth declined 5 percent compared with 1951. The domestic supply[2] of bismuth metal, however, was virtually unchanged from 1951 owing to larger imports. Exports of bismuth metal during 1952 increased 67 percent above the 1951 figure, and the United Kingdom again received the major portion. Stocks of refined metal held by domestic producers were 7 percent higher on December 31, 1952, than at the end of 1951.

Peru continued in 1952 to be the largest foreign producer of refined metal, supplying 93 percent of the total imports of the United States.

The New York market price of metallic bismuth remained through the year at $2.25 per pound in ton lots, unchanged since September 5, 1950.

DOMESTIC PRODUCTION

Most of the bismuth produced in the United States is obtained as a byproduct from smelting domestic and foreign lead ores and by refining imported bismuth bars containing lead as a major impurity. The Bureau of Mines is not at liberty to divulge the quantities produced, but 1952 output declined 5 percent compared with 1951.

Companies reporting output of refined bismuth metal in 1952 were American Smelting & Refining Co., at Omaha, Nebr., and Perth Amboy, N. J.; Anaconda Copper Mining Co., at Anaconda, Mont.; and United States Smelting Lead Refinery, Inc. (subsidiary of United States Smelting, Refining & Mining Co.), at East Chicago, Ind. The Cerro de Pasco Corp., at its Brooklyn, N. Y., plant, is the principal domestic producer of bismuth alloys; the bismuth metal used is obtained from the company lead smelter at La Oroya, Peru.

CONSUMPTION AND USES

Demand for bismuth, particularly in the form of refined metal, was firm in 1952. Its use in pharmaceuticals was the lowest on record, reflecting the continuing trend toward the antibiotics and kaolin-base preparations that have replaced bismuth compounds to some extent since World War II.

[1] Commodity-industry analyst.
[2] Opening stocks plus domestic refinery production plus imports minus exports minus year-end stocks.

Effective January 15, all limitations on the use of bismuth were withdrawn by the National Production Authority; because the bismuth producing and consuming industry successfully met the needs of the defense program, Order M-48 was revoked on May 15, 1952.

TABLE 1.—Bismuth metal consumed in the United States in 1951–52, by uses

Use	1951 [1]		1952	
	Pounds	Percent of total	Pounds	Percent of total
Pharmaceutical	569, 600	36	406, 800	23
Solder	100, 200	6	145, 900	8
Fuse alloys	186, 800	12	261, 700	15
Manufacturing alloys	513, 400	32	871, 400	49
Other and unspecified alloys [2]	222, 000	14	89, 200	5
Total consumption	1, 592, 000	100	1, 775, 000	100

[1] February through December only; compiled by National Production Authority, U. S. Department of Commerce.
[2] Principally rectifier coatings.

TABLE 2.—Percentage distribution of bismuth in the United States 1948–52, by major use groups

Use group	1948	1949	1950	1951	1952
Pharmaceuticals	49	31	36	36	23
Metal and alloys [1]	51	69	64	64	77

[1] Principally fabricating alloys but includes pure metal, ammunition solder, fuse alloys, aluminum alloys and other minor compositions.

STOCKS

Producers' inventories of refined metal at the end of 1952 increased 7 percent above those at the end of 1951. Consumers' stocks of bismuth were 9 percent less than at the end of 1951.

The Munitions Board Stockpile Report to the Congress on February 15, 1953, stated that bismuth was one of the 18 commodities for which the stockpile objective had been met as of December 31, 1952.

PRICES

The New York price for refined bismuth metal remained unchanged at $2.25 per pound in ton lots throughout 1952, according to the E&MJ, Metal and Mineral Markets. The Metal Bulletin (London) quotation for high-purity metal, per pound, 2 cwt. minimum, on January 4 was 28s. (equivalent to $3.92), subsequent fluctuations being recorded as follows: June 6, 21s. ($2.94); December 30, 17s. 6d. ($2.45). Bismuth ore, per pound of contained metal c. i. f., was quoted on December 30, 1952, at 9s. 9d. ($1.37) for 65 percent minimum bismuth content, scaling downward to 2s. 6d. ($0.35) for ore containing less than 20 percent bismuth.

FOREIGN TRADE[3]

Imports.—Receipts of refined metal in 1952 showed a rise of 38 percent above 1951. The approximate percentage distribution of receipts by countries of origin was: Peru 93, Yugoslavia 5, and Korea 2 percent. There were no transactions in chemical compounds, mixtures and salts of bismuth in 1952.

Exports.—Exports of bismuth and alloys increased 67 percent in 1952. The United Kingdom was again the principal recipient, taking 208,200 pounds. Australia received 11,200 pounds; West Germany, 9,700 pounds; and Canada, 2,500 pounds. Exports of bismuth salts and compounds totaled 233,200 pounds, valued at $741,300.

TABLE 3.—Bismuth metal and alloys imported into and exported from the United States, 1943–47 (average) and 1948–52

[U. S. Department of Commerce]

Year	Imports of refined[1] metallic bismuth		Exports of metal and alloys	
	Pounds	Value	Pounds	Value
1943–47 (average)	386,444	$418,692	107,161	$158,789
1948	299,824	464,733	352,027	711,354
1949	541,852	833,940	190,882	356,576
1950	781,670	1,287,098	199,253	387,458
1951	514,020	1,003,285	146,998	376,246
1952	708,254	1,451,729	244,797	635,260

[1] Excludes imports of bismuth contained in bismuth-lead bars from Mexico; also excludes imports of bismuth contained in concentrates.

TECHNOLOGY

The United States Naval Ordnance Laboratory reported[4] that—

A permanent magnet of high coercive force and maximum energy product was prepared and designated Bismanol. Compacts were prepared of the finely pulverized intermetallic compound MnBi which exhibits permanent-magnet characteristics and was chosen because it has the highest recorded magnetic crystal anisotropy constant. Some of these pressed magnets showed a maximum energy product as high as 2.9×10^6 gauss-oersteds, a coercive force of 3,100 oersteds, and a residual flux density of 3,400 gauss. Only the high-Co and the Pt-Fe alloys exceed this material in maximum energy product; no known material has a higher coercive force. Bismanol may be valuable as a substitute for magnets requiring Co and for special applications requiring high coercive force.

High-chromium steel's resistance to attack by liquid bismuth alloys was the subject of a report. The report[5] states that—

The use of bismuth alloys in heat-transfer applications depends on the selection of suitable constructional materials to contain them. Investigation of the rate of attack of bismuth-lead alloys on such materials indicates that nickel and high-nickel alloys, copper and copper alloys, and cobalt alloys are unsuitable as containers.

Among the steels, the high-chromium alloys are more resistant than the nickel-chromium materials as a general rule. Little information has been available on the rates of attack of other bismuth alloys.

[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.
[4] United States Naval Ordnance Laboratory, Bismanol: Navord Rept. 2440, May 20, 1952, 15 pp.
[5] Materials and Methods, vol. 34, No. 4, October 1951, pp. 112–114.

The dynamic corrosion of graphite by liquid bismuth was the subject of another report relating to the use of bismuth in heat transfer applications. The authors stated: [6]

> No corrosion or mass transfer of graphite by bismuth was observed when the liquid metal was circulated by means of thermal convection in an all-graphite system. A calculated linear velocity of approx. 7 in./sec. was maintained for a period of 279 hr. at a max. temp. of 1,400° C. and a min. temp. of 875° C. No metallographic evidence of solution of graphite in bismuth was found and measurement of the inside diameter of the tubes before and after operation showed no change of dimension. No indication of penetration of the graphite by bismuth was found.

WORLD REVIEW

Canada.—The Consolidated Mining & Smelting Co. of Canada, Ltd., Trail, B. C., continued during 1952 in its position as Canada's largest producer. Some shipments of bismuth oxychloride were made by the Molybdenite Corp. of Canada, Ltd., from its operations at La Corne, Quebec.

Peru.—The world's largest producer of refined bismuth metal was the Cerro de Pasco Corp., as a byproduct of its copper- and lead-smelting operations at Oroya.

South Korea.—Bismuth occurs as the mineral bismuthinite in the tungsten ores of the San Dong mine, South Korea. Bismuth production increased from 13 metric tons in 1951 to 99 tons in 1952.

United Kingdom.—Bismuth ores and residues were smelted and refined by Capper Pass & Son, Ltd., Bristol, and Mining & Chemical Products, Ltd., London.

Yugoslavia.—The mines formerly operated by Trepca Mines, Ltd., are now one of the world's main bismuth producers. Production increased from 88 metric tons in 1951 to 99 tons in 1952.

[6] Hallet, W. J., and Coultas, T. A., Dynamic Corrosion of Graphite by Liquid Bismuth: Nuclear Science Abs. vol. 6, No. 22, Nov. 30, 1952, p. 773.

TABLE 4.—World production of bismuth, 1947–52, by countries,[1] in kilograms [2]

[Compiled by Pauline Roberts]

Country	1947	1948	1949	1950	1951	1952
North America:						
Canada (metal) [3]	128,988	108,971	46,680	86,918	104,461	81,745
Mexico (in impure bars)	256,000	154,000	249,000	263,000	338,000	304,952
United States	(4)	(4)	(4)	(4)	(4)	(4)
Total	(4)	(4)	(4)	(4)	(4)	(4)
South America:						
Argentina:						
Metal	[5] 22,000	(6)	(6)	(6)	(6)	(6)
In ore	[5] 20,000	(6)	(6)	(6)	(6)	(6)
Bolivia (in ore and bullion exported)[7]	88,964	35,142	8,222	24,443	69,081	(6)
Peru:						
Metal	233,794	205,861	215,707	226,851	262.655	320,000
In lead-bismuth alloy	3,043	47,225	2,398			(6)
Total [5]	369,000	289,000	228,000	254,000	335,000	323,000
Europe:						
France (in ore)	55,000	56,000	59,000	78,000	(6)	(6)
Spain (metal)	21,172	24,269	19,854	11,344	15,180	(6)
Sweden	10,998				(6)	(6)
Yugoslavia (metal)	42,700	51,100	38,100	60,531	87,760	98,700
Total	255,000	256,000	272,000	305,000	[5] 390,000	[5] 420,000
Asia:						
China (in ore)	(6)	(6)	[5] 5,000	(6)	(6)	(6)
Japan (metal)	22,862	23,327	25,946	33,049	42,010	44,000
Korea, South		104,000	173,420	(6)	12,500	98,500
Total [5]	28,000	135,000	204,000	54,000	85,000	200,000
Africa:						
Belgian Congo (in ore)	815	456	540	668	225	[5] 700
South-West Africa (in ore) [5]			500	7,200	100	(6)
Uganda		3,963	7,519	3,658	2,896	[5] 1,000
Union of South Africa (in ore)		437	5,045	7,649	3,184	[5] 1,000
Total	815	4,856	[5] 14,000	[5] 19,000	[5] 6,000	[5] 4,000
Australia (in ore) [8]	4,369	4,064	660	914	1,372	1,700
World total (estimate)	1,500,000	1,500,000	1,500,000	1,400,000	1,700,000	1,800,000

[1] Bismuth is believed to be produced also in Brazil, Germany, Rumania, U. S. S. R., and United Kingdom. Production figures are not available for these countries, but estimates by author of chapter are included in total.
[2] This table incorporates a number of revisions of data published in previous bismuth chapters
[3] Refined metal plus bismuth content of bullion exported.
[4] Production included in total; Bureau of Mines not at liberty to publish separately.
[5] Estimate.
[6] Data not available. Estimate by author included in total.
[7] Excludes bismuth content of tin concentrates exported.
[8] Partly estimated. Excludes content of some bismuth-tungsten concentrates.

Boron

By Joseph C. Arundale [1] and Flora B. Mentch [2]

THE UNITED STATES remained the world's largest producer of boron minerals and compounds; all domestic production comes from California. After rising to a record level in 1951, sales of boron compounds by primary producers dropped sharply at the end of 1951, and total volume in 1952 was 583,828 short tons valued at $14,105,000. It was reported that consumers were reducing stocks built up during 1950 and 1951.

There was increasing interest in the use of boron in steels, thereby effecting a substantial saving in scarce alloying materials, such as chromium, nickel, and molybdenum. The Bureau of Mines made progress during the year in its study of high-temperature electric furnace techniques for making hard and refractory borides and related compounds and fabricating them into useful components.

TABLE 1.—Salient statistics of boron minerals and compounds in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Sold or used by producers:[1]						
Short tons:						
Gross weight	358, 556	450, 932	467, 592	647, 735	862, 797	583, 828
B_2O_3 content	111, 880	134, 700	139, 200	191, 000	241, 000	169, 100
Value [2]	$8, 407, 287	$11, 147, 735	$11, 511, 893	$15, 890, 000	$20, 030, 000	$14, 105, 000
Imports for consumption (refined):						
Pounds	[3] 20, 754	3, 056	886	[4] 1, 224	1, 424	[5] 860
Value	[3] $1, 056	$1, 503	$435	[4] $416	$497	[5] $306
Exports:						
Short tons	48, 478	70, 940	109, 491	142, 580	213, 445	103, 292
Value	$2, 461, 552	$4, 075, 049	$6, 862, 928	$8, 301, 081	$13, 322, 383	$6, 723, 925
Apparent consumption: Short tons [6]	310, 088	379, 994	358, 101	505, 167	649, 353	480, 536

[1] Borax, anhydrous sodium tetraborate, kernite, boric acid, and colemanite.
[2] Partly estimated.
[3] In addition, 525 pounds of crude valued at $7 in 1943.
[4] In addition, 21,286 pounds of crude valued at $200.
[5] In addition, 88 pounds of crude valued at $2.
[6] Quantity sold or used by producers plus imports minus exports.

DOMESTIC PRODUCTION

Boron minerals production in the United States in 1952 was confined to California. Five firms reported production of boron compounds from natural sources. American Potash & Chemical Corp., 3030 West 6th St., Los Angeles 54, Calif., recovered boron compounds from the brines of Searles Lake at Trona, Calif. Pacific Coast Borax Co., 630 Shatto Pl., Los Angeles 5, Calif., mined kernite (hydrous sodium borate) from a bedded deposit at Boron in the

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.

Kramer district. A portion of this material was refined at the mine and the remainder at the firm's plant at Wilmington, Calif. A subsidiary of this firm, United States Borax Co., produced colemanite (hydrous calcium borate) from a vein deposit near Shoshone, Calif. West End Chemical Co., 608 Latham Square Bldg., Oakland 12, Calif., recovered boron compounds from the brine of Searles Lake. Columbia-Southern Chemical Corp. produced borax in Inyo County, Calif.

Companies producing boron alloys and related compositions are as follows:

Producer	*Products*
American Electro Metal Corp., Yonkers, N. Y.	Miscellaneous metal borides; experimental.
F. W. Berk Co., Inc., Wood-Ridge, N. J.	Boron.
Cooper Metallurgical Associates, Cleveland, Ohio	Boron; borides of Zr, Ta, W, Ti, Cr, Th, Mo, Cb, Al; cobalt boron; aluminum boron; lithium boron; copper boron; aluminum-titanium boron; boron nitride.
Electro Metallurgical Division, Union Carbide & Carbon Corp., Niagara Falls, N. Y.	Ferroboron, manganese boron, nickel boron, cobalt boron, Silcaz, calcium boride, boron carbide.
Metal Hydrides, Inc., Beverly, Mass	Borohydrides of sodium, lithium, beryllium, and other elements.
Molybdenum Corp. of America, Washington, Pa.	Ferroboron, manganese boron, cobalt boron, chromium boron, calcium boride.
Niagara Falls Smelting & Refining Division, Continental-United Industries, Inc., Buffalo, N. Y.	Manganese-aluminum boron, nickel-aluminum boron.
Norton Co., Worcester, Mass	Boron carbide, boron, ferroboron.
Ohio Ferro-Alloys Co., Philo, Ohio	Borosil.
Titanium Alloy Mfg. Division, National Lead Co., Niagara Falls, N. Y.	Carbortam.
U. S. Atomic Energy Commission, Oak Ridge, Tenn.	Boron isotopes B–10 and B–11.
Vanadium Corp. of America, Bridgeville, Pa.	Grainal alloys.

CONSUMPTION AND USES

The record volume of purchases in 1950 and 1951 resulted in the accumulation of larger than normal stocks in the hands of some consumers and in 1952 these stocks were being reduced. There was no indication that the decreased volume of sales during 1952 meant a greatly decreased rate of consumption. However, the ceramics industry accounts for an estimated half of the consumption of borax, and there was a slight decrease in volume of production of certain ceramic materials, such as enamel, tile, and pottery.

A list of boron-treated-type steels was published. The list indicates some of the applications in which boron steels reportedly have substituted successfully for the more highly alloyed grades.[3]

These applications include core wire for electric cables, propeller blades, bolts and cap screws, and gears, shafts, pinions, springs, and forgings in the automotive, aircraft, truck, and tractor industries.

Boron in steel assumes an importance out of proportion to the quantity of boron actually used. Only a few thousandths of 1 percent by weight of such steel is boron. In 1952 only a little over 24 short tons of boron was used in making over 700,000 tons of steel.

[3] Materials and Methods, vol. 35 ,No. 2, February 1952, pp. 127–129.

TABLE 2.—Consumption of alloying metals in the manufacture of steel in the United States, 1949–52 [1]

	Pounds of named alloying metal contained			
	1949	1950	1951	1952
Boron	(2)	(2)	[3] 29,594	48,973
Chromium	148,442,803	247,649,084	305,289,694	278,085,534
Cobalt	991,645	2,949,118	2,581,689	2,633,413
Columbium	632,051	752,121	826,621	340,871
Manganese	(2)	(2)	(2)	930,541,611
Molybdenum	11,243,780	17,242,931	19,069,143	16,530,769
Nickel	51,882,941	79,135,137	75,914,210	84,854,360
Titanium	4,222,221	4,932,319	5,202,645	4,909,339
Tungsten	2,170,483	3,929,779	3,783,382	2,650,147
Vanadium	1,079,024	1,825,831	3,310,898	3,050,586
Zirconium	1,440,141	1,834,977	1,783,443	1,449,282

1 American Iron and Steel Institute, Annual Statistical Report: New York, N. Y., 1952, p. 17.
2 Not available.
3 Revised.

TABLE 3.—Production of alloy-steel ingots (other than stainless steel ingots) in the United States, net tons [1]

Grade	1951 total	1952		
		Without boron	With boron	Total
Nickel	92,505	29,811		29,811
Molybdenum	436,787	223,053	143,024	366,077
Manganese	288,826	281,193	26,010	307,203
Manganese-molybdenum	294,563	189,221	6,223	195,444
Chromium	1,484,578	1,329,789	99,503	1,429,292
Chromium-vanadium	139,012	101,154	10	101,164
Nickel-chromium	116,450	88,565	25,857	114,422
Chromium-molybdenum	890,313	1,187,435	4,405	1,191,840
Nickel-molybdenum	155,036	146,092	13,085	159,177
Nickel-chromium-molybdenum	2,206,461	1,388,068	316,502	1,704,570
Silico-manganese	116,543	99,963		99,963
All other	870,178	582,038	27,517	609,555
Subtotal	7,091,252	5,646,382	662,136	6,308,518
High-strength steels	905,747	796,758	40,739	837,497
Silicon sheet steels	1,064,456	940,666		940,666
Total all grades	[2] 9,061,455	7,383,806	702,875	8,086,681

1 American Iron and Steel Institute, Annual Statistical Report: New York, N. Y., 1952, p. 45.
2 Includes 372,131 tons with boron.

The California State Water-Pollution-Control Board has set a temporary upper limit for boron in waste water at 1 p. p. m. Above 1 p. p. m. symptoms similar to those caused by a calcium deficiency are said to occur in plants. A water survey of Ventura County was being conducted by the State Division of Water Resources. This survey may result in revision of the maximum allowable boron content of waste water.

About 2 million pounds of borax is said to be used each year by California citrus packers to prevent decay in fresh fruit. About 7 percent stays on the treated fruit. Treating tanks are emptied periodically (at intervals ranging from once a season to once every 10 days), and fresh solutions are put in. Packing wastes run as high as 6,000 p. p. m.

Four methods have been proposed for coping with the problem: (1) Collecting rinse water for haulage to safe disposal areas; (2) construction of disposal lines running to the ocean; (3) concentration of rinse water for reuse; and (4) development of other processing materials or techniques.

One research laboratory has experimented with a vapor treatment, using trimethyl borate. Laboratory results reportedly are promising, but conversion to this method would be costly. It is not generally agreed that boron must be eliminated from packing wastes. Examination of wells is said to have shown no correlation between boron content and proximity to packing houses. Other factors to be considered are the natural boron content of indigenous streams and the type of soil in the drainage basin. Experiments with boron weed-killer compounds have shown that it takes 5 to 10 times as much boron to kill weeds in clay soils as in sandy soils.

Twenty-six packing plants in Ventura County are reported to have hired a research laboratory to find a substitute for borax for this purpose or a method for reducing to 1 p. p. m. the quantity of boron in their waste water.[4]

Boron trichloride has been found effective in extinguishing magnesium fires in heat-treating and annealing furnaces. It is convenient to use because it vaporizes readily and is therefore easily applied. It acts essentially to smother the fire by limiting access of oxygen to the burning metal. It is therefore best adapted to use in reasonably tight enclosures such as the furnaces mentioned above. Much of the experience with this material to date on magnesium fires has been experimental. Suggested procedures for using boron trichloride for such a purpose were outlined in an article.[5]

PRICES

According to Oil, Paint and Drug Reporter the following prices for boron compounds were quoted during 1952:

Borax, Tech., anhydrous, bags, C. L., works, ton	$74. 50
Ton lots, ex warehouse, New York or Chicago	120. 25
Crystals, 99½ percent, bags, C. L., works	63. 75
Ton lots, ex warehouse, New York or Chicago	109. 50
Granular, 99½ percent, bags, C. L., works	37. 75
Ton lots, ex warehouse, New York or Chicago	83. 50
Powder, bags, C. L., works	42. 75
Ton lots, ex warehouse, New York, or Chicago	88. 50

Borax packed in kegs is $45.50 per ton higher than borax packed in paper bags. U. S. P. borax, $15 per ton higher than tech. There was no change in the price of borax during 1952.

Boric acid, tech., 99½ percent:	
Crystal, bags, C. L., works	$120. 75
Ton lots, ex warehouse, New York or Chicago	166. 50
Granular, bags, C. L., works	95. 75
Ton lots, ex warehouse, New York or Chicago	141. 50

U. S. P., $25 per ton higher. The price of boric acid did not change during 1952.

FOREIGN TRADE[6]

The United States supplies much of the world's requirements for boron compounds. Shipments of various boron compounds were made to nearly every country in the World except U. S. S. R. and satellite countries, as shown in table 4.

[4] Chemical Week, vol. 70, No. 25, June 21, 1952, pp. 35, 36, 38.
[5] Foundry, Extinguishing Magnesium Fires with Boron Trichloride, vol. 80, No. 8, August 1952, pp. 257–259.
[6] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

In 1952 only 88 pounds of crude borates valued at $2 was imported (from Chile) into the United States, and 860 pounds of refined borates valued at $306 was imported (from United Kingdom). In 1952, 31,365 pounds of boron carbide valued at $46,518 was imported from Canada.

TABLE 4.—Exports of boric acid and borates, crude and refined from the United States in 1952, by countries of destination

Country	Pounds	Value
Australia	4, 560, 136	$168, 055
Austria	2, 246, 577	50, 544
Belgium-Luxembourg	3, 357, 517	130, 794
Brazil	4, 158, 482	144, 599
British Malaya	40, 000	1, 069
British West Indies	15, 000	2, 229
Canada	21, 310, 945	826, 704
Ceylon	37, 632	2, 425
Chile	15, 000	3, 120
Colombia	868, 720	39, 770
Costa Rica	60, 354	2, 682
Cuba	763, 215	28, 375
Denmark	732, 365	18, 929
Dominican Republic	34, 068	3, 316
Ecuador	20, 500	1, 304
Egypt	428, 632	12, 159
El Salvador	12, 932	1, 290
Finland	187, 826	7, 842
France	19, 217, 002	586, 484
Germany, West	31, 862, 274	844, 108
Greece	386, 647	10, 020
Honduras	26, 100	1, 692
Hong Kong	2, 988, 832	91, 276
India	669, 893	49, 336
Indonesia	28, 820	1, 144
Iran	384, 600	10, 464
Ireland	1, 968, 960	64, 939
Israel-Palestine	154, 024	8, 506
Italy	5, 159, 510	164, 484
Japan	7, 144, 054	228, 449
Mexico	4, 272, 128	200, 366
Netherlands	23, 696, 405	703, 512
New Zealand	1, 199, 616	40, 490
Nicaragua	69, 100	8, 510
Norway	969, 789	39, 436
Pakistan	892, 456	46, 098
Panama	42, 074	1, 320
Peru	259, 914	10, 000
Philippines	892, 979	43, 083
Portugal	1, 357, 270	57, 951
Southern Rhodesia	215, 754	11, 581
Spain	2, 018, 160	49, 493
Sweden	5, 064, 596	154, 110
Switzerland	1, 017, 269	38, 375
Taiwan	579, 700	22, 067
Thailand	35, 435	1, 806
Trinidad and Tobago	18, 270	1, 245
Union of South Africa	1, 544, 406	74, 312
United Kingdom	53, 010, 457	1, 682, 831
Uruguay	142, 033	5, 336
Venezuela	172, 227	12, 444
Yugoslavia	192, 770	7, 528
Other countries, under $1,000	81, 244	5, 923
Total	206, 584, 669	6, 723, 925

TECHNOLOGY

A report on boron steels prepared by the Panel on Substitution of Alloying Elements in Engineering Steels of the Minerals and Metals Advisory Board was submitted to the Research and Development Board, United States Department of Defense. In this report it was pointed out that approximately 5 percent of the engineering alloy steel produced contained boron, and therefore boron steels can now be regarded as having progressed beyond the experimental stage. The engineering and technical data that supported this rapid expansion were acquired largely during the past 10 years by research and development done by steel consumers, steel producers, the manufacturers of ferroalloys, and others. This work is being continued. These groups concentrated their efforts on determining the mechanical properties of the boron steels and their behavior in fabricating and heat-treating processes. The panel expressed the opinion that the present development programs have progressed to the extent that the use of boron steels could be broadened to include many additional applications on the basis of established equivalent hardenability. The panel felt, however, that conservation of alloying elements would be achieved more rapidly by placing emphasis on research and development projects dealing with specific properties and applications of the boron steels. The panel recommended 29 research projects (some of which are in progress or contemplated) on the hardenability of boron steels; stress distribution in quenched and tempered steels; the properties of boron steels, the same steel without boron, and higher alloy nonboron steels with equivalent hardenability; and fundamental research, as well as substitutes or materal that alternates for boron.[7]

The Department of the Air Force initiated a program to evaluate some of the boron-treated low-alloy steels that showed the most promise of being satisfactory substitutes for high-alloy steels. It was desired to gain information on the susceptibility to temper brittleness, low-temperature impact, fatigue, and other properties of the boron-treated low-alloy steels in the range of 0.30 to 0.45 percent carbon, which is of vital interest to the aircraft industry.

A steel of American Iron and Steel Institute Specification 80B30 was selected as a possible substitute for AISI4130 and AISI8630. One heat of 80B30 was thoroughly tested in all conditions. It was found that where Charpy impacts of 10 to 20 foot-pounds are considered adequate 80B30 can be used, except in the normalized condition down to −100° F. At high strength-levels 80B30 shows as good impact values as either AISI4130 or AISI8630, but in the 125,000- to 150,000-p. s. i. strength range the older steels are better. This heat was susceptible to temper brittleness.[8]

A number of special features regarding boron steels were summarized as follows:

1. More boron is required in the lower carbon grades to obtain the maximum hardenability effect.
2. Too much boron may cause the steel to become hot short. In high-carbon steels, this maximum is about 0.005 percent boron; in low-carbon grades, the maximum is 0.008 percent boron.
3. The effect of boron on hardenability decreases with increasing carbon up to about 0.90 percent carbon. Above this carbon level, boron has no further effect on hardenability.
4. More distortion is likely in heat treating carburized boron steels.
5. Boron is generally effective when the steel is in the liquid quenched condition.
6. Boron steels become embrittled when drawn above 540° C. (1,000° F.).
7. More precise control in heat treating is required with boron steels than with those with high alloy content.

---

[7] Panel on Substitution of Alloying Elements in Engineering Steels of the Minerals and Metals Advisory Board, National Research Council, National Academy of Sciences: Recommended Research Projects on Boron Steels: Rept. MMAB-11-M, Washington, D. C., Mar. 12, 1953, 6 pp.

[8] Imhoff, Lt. R. N., and Poynter, James W., How Good is 80B30?: Iron Age, vol. 169, No. 26, June 26, 1952, pp. 102–107.

Some additional advantages, other than increased hardenability, were reported: [9]

1. In substituting AISI1035 boron-treated steel for AISI4140 for cold-headed bolts, the following advantages were realized:
(*a*) Greater die life;
(*b*) Fewer split heads;
(*c*) Greater die life for dies used on the rolled threads;
(*d*) Entire production increased by the use of lower alloy steel which is softer in the annealed condition.
2. In large sections, flakes and shatter cracks are either absent or seldom occur in boron-treated steels. This is not necessarily due to the boron addition, but to the fact that less nickel, chromium, and molybdenum are usually present in the steel.
3. When heated, boron steels acquire a loose, flaky type of scale rather than the tightly adhering scale usually obtained when, for example, a 3½-percent nickel steel is used. Hot-forming problems, therefore, are considerably simplified when boron steel is used.
4. Boron steel normally contains less molybdenum and chromium than the grade for which it is substituted. These elements tend to form stable carbides; hence, the use of boron steel permits the use of lower tempering temperatures and shorter annealing times.

In the United States, when boron has been added to alloy steels, it usually has been done to obtain equivalent properties in lower alloy steels and thereby conserve scarce materials. However, in studies made in England by United States Steel Cos., Ltd., boron was added to obtain high ultimate tensile strength and yield values in steel in the as-rolled or normalized condition.[10] In a series of tests on 0.05 carbon steel the effect of boron on the mechanical properties in the presence of 0.15 percent molybdenum was negligible. Tensile strength and yield strength increased progressively with increase in molybdenum. At 0.44 percent molybdenum, ultimate tensile strength had increased 48 percent and yield more than doubled. Further increase in molybdenum content had no significant effect. A second series, steels with 0.14 percent carbon, had similar characteristics. The effect of increasing boron in the presence of 0.5 percent molybdenum was found to be beneficial up to about 0.007. Beyond this figure ultimate tensile strength and yield decreased to low values. Boron did not improve low-carbon steels containing respectively, 0.6 percent nickel, up to 1.5 percent chromium, and 0.07 percent and 0.1 percent vanadium. Tests were also conducted on a 1.0-percent manganese-molybdenum-boron steel of variable molybdenum content, on 2.0-percent nickel steels of varying molybdenum content, and on chromium-molybdenum steels. The best low carbon steel from the point of high ultimate tensile strength and yield point was that containing over 0.35 percent molybdenum with about 0.003 percent boron. The lower limit of effective boron was also studied in these tests.

An investigation was conducted to develop low-alloy steels for use where short-life periods are permissible, such as in jet or rocket engines. It was found that boron, nitrogen, and titanium increased the high-temperature strength of ferritic steels. The preparation of a promising titanium–boron steel, its heat treatment, properties, and welding characteristics were discussed in an article.[11]

[9] Gertsman, S. L., Substitution for Strategic Metals in Steel Production: Canada Dept. of Mines and Tech. Surveys, Ottawa, Feb. 1, 1952, pp. 9-11.
[10] Bardgett, W. E., English Use Boron in Normalized and Drawn Heavy Sections: Iron Age, vol. 169, No. 2, Jan. 10, 1952, pp. 81-84.
[11] Everhart, John L., New Titanium-Boron Alloy Steel Shows Promise for Jets and Rockets: Materials and Methods, vol. 36, No. 3, September 1952, pp. 96-98.

Basic data on boron steels published during the year included discussions of the criteria for selecting the various boron steels; the effects of heat-treating and case-hardening on their properties;[12] hardenability of some of the new boron steels; new steel compositions to conserve critical alloying elements;[13] techniques in the hardening of a plain carbon-boron steel to assure surface hardness over a tough core;[14] the results of research by industry on the properties of the new boron steels;[15] the treatment of boron steels and the advantages and limitations of available steels;[16] the effect of carbon on boron steel behavior.[17]

The preparation of diborane from lithium hydride or lithium aluminum and boron trifluoride etherates under different conditions was described. The reactions were shown to proceed through two stages. First a lithium borohydride is formed which reacts with additional trifluoride to yield diborane and lithium fluoride.[18]

A patent was granted on a lignin–phenolic-borate tanning material claimed to be suitable for use as a replacement for vegetable tannins.[19]

Boron nitride has been used as a thermal insulator in induction vacuum furnaces, as a mold wash in the manufacture of high-tension insulators, and as a coating for refractory supports in automatic welding; a number of other uses have been proposed. The history of boron nitride was reviewed in an article; the chemical, physical and electrical properties were tabulated, and a procedure for producing boron nitride of high purity, and a method of analyzing was described.[20]

The molybdenum–boron system was investigated. The raw material and preparation were described, phase diagrams prepared, and the structure and properties of these borides discussed.[21]

A project conducted at the Bureau of Mines Electrometallurgical Laboratory at Boulder City, Nev., had as its objective the study of high-temperature electric-furnace techniques for making hard and refractory borides and related compounds and fabricating them into useful components. Test lots were made of the borides of zirconium, chromium, iron, titanium, tungsten, cobalt, nickel, and manganese.

[12] Knowlton, H. B., Hardenability as the Criterion for Selecting Boron Steels: Materials and Methods, vol. 35, No. 3, March 1952, pp. 84–87.

[13] Materials and Methods, vol. 35, No. 3, March 1952, pp. 121, 123.

[14] Van Camp, George, Induction Hardening Boron-Steel Gears: Materials and Methods, vol. 36, No. 5, November 1952, pp. 121–122.

[15] Ruhnke, Donald H., Boron Steels Supplement Scarce Nickel, Moly Alloys: Steel, vol. 130, No. 2, January 14, 1952, pp. 66, 69, 70, 72, 75.

[16] d'Arcambal, Alexander H., Alloy Conservation; Boron Fills the Bill: Steel, vol. 130, No. 7, Feb. 18, 1952, pp. 107, 108.

[17] Jameson, A. S., Carbon Content Determines Boron-Steel Behavior: Steel, vol. 131, No. 15, Oct. 13, 1952, pp. 154–156.

[18] Elliott, J. R., Boldebuck, E. M., and Roedel, G. F., Preparation of Diborane from Lithium Hydride and Boron Trihalide Ether Complexes: Jour. Am. Chem. Soc., vol. 74, No. 20, Oct. 20, 1952, pp. 5047–5052.
Shapiro, I., Weiss, H. G., Schmich, M., Skolnik, Sol, and Smith, G. B. L., Preparation of Diborane by the Lithium Aluminum Hydride–Boron Trifluoride Reaction: Jour. Am. Chem. Soc., vol. 74, No. 4, Feb. 20, 1952, pp. 901–905.

[19] Balon, Walter J. (assigned to E. I. du Pont de Nemours & Co.), Lignin-phenolic-borate tanning material, U. S. Patent 2,600,606, June 17, 1952.

[20] Finlay, Gordon R., and Fetterley, Guy H., Boron Nitride—an unusual Refractory: Am. Ceram. Soc. Bull., vol. 31, No. 4, April 1952, pp. 141–143.

[21] Steinetz, Robert, Binder, Ira, and Moskowitz, David, System Molybdenum–Boron and Some Properties of the Molybdenum–Borides: Jour. Metals, Trans. Am. Inst. Min. and Met. Eng., vol. 4, No. 9, September 1952, pp. 983–987.

WORLD REVIEW

Although California is the present largest source of borates, large deposits occur in other countries. Ulexite is found in South America in Argentina, Bolivia, Chile, and Peru; priceite in Turkey; sassolite in Italy; stassfurtite in Germany; and tincal in Tibet. Ulexite has been found recently in Iran. High-grade boron minerals and boron in solution are found in Inder Lake between the Caspian Sea and the city of Uraljak.

Production of boracite in Turkey in 1952 was reported as 13,730 metric tons as compared with 12,015 metric tons in 1951. Exports of boracite from Turkey in 1952 were 12,161 metric tons as compared with 12,552 tons in 1951.[22]

Production of boric acid in Italy in 1952 was reported to be 4,352 metric tons.[23]

[22] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 5, November 1953, p. 40.
[23] American Embassy, Rome, Italy, State Department Despatch 2621, May 29, 1953.

Bromine

By Joseph C. Arundale [1] and Flora B. Mentch [2]

THE NEARLY 184,000,000 pounds of bromine and bromine compounds sold by primary producers in the United States during 1952 was the largest volume of sales ever recorded. As the production of motor fuels increased, the production of ethylene dibromide soared to meet the demand for this compound as an ingredient of gasoline antiknock additive. This and the increasing interest in bromine compounds as soil, seed, and food fumigants were the most significant developments in the bromine industry during the year.

DOMESTIC PRODUCTION

Bromine production in the United States was begun about 1846, but was of scientific interest only, until the 1860's. By that time medicinal and photographic uses had been developed. Germany and the United States were in active competition for the market until the First World War. A requirement for bromine in war gases was added to the other demands, and domestic production from brine-processing plants along the Ohio River increased to nearly 2,000,000 pounds annually. The next impetus to the industry was in the 1920's, when a mixture of tetraethyl lead and ethylene dibromide was introduced as a gasoline antiknock compound. The ethylene dibromide is added to prevent the lead from depositing on the cylinders, valves, and spark points of the motor. Additional supplies rapidly were made available from well brines in Ohio, Michigan, and West Virginia. In 1924 the cruise of the S. S. *Ethyl*, a floating chemical research plant, demonstrated the feasibility of extracting bromine from sea water, and this inexhaustible source soon was furnishing the bulk of domestic supplies.

Bromine is produced in the United States from sea water, well brines, and saline lake brine. Ethyl-Dow Chemical Co. recovers bromine from sea water at Freeport, Tex., and Westvaco Chemical Division of Food Machinery and Chemical Corp. operates a sea-water plant in the San Francisco Bay area. The following firms recover bromine from well brines in Michigan: The Dow Chemical Co., Midland and Ludington; Great Lakes Chemical Corp., Filer City; Michigan Chemical Corp., Eastlake and St. Louis; and Morton Salt Co., Manistee. Pomeroy Salt Co. at Minersville, Ohio, and Westvaco Chemical Division at South Charleston, W. Va., also treat well brines. American Potash & Chemical Corp. recovers bromine from the brine of Searles Lake in California.

The Dow Chemical Co. was completing a program of expansion which involved drilling additional brine wells and disposal wells and additional facilities for recovering bromine and manufacturing bro-

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.

mine compounds. Michigan Chemical Corp. was rehabilitating additional facilities at Eastlake, Mich., acquired from Rademaker Chemical Corp.

TABLE 1.—Bromine and bromine in compounds sold by primary producers in the United States, 1943–47 (average) and 1948–52

Year	Pounds	Value	Year	Pounds	Value
1943–47 (average)	79,373,366	$15,402,730	1950	98,502,300	$18,794,978
1948	76,047,551	14,825,470	1951	129,563,073	26,179,556
1949	88,725,709	16,267,908	1952	156,201,577	30,639,292

TABLE 2.—Bromine and bromine compounds sold by primary producers in the United States, 1951–52

	Pounds		Value
	Gross weight	Bromine content [1]	
1951			
Elemental bromine	6,420,016	6,420,016	$1,312,409
Sodium bromide	1,005,685	780,915	278,500
Potassium bromide	3,287,821	2,207,773	897,511
Ammonium bromide	401,300	327,381	128,016
Other, including ethylene dibromide	141,275,259	119,826,988	23,563,120
Total	152,390,081	129,563,073	26,179,556
1952			
Elemental bromine	6,692,418	6,692,418	1,273,659
Sodium bromide	909,637	706,333	261,582
Potassium bromide	2,663,940	1,788,836	708,424
Ammonium bromide	(2)	(2)	(2)
Other, including ethylene dibromide	173,452,068	147,013,990	28,395,627
Total	183,718,063	156,201,577	30,639,292

[1] Calculated as theoretical bromine content present in compound.
[2] Included with "Other, including ethylene dibromide."

CONSUMPTION AND USES

Only a small portion of the output of bromine is sold as liquid elemental bromine. About 90 percent is consumed as ethylene dibromide, the bulk of which is added to antiknock compounds containing tetraethyl lead. More automobiles with engines of higher compression ratios are being operated, and motorists are consuming more and better gasoline. Expanding aircraft production and miles flown increase the demand for higher grade fuel.

This draws attention to two factors in the outlook for the bromine industry. Will better automotive-engine performance be gained by higher octane fuels with more or better additives, or will it come from engines of new design using today's fuels, or even lower grade fuels? Will the trend from reciprocating to jet engines reduce the requirement for high-grade gasoline? The answers to these questions are important to the bromine industry.

In the chemical industry bromine is important in both the organic and inorganic fields. It has many medicinal and pharmaceutical uses, such as in disinfectants and anesthetics.

In the photography industry, silver bromide is an important constituent of photographic film. It is reported to be used in the manufacture of dyes, ink, resins, and leather and rubber products. The Military Establishment has used bromine in poisonous gases. Ethylene dibromide and methyl bromide are useful soil fumigants in the control of nematodes and soil insects. This use is increasing. Bromide mixtures are used as fumigants to protect foodstuffs from infestation by insects. Potassium bromate reportedly is used in breadmaking. Colors made with bromine compounds are used in lipsticks. Some home permanent-wave kits are said to contain bromine compounds as neutralizers. Bromine is, moreover, used in water sterilization and in sanitation.

PRICES

Soon after the technology of bromine production from brine was developed, the price declined and in 1880 was about 25 cents a pound. Since then the wholesale price for bulk elemental bromine has remained at about that price (with fluctuations during the two World Wars). According to Oil, Paint and Drug Reporter, prices for bromine and the principal bromine compounds were unchanged during 1952. Purified bromine in cases, freight allowed, east of the Rockies or in lead-lined drums delivered, was quoted at 25 cents per pound. Potassium bromide, U. S. P., was quoted at 34 cents per pound and sodium bromide, U. S. P., at 34 to 35 cents per pound.

FOREIGN TRADE [3]

With domestic capacity adequate to the needs of United States consumers, imports of bromine and bromine compounds were negligible. A total of 2,394 pounds of bromine and bromine compounds valued at $12,064 was imported, 2,340 pounds of which came from United Kingdom and the remainder from Canada, West Germany, France, and Australia.

A total of 2,789,749 pounds of bromine, bromides, and bromates valued at $1,436,311 was exported. A little over 2 million pounds of this went to Brazil; the remainder was shipped in smaller lots to about 46 different countries.

TECHNOLOGY

Bromine is a corrosive liquid that is volatile at room temperature. Both the liquid and the vapor irritate the skin, eyes, and mucous membranes. Inhalation of the vapor can cause injury to the respiratory tract. The hazards in handling bromine can be minimized if precautionary measures are taken. Recommended safeguards and personal protective equipment were outlined and described in a pamphlet.[4] Some of the precautions suggested are: Avoid contact of bromine with skin, eyes, and clothing; avoid inhaling vapor; wear protective clothing, such as rubber gloves and goggles; provide

[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

[4] Manufacturing Chemists Assocation, Properties and Essential Information for Safe Handling and Use of Bromine: Washington, D. C., Chemical Safety Data Sheet SD-49, 1952, 15 pp.

ventilation in areas where vapors may accumulate; and observe all regulations regarding containers and their loading, unloading, shipping, and storage.

On May 12 the Food and Drug Administration, Federal Security Agency, issued definitions and standards of identity for several types of bread. Potassium bromate was defined as an optional ingredient, and the Standard designated that it must be named on the label. The Standard specifies that the total quantity of potassium bromate (including the potassium bromate in any bromated flour used) is not more than 0.0075 part for each 100 parts by weight of flour used.[5]

Methyl bromide fumigation for destroying pink bollworm larvae was authorized by the United States Department of Agriculture for treating sacked cottonseed in 1946 and for bulk cottonseed in storage tanks in 1948. A method for fumigating bulk cottonseed in freight cars, developed between 1945 and 1951, was described in a paper. The problem to be solved in developing this method was that of attaining satisfactory distribution of methyl bromide throughout the cottonseed. In the method finally adopted, a portable blower pulls air from beneath the load through a specially designed duct system and returns it to the space above the load. The blower is run during gas volatilization and for 2 to 10 minutes thereafter, then disconnected and the cars sealed. The dosage schedule is 7 pounds per 1,000 cubic feet for 24 hours exposure at 60° F. or above and 8 pounds at lower temperatures. This method for treating cottonseed was authorized for use on quarantined cottonseed in February 1950 in a limited area under supervision. In July 1950 this forced-circulation method was authorized as an alternate method for treating cottonseed.[6]

A patent was issued on a process for recovering bromine from Searles Lake brine. To the brine from which sulfide has been removed silver chloride is added in excess of the stoichiometric equivalent of bromide ion to precipitate silver chloride and silver bromide. The precipitate is removed and treated with chlorine gas which decomposes the silver bromide to silver chloride and an effluent gas consisting of bromine and chlorine. This gaseous mixture is chemically treated to remove the bromine and the chlorine is recycled.[7]

A patent was issued on a method for improving the growth characteristics of plants, which consists of introducing into the soil around the plant a solution of ethylene bromide in water, the ethylene bromide being supplied in quantity equal to 1.125 to 18.0 pounds per 100 cubic yards of soil wetted by the solution.[8]

[5] Federal Security Agency, Food and Drug Administration, Bakery Products, Definitions and Standards Under the Federal Food, Drug, and Cosmetics Act: Service and Regulatory Announcements, Food, Drug, and Cosmetic No. 2, part 17, May 12, 1952, 6 pp.

[6] Phillips, G. L., Methyl Bromide Fumigation of Cottonseed in Freight Cars for the Destruction of Pink Bollworms: U. S. Department of Agriculture, Agricultural Research Admin., Bureau of Entomology and Plant Quarantine, E-838, June 1952, 16 pp.

[7] Lindstaedt, Frank F., and Shatto, David L., Process of Removing Bromine From Brine: U. S. Patent 2,622,966, Dec. 23, 1952.

[8] Kagy, John F., and McPherson, Robert R. (assigned to Dow Chemical Co.), Plant-Growth Improvement: U. S. Patent 2,596,929, May 13, 1952.

WORLD REVIEW

Israel.—The potash works at the southern tip of the Dead Sea was expected to resume activity in the summer of 1953. With resumption of potash extraction, it reportedly is planned to recover bromine compounds as well. Satisfactory laboratory tests on bromine utilization in the textile and cellulose industries are said to have been completed.[9]

[9] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 3, March 1953, pp. 29, 37–38.

342070—55——16

Cadmium

By Robert L. Mentch[1]

THE OUTSTANDING feature of the cadmium industry in the United States in 1952 was importation of a record quantity of low-price metal, which displaced a substantial portion of domestic cadmium in the domestic market and brought about a large increase in stocks. Imports totaled 1,479,000 pounds, over 16 times the quantity imported in 1951 and nearly doubled the previous record high import figure of 1937. Metal producers, compound manufacturers, and distributors had 1,867,000 pounds of metallic cadmium on hand on December 31 compared with year-end stocks of 1,123,000 pounds in 1951. Increased production at United States plants contributed to the large expansion in total supplies. Apparent consumption of primary cadmium, including significant Federal Government purchases for the National Stockpile, increased 26 percent to 9,042,000 pounds in 1952. Nevertheless, supply from all sources exceeded total distribution, including exports, by 639,000 pounds. The market price for commercial sticks declined from $2.55 a pound to $2.00 during the year.

The National Production Authority cadmium conservation order, invoked January 1, 1951, to restrict the use of cadmium almost exclusively to the production of war goods or essential civilian products, was revoked on May 15, 1952, because defense orders were not as large as had been anticipated and production and accumulated stocks were deemed adequate for all purposes.

TABLE 1.—Salient statistics of the cadmium industry in the United States, 1943–47 (average) and 1948–52, in pounds of contained cadmium

	1943–47 (average)	1948	1949	1950	1951	1952
Production (primary)	8,121,956	7,775,657	8,226,617	9,190,394	8,311,337	8,567,159
Imports (metal)	36,390	9,809	157,204	630,109	90,065	1,478,770
Exports (metal)	250,169	955,701	566,135	352,927	606,233	300,918
Consumption, apparent	7,919,832	7,797,105	7,486,274	[1] 9,545,502	[1] 7,170,930	9,042,052

[1] Revised figure.

DOMESTIC PRODUCTION

The entire domestic supply of primary cadmium is recovered concurrently with the treatment of ores of other metals as a byproduct from the flue dusts of zinc-blende roasting furnaces and lead blast furnaces, from zinc dust collected in the early stages of distillation in zinc retorts, and from the high-cadmium precipitate obtained in purifying zinc electrolyte at electrolytic zinc plants. A relatively

[1] Commodity-industry analyst.

small quantity of secondary metal is recovered from old bearings and other alloys but constitutes no great proportion of the total supply. It is estimated that about 50 percent of the primary cadmium metal produced in the United States is of foreign origin, obtained from imported flue dust and imported zinc ores and concentrates. Mexico is the chief source of the foreign cadmium-bearing raw materials, followed by Canada and Peru.

The output of primary metallic cadmium at domestic plants increased 3 percent in 1952, while the production of primary compounds (cadmium content) decreased 9 percent. Recovery of cadmium in secondary metal and compounds declined 52 percent.

TABLE 2.—Cadmium produced and shipped in the United States, 1943–47 (average) and 1948–52, in pounds of contained cadmium

	1943–47 (average)	1948	1949	1950	1951	1952
Production:						
Primary:						
Metallic cadmium	7,798,005	7,582,961	8,023,616	8,849,690	8,114,238	8,387,824
Cadmium compounds [1]	323,951	192,696	203,001	340,704	197,099	179,335
Total primary production	8,121,956	7,775,657	8,226,617	9,190,394	8,311,337	8,567,159
Secondary (metal and compounds) [1 2]	160,323	121,159	384,398	427,052	167,957	80,000
Shipments by producers:						
Primary:						
Metallic cadmium	7,770,004	7,639,113	7,867,486	8,851,835	7,767,055	7,746,361
Cadmium compounds [1]	329,171	192,696	203,001	340,704	197,099	179,335
Total primary shipments	8,099,175	7,831,809	8,070,487	9,192,539	7,964,154	7,925,696
Secondary (metal and compounds) [1 2]	171,599	121,159	384,398	427,052	87,633	122,785
Value of primary shipments:						
Metallic cadmium	$7,513,152	$12,679,571	$14,813,382	$17,925,482	$19,397,411	$17,130,966
Cadmium compounds [3]	345,088	319,875	381,642	689,926	492,215	396,581
Total value	7,858,240	12,999,446	15,195,024	18,615,408	19,889,626	17,527,547

1 Excludes compounds made from metal.
2 Bureau of Mines not at liberty to publish figures separately for secondary cadmium compounds.
3 Value of metal contained in compounds made directly from flue dust or other cadmium raw materials (except metal).

A list of plants producing cadmium metal in the United States in 1952 follows.

Primary metallic cadmium

Colorado: Denver—American Smelting & Refining Co.
Idaho:
- Bradley—Bunker Hill & Sullivan Mining & Concentrating Co.
- Kellogg—Sullivan Mining Co.

Illinois:
- Depue—New Jersey Zinc Co.
- East St. Louis—American Zinc Co. of Illinois.

Missouri: Herculaneum—St. Joseph Lead Co.
Montana: Great Falls—Anaconda Copper Mining Co.
Oklahoma:
- Bartlesville—National Zinc Co., Inc.
- Henryetta—Eagle-Picher Co. (Mining & Smelting Div.)

Pennsylvania:
- Donora—United States Steel Corp. (American Steel & Wire Div.)
- Josephtown—St. Joseph Lead Co.
- Palmerton—New Jersey Zinc Co. (closed in February).

Texas: Corpus Christi—American Smelting & Refining Co.
Utah: International—International Smelting & Refining Co.

Secondary metallic cadmium

Arkansas: Jonesboro—Arkansas Metals Co.
Kansas: Coffeyville—Sherwin-Williams Co.
New York: Whitestone, L. I.,—Neo-Smelting & Refining Co.

Output of cadmium oxide (cadmium content) increased less than 1 percent during the year, while the cadmium content of sulfide produced decreased 6 percent. Data for the production of other cadmium compounds are largely unavailable.

TABLE 3.—Cadmium oxide and cadmium sulfide produced in the United States, 1943–47 (average) and 1948–52, in pounds

Year	Oxide		Sulfide [1]		Year	Oxide		Sulfide [1]	
	Gross weight	Cd content	Gross weight	Cd content		Gross weight	Cd content	Gross weight	Cd content
1943–47 (average)	472, 454	412, 672	2, 170, 858	773, 114	1950	579, 538	505, 336	4, 383, 943	1, 570, 522
1948	334, 859	291, 847	3, 137, 035	1, 096, 770	1951	606, 369	528, 645	3, 118, 413	955, 742
1949	570, 993	497, 876	2, 631, 888	999, 386	1952	608, 236	531, 018	2, 665, 955	898, 629

[1] Includes cadmium lithopone and cadmium sulfoselenide.

CONSUMPTION AND USES

The apparent consumption of primary cadmium in all forms totaled 9,042,000 pounds in 1952, as computed by adding production and net imports of metal and adjusting for producers', distributors', and compound manufacturers' stock changes. This figure represented a 26-percent increase over the quantity apparently consumed in 1951. In 1952, as in the previous 4 years, cadmium metal in substantial quantities was purchased by the Federal Government for the National Stockpile. About 95 percent of the cadmium consumed is used in electroplating, bearing alloys, and pigments. The remaining 5 percent goes into solders, miscellaneous alloys, laboratory reagents, and photographic chemicals.

Electroplating.—The principal use of cadmium metal is as a protective coating for iron and steel and, to a much smaller extent, for copper-base alloys and other metals and alloys.

Although data on the distribution of consumption by end uses are not available, it is believed that the use of cadmium for plating in 1952 was considerably lower than during World War II and pre-Korea periods. The underlying cause for this fluctuation in demand is the relative ease with which cadmium can be replaced by zinc and other protective coatings.

In 1950 and 1951, when cadmium was in short supply and restrictions on uses were invoked, many platers used substitutes for cadmium wherever possible; in 1952, when the supply was plentiful, they were reluctant to change back to cadmium for fear of the possibility of recurrent shortages.

Cadmium Bearing Alloys.—The second-largest use of cadmium is as a bearing alloy. Cadmium-base bearing metals are used successfully in internal-combustion engines for service under high pressures and temperatures and at high speeds. The bearing alloys are generally of two types—the cadmium-nickel bearing, composed of 98.5

percent or more cadmium and 1.2 percent nickel, and the cadmium-silver bearing, containing 98.3 percent or more cadmium, 0.7 percent silver, and 0.6 percent copper. "Graphalloy," a cadmium-impregnated graphite containing 30 to 35 percent cadmium, is used in oilless bearings, bushing linings, and for electrical purposes, chiefly brushes and contacts for controller switches.

Cadmium Solders and Other Cadmium Alloys.—Relatively small quantities of cadmium metal are used in the manufacture of low-melting-point alloys (chiefly tin-lead-cadmium, lead-tin-bismuth-cadmium, and zinc-lead-cadmium) for soldering and brazing and fusible alloys, composed largely of lead, bismuth, and cadmium, for sprinkler apparatus, fire-detector systems, and valve seats for high-pressure gas containers.

Cadmium-Nickel Batteries.—A potentially large use of cadmium is in nickel-cadmium storage batteries. A standard European-type battery contains about 7 pounds of cadmium, but models containing only about 1.4 pounds have been manufactured in the United States. The ultimate utilization of cadmium in batteries is difficult to predict. Production of the battery, however, has not been large since its introduction in the United States after World War II.

Cadmium Compounds.—Compounds of cadmium have a wide variety of uses. Cadmium sulfide and cadmium sulfoselenide are standard agents for imparting high-quality yellow and red colors, respectively, to paint, soap, rubber, glass, ceramic glazes, paper, textiles, artists' colors, luminescent colors, leather, printing ink, and other products. Virtually all the cadmium oxide, hydrate, and chloride produced is used in electroplating solutions. Cadmium bromide, chloride, and iodide are used in photographic films, process engraving, and lithographing. A table listing the more important cadmium compounds, their physical properties, and uses can be found in the Cadmium chapter of Minerals Yearbook, 1949 (pp. 187–188).

STOCKS

Total domestic stocks of cadmium metal and compounds, excluding consumers' stocks, for which data are not available, increased 49 percent. Details are given in table 4.

TABLE 4.—Cadmium stocks at end of year, 1951–52, in pounds of contained cadmium [1]

	1951 [2]			1952		
	Metallic cadmium	Cadmium compounds	Total cadmium	Metallic cadmium	Cadmium compounds	Total cadmium
Metal producers (primary)	859,630		859,630	1,501,093		1,501,093
Compound manufacturers	58,111	246,555	304,666	189,482	225,460	414,942
Distributors [3]	205,415	78,657	284,072	176,738	58,554	235,292
Total stocks [4]	1,123,156	325,212	1,448,368	1,867,313	284,014	2,151,327

[1] Excludes cadmium in National Stockpile.
[2] Figures partly revised.
[3] Comprises principally 8 largest dealers and producers of plating salts.
[4] Excludes consumers' stocks, which were about 1,000,000 pounds at the end of 1944 (latest date for which figures were compiled).

PRICES

The quoted New York price of $2.55 a pound for commercial sticks of cadmium, established December 1, 1950, continued in effect through May 14, 1952. On May 15 the price for sticks declined to $2.25 a pound and that for special platers' shapes dropped from $2.80 a pound to $2.40. Effective August 1, quotations for sticks and platers' shapes fell to $2.00 and $2.15 a pound, respectively. On November 28, 1 domestic producer lowered its selling price for commercial sticks to $1.50 a pound, subsequently raising it to $1.75 on December 18. Other sellers adhered to the $2.00-per-pound basis during this period.

In the London market the quotation for cadmium ranged from 18s. 9d. ($2.62) to 10s. 9d. ($1.50) per pound during the year. In general, price changes followed those in the United States market.

FOREIGN TRADE [2]

Total imports (for consumption) of metallic cadmium and cadmium contained in flue dust increased 105 percent in weight and 95 percent in value in 1952. The total value of exports, principally metal, decreased 55 percent from 1951.

Imports.—The United States imported a record quantity of cadmium metal in 1952, over 16 times the 1951 total and nearly 9 times the 1946–51 average. Of the 1,479,000 pounds received, Belgium-Luxembourg supplied 81 percent, Japan 18 percent, and Canada and West Germany small quantities. Imports of flue dust (cadmium content), preponderantly from Mexico, were 24 percent greater than in 1951.

Exports.—Exports of cadmium, principally in metallic form, from the United States in 1952 totaled 301,000 pounds compared with metal exports of 606,000 pounds in 1951. Shipments to European Recovery Program "participating countries" accounted for approximately 92 percent of the total. Of the quantity exported, the United Kingdom received 56 percent, France 27 percent, West Germany and Canada 4 percent each, Mexico 2 percent, and 17 other countries the remaining 7 percent.

---

[2] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 5.—Cadmium metal and flue dust imported for consumption in the United States, 1950–52, by countries

[U. S. Department of Commerce]

Country	1950		1951		1952	
	Pounds	Value	Pounds	Value	Pounds	Value
METALLIC CADMIUM						
Australia	7,918	$21,528	9,627	$30,962		
Belgium-Luxembourg	143,825	518,552	52,870	209,246	1,195,186	$2,152,950
Canada	237,494	472,322	3,336	11,684	10,080	13,104
Egypt	1,240	2,292				
Germany, West					6,083	10,666
Italy	4,400	10,120				
Japan	194,745	368,084	18,808	70,813	267,421	449,806
Netherlands	34,205	95,031	5,402	21,466		
New Zealand	2,264	6,722				
Peru	3,010	6,624				
Sweden			22	111		
United Kingdom	1,008	2,621				
Total metallic cadmium	630,109	1,503,896	90,065	344,282	1,478,770	2,626,526
FLUE DUST (CD CONTENT)						
Canada					2,506	6,645
Mexico	1,601,640	1,519,104	1,606,775	2,261,390	1,984,831	2,429,495
Peru					4,212	10,742
Total flue dust	1,601,640	1,519,104	1,606,775	2,261,390	1,991,549	2,446,882
Grand total	2,231,749	3,023,000	1,696,840	2,605,672	3,470,319	5,073,408

TABLE 6.—Cadmium exported from the United States, 1950–52, by kinds, in gross weight

[U. S. Department of Commerce]

Kind	1950		1951		1952	
	Pounds	Value	Pounds	Value	Pounds	Value
Dross, flue dust, residues, and scrap			200,579	$10,029	300,918	$1,005,370
Metal	352,927	$794,540	606,233	2,198,311		
Alloys	9,106	11,575	5,639	9,311		
Total		806,115		2,217,651		1,005,370

Tariff.—Action taken at the Geneva Trade Conference of 1947 reduced, as of January 1, 1948, the import duty on cadmium metal from 7½ cents per pound as established in the Canadian Trade Agreement of 1939 to 3¾ cents per pound. Cadmium contained in flue dust remained duty free in 1952.

TECHNOLOGY

Metallurgy.—Investigations [3] conducted by the Bureau of Mines, to develop methods and determine conditions under which metallic sulfides with lower boiling points than sphalerite might be removed from zinc sulfide concentrates by volatilization, showed that it is possible to remove over 90 percent of the lead, cadmium, and germanium as an enriched sublimate. A higher percentage of extraction of these metals than is common in current practice was sought.

Lead sulfide, cadmium, and germanium, presumably also as sulfides, were successfully removed from Tri-State zinc concentrates by

[3] Kenworthy, H., and Absalom, J. S., Separation of Lead, Cadmium, and Germanium Sulfides from Zinc Sulfide Concentrates, Bureau of Mines Rept. of Investigations 4876, 1952, 7 pp.

volatilization. Although 0.5 to 3 percent of the zinc was also volatilized, the volatile product was greatly enriched in lead, cadmium, and germanium. The experiments were performed over a temperature range of 700° to 1,050° C. Volatilizations were made in a partial vacuum, in an inert atmosphere, and in a reducing atmosphere, with highest extractions attained in experiments utilizing the partial vacuum and the reducing atmosphere.

Continuation of the investigations is being directed toward separating the fumed sulfides of cadmium, germanium, and lead by selective volatilization.

Uses.—In addition to its major uses, cadmium occupies an important place in nuclear physics, where it is employed to control the fissionable elements in reactors. Its specific use in nuclear physics was disclosed under terms of an agreement among the United States, Canada, and the United Kingdom to make public scientific discoveries that have no military value.[4] In describing construction of what was termed the smallest reactor yet built, its center was said to be a hollow sphere about 10 inches in diameter filled with water and about 12 pounds of dissolved uranium.

The sphere itself is covered with a layer of beryllium oxide and is enclosed in the center of a 5-foot cube of graphite. The graphite, in turn is enclosed, respectively, in cadmium 1/32-inch thick, in lead 4 inches thick, and finally in concrete 5 feet thick. The whole forms a cube with 15-foot sides.

Of the dissolved uranium, nearly 2 pounds is uranium–235, the splitting variety. The U–235 atoms split continuously, emitting neutrons which, in turn, split other uranium atoms, and the fission builds up so rapidly that the heat generated, if uncontrolled, would melt the steel, the beryllium, and probably the graphite and the lead.

However, the fission is controlled by two rods of cadmium projecting into the water. Cadmium absorbs thermal neutrons readily, so that not enough remain free to start a chain reaction of splitting. The purpose of the reactor is to produce neutrons, and pulling the cadmium rods out starts the water boiling within a few seconds and production of neutrons. Adjustment of the cadmium rods keeps the water at an even temperature.

RESERVES

There are no commercial ore reserves of cadmium. Greenockite (cadmium sulfide), the most common mineral, is associated almost exclusively with sphalerite, the zinc sulfide, and is recovered as a byproduct in connection with the smelting and refining of zinc-bearing ores. Hence, cadmium reserves depend upon the size of zinc-ore reserves and the cadmium content of these reserves.

An estimate by the Federal Geological Survey in 1944 placed the recoverable cadmium in domestic reserves of zinc ore of all grades (measured, indicated, and inferred) at 100 million pounds.[5] Estimates of zinc-ore reserves in 1950 [6] indicate contained recoverable cadmium in quantities of approximately the same magnitude as in 1944.

---

[4] Canadian Mining Journal, Cadmium Finds New Use: Vol. 73, No. 10, October 1952, pp. 77, 78.

[5] Fitzhugh, E. F., Jr., McKnight, Edwin T., and Wootton, T. P., Cadmium: Mineral Position of the United States, Appendix to Investigation of National Resources, Hearings Before U. S. Senate National Resources Economic Subcommittee, Committee on Public Lands, May 15, 1947, pp. 226–227.

[6] Bureau of Mines, Zinc: Materials Survey, prepared for National Security Resources Board, 1951, Ch. III, pp. 7–14.

WORLD REVIEW

The United States is by far the world's largest producer of cadmium, annually supplying about two-thirds of the total world output. United States production is not solely from domestic ores, of course; output from domestic ores constitutes about 30 percent of the world total.

Other large producers of cadmium are, with one exception, leading zinc producers. The exception, South-West Africa, is not one of the larger zinc producers but, by virtue of the high cadmium content of the ore mined, ranks among the largest cadmium producers. South-West Africa does not produce refined metal; lead-zinc-copper concentrates containing large quantities of cadmium are exported, principally to the United States, the United Kingdom, Belgium, and France, where the metals, including cadmium, are recovered.

Mexico, Canada, and Australia, all large zinc producers, are important producers of cadmium. Virtually all of the Mexican cadmium is exported in flue dust and zinc concentrates, chiefly to the United States. Canada and Australia produce refined cadmium metal. Belgium and the United Kingdom, working on imported materials, are also significant cadmium producers. Japan, Norway, and Italy, operating on domestic materials, and France, treating imports, produce sizable quantities of cadmium. Germany formerly recovered large quantities of cadmium from the cadmium-rich zinc ore of Upper Silesia, but with cession of that territory to Poland after World War II, Germany has been relatively unimportant as a source of cadmium.

World production of cadmium in recent years, insofar as data are available, is shown in table 7.

TABLE 7.—World production of cadmium, by countries 1947–52, in kilograms [1]

[Compiled by Berenice B. Mitchell]

Country	1947	1948	1949	1950	1951	1952
Australia (Tasmania)	209,030	293,352	263,767	299,125	234,708	292,978
Belgian Congo	26,040	18,056	24,635	29,668	24,316	[2] 20,000
Belgium [2]	86,300	157,900	148,000	365,000	450,000	600,000
Canada	325,874	347,491	383,983	384,828	601,878	455,687
France	43,000	50,067	58,123	71,591	84,997	[2] 100,000
Germany, West	1,206	3,500	5,000		70,000	[2] 70,000
Italy	38,400	47,000	74,000	75,000	204,000	133,000
Japan	8,710	18,874	52,484	90,348	117,687	[2] 130,000
Mexico [3]	778,000	905,000	820,000	689,000	893,000	733,000
Norway	50,000	62,000	71,400	78,747	100,000	[2] 100,000
Peru	1,407	1,592	800	1,365		
Poland	[4] 120,000	[4] 160,000	[4] 240,000	[2] 240,000	[2] 240,000	[2] 240,000
South-West Africa [5]		517,093	753,867	609,625	650,448	504,392
Spain		5,368	5,116	4,348	3,900	[2] 5,000
U. S. S. R.[2]	57,000	58,000	58,000	70,000	80,000	90,000
United Kingdom	106,440	115,769	102,662	118,899	139,026	157,285
United States:						
Metallic cadmium	3,632,025	3,439,555	3,639,432	4,021,254	3,680,537	3,804,633
Cadmium compounds (Cd content)	227,185	87,405	92,079	154,540	89,402	81,345
Total (estimate)	4,933,000	4,866,000	5,219,000	6,005,000	6,120,000	6,280,000

[1] This table incorporates a number of revisions of data published in previous cadmium chapters.
[2] Estimate.
[3] Cadmium content of flue dust exported for treatment elsewhere; represents in part shipments from stocks on hand. To avoid duplication of figures, data are not included in the total.
[4] Planned production.
[5] Cadmium content of concentrates exported for treatment elsewhere. To avoid duplication of figures, data are not included in the total.

CALCIUM

By Joseph C. Arundale [1] and Flora B. Mentch [2]

SALES of calcium chloride decreased slightly in 1952 but were near the record level of 1951. Imports of calcium metal exceeded those in any previous year, and a new firm was added to the list of domestic calcium-metal producers.

DOMESTIC PRODUCTION

Shipments in 1952 of 421,995 short tons of solid and flake calcium chloride (77–80 percent $CaCl_2$) and 154,476 short tons of liquid calcium chloride (40–45 percent $CaCl_2$) were only slightly less than in the previous record year of 1951. These figures include shipments of calcium chloride produced as a byproduct in the manufacture of soda ash by the ammonia-soda process.

The following firms produced calcium chloride (and calcium magnesium chloride) from natural brines in 1952: California Salt Co., 2436 Hunter St., Los Angeles 21, Calif., plant at Amboy, Calif.; Hill Bros. Chemical Co., 2159 Bay St., Los Angeles, Calif., plant at Saltus, Calif.; National Chloride Co. of America, 354 South Spring St., Los Angeles 13, Calif., plant at Amboy, Calif.; Michigan Chemical Corp., 500 North Bankson St., St. Louis, Mich., plant at St. Louis, Mich.; Wilkinson Chemical Co., Mayville, Mich.; The Dow Chemical Co., Midland, Mich., plants at Midland and Ludington, Mich.; Pomeroy Salt Corp., Pomeroy, Ohio, plant at Minersville, Ohio; Westvaco Chemical Division, Food Machinery and Chemical Corp., South Charleston 3, W. Va.

The production in California is from the brine of Bristol Lake. In Michigan, Ohio, and West Virginia, calcium chloride is recovered from well brines, with bromine and magnesia as coproducts.

Commercial calcium-metal production in the United States was begun in 1939 by the Electro Metallurgical Division, Union Carbide & Carbon Corp., Sault Ste. Marie, Mich. New England Lime Co., Canaan, Conn., began production during World War II, and in 1952 the Ethyl Corp. put on the market a crystalline calcium metal made in its plant at Baton Rouge, La.

Interstate Commerce Commission Regulations for Transportation of Explosives and Other Dangerous Articles was amended April 23,

TABLE 1.—Calcium chloride and calcium-magnesium chloride from natural brines sold by producers in the United States, 1943–47 (average) and 1948–52

[In terms of 75 percent (Ca, Mg) Cl_2]

Year	Short tons	Value	Year	Short tons	Value
1943–47 (average)	230,487	$1,983,634	1950	299,821	$3,801,508
1948	309,660	3,906,858	1951	328,042	4,756,242
1949	255,797	3,260,675	1952	(1)	(1)

1 Figures withheld to avoid disclosure of individual company operations.

1 Assistant chief, Construction and Chemical Materials Branch.
2 Statistical assistant.

1952, to require that shipments of crystalline metallic calcium be made in wooden boxes of ICC Specification 15A or 15B, with airtight inside metal containers, each of which may not be larger than 1-gallon capacity. This material may also be shipped in metal drums or barrels with the gross weight not to exceed 350 pounds and meeting ICC Specifications 6A, 6B, or 6C. It may also be shipped in single-trip drums meeting ICC Specification 17C. Shipments by rail express may not exceed 25 pounds in a single container.

CONSUMPTION AND USES

The periodic issues of Calcium Chloride Institute News contained information on the many uses of calcium chloride. This material may be added to the liquid ballast in tires on tractors, motor graders, off-the-road equipment, and industrial machines to increase the weight, reduce the freezing temperature of the liquid, and improve the performance of the equipment.[3] It has been found that calcium chloride added to concrete at the rate of about 2 percent of the weight of cement contributes to early strength of the concrete and improves the strength at all ages.[4] The use of calcium chloride brine in ice making,[5] and in the coal industry for dust control was described.[6]

The calcium chloride produced in California reportedly was used in that area for road treatment, dust prevention, weed killer, and portland cement. One firm is said to use this material for treating seaweed in the manufacture of agar agar.

Calcium metal has many uses in the metallurgical industry. It is a reducing agent in the preparation of thorium, uranium, zirconium, and chromium; an alloying agent for aluminum, bearing metals, copper, lead, and magnesium; a decarburizer and desulfurizer for ferrous metals and alloys; a debismuthizer of lead; and a deoxidizer of iron castings. It is used also in separating argon and nitrogen, dehydrating alcohol, and removing sulfur from petroleum fractions.

PRICES

According to Oil, Paint and Drug Reporter, prices for calcium chloride throughout 1952 were as follows: Flake, 77–80 percent, paper bags, carlots, works, freight equalized, per short ton, $25; liquor, 40 percent, tank cars, works, freight allowed, $10.50; pellets, bags, carlots, works, $31.25; powder, bags, carlots, works, $35.65; solid, 73–75 percent, drums, carlots, freight equalized, $23.50; less than carlots, works, same basis, $32.80–$69; U. S. P., granular, barrels, per pound, $0.30.

E&MJ Metal and Mineral Markets quoted calcium metal cast in slabs and small pieces, in ton lots, per pound, at $2.05 throughout 1952.

FOREIGN TRADE [7]

Imports of calcium metal from Canada continued to increase. The only other imports were 20 pounds from France.

[3] Calcium Chloride Institute News, vol. 2, No. 3, June 1952, p. 12; vol. 2, No. 5, October 1952, pp. 6, 7.
[4] Calcium Chloride Institute News, vol. 2, No. 6, December 1952, p. 9.
[5] Calcium Chloride Institute News, vol. 2, No. 2, April 1952, pp. 6, 7.
[6] Calcium Chloride Institute News, vol. 2, No. 1, February 1952, pp. 6, 7.
[7] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce

TABLE 2.—Calcium metal and calcium-silicon imported for consumption in the United States, 1943–47 (average) and 1948–52

[U. S. Department of Commerce]

Year	Calcium metal		Calcium-silicon	
	Pounds	Value	Pounds	Value
1943–47 (average)	3,488	$3,304	132,273	$17,534
1948	796	2,483	429,488	52,378
1949	3,510	4,736	112,000	14,977
1950	75,756	66,407	491,646	11,479
1951	574,636	602,226		
1952	751,215	807,997		

In 1952 calcium chloride was imported from Canada, United Kingdom, and Belgium-Luxembourg.

TABLE 3.—Calcium chloride imported for consumption in and exported from the United States, 1943–47 (average) and 1948–52

[U. S. Department of Commerce]

Year	Imports		Exports	
	Short tons	Value	Short tons	Value
1943–47 (average)	3,273	$41,743	10,032	$345,643
1948	5	249	11,456	437,763
1949	(1)	20	21,094	507,845
1950	1,881	54,170	15,624	403,230
1951	813	37,451	18,637	559,284
1952	1,333	45,888	19,193	594,904

1 Less than 1 ton.

TECHNOLOGY

The technical panel of the Calcium Chloride Institute held its second annual meeting in September 1952. At this meeting it was voted to continue research on road stabilization at the Iowa State Highway Research Board and at the Highway Research Board, Washington, D. C. It was also voted to continue frost studies at Purdue University and concrete studies at the National Bureau of Standards. Further investigations were recommended regarding the use of calcium chloride in concrete curing and costs of highway curing methods. A report on the jointly sponsored ion exchange water treatment project at the University of Texas was approved.[8]

In California a solution of calcium chloride and sodium chloride is collected in trenches dug in the salt beds. It is concentrated by solar evaporation to precipitate sodium chloride, and the calcium chloride liquor is either sold as such or made into flake calcium chloride.[9]

Calcium metal is produced by one firm in the United States by the electrolysis of calcium chloride. A second firm produces calcium by reducing lime with aluminum in a vacuum retort. A third firm recovers calcium from sludges that accumulate in the electrolytic production of sodium metal. In this process the source of the calcium is the calcium chloride in the electrolyte.

8 Calcium Chloride Institute News, vol. 2, No. 5, October 1952, pp. 3-4.
9 California Journal of Mines and Geology, vol. 48, No. 1, January 1952, p. 116.

The Ethyl Corp. reported production on a pilot-plant scale of a material described as "crystalline calcium metal." The material is said to be 94 to 97 percent free calcium metal and to range in particle size from 50- to 400- mesh. A bulletin issued by the firm describes the properties and potential uses of the new product.[10]

The results of tests on the performance of calcium chloride-treated gravel roads in Onondaga County, N. Y., was reviewed at a conference of the Highway Research Board. The use of calcium chloride was said to have saved a considerable tonnage of gravel and substantially lowered the maintenance blading cost.[11]

WORLD REVIEW

Before World War II the bulk of the calcium and calcium alloys produced was made in France and Germany. In 1945 commercial production of calcium in Canada was begun by Dominion Magnesium, Ltd., at Haley, Ontario. This firm soon became one of the world's leading producers. The process employed involves thermal reduction of lime.

TABLE 4.—Production (shipments) of calcium metal in Canada, 1945–51 [1]

Year	Pounds	Year	Pounds
1945	22,720	1948	895,203
1946	53,548	1949	520,069
1947	602,665	1950–51	(2)

[1] The Miscellaneous Metal Mining Industry, 1951, Dominion Bureau of Statistics, Department of Trade and Commerce, Ottawa, Canada, 1953, page E–11.
[2] Not available for publication.

Calcium chloride is produced in Canada by Brunner-Mond & Co., Ltd., at Amherstburg, Ontario. Most of this material was for domestic consumption.

[10] Crystalline Calcium Metal, Ethyl Corp., New York, N. Y., 1952.
Oil, Paint and Drug Reporter, vol. 162, No. 16, Oct. 20, 1952, p. 85.
[11] Contractors and Engineers Monthly, Calcium Treatment Lowers Blading Costs: Vol. 49, No. 4, April 1952, pp. 107–108.

Cement

By Oliver S. North[1] and Esther V. Balser[2]

A NEW RECORD output of portland cement was established in the United States in 1952 when 249,256,154 barrels[3] was produced. Shipments were also at an alltime high, reaching 251,368,503 barrels valued at $638,512,228.

Contrary to the upward trend in portland cement, production of one group of hydraulic cements—natural, masonry (natural), and puzzolan—tapered off for the second successive year. Also declining moderately were output and shipments of prepared masonry mortars, although 107 plants manufactured that material compared to 100 plants in 1951.

The portland-cement industry operated at 87.8 percent of capacity in 1952, compared to 87.4 in 1951. The estimated annual capacity of all portland-cement-producing facilities in the United States and Puerto Rico at the end of 1952 was about 284 million barrels—a relatively small increase from 1951.

The average net mill realization per barrel of portland cement remained unchanged from 1951 at $2.54. Also unchanged were the average values of the other hydraulic cements, as a group at $2.83 per barrel, and prepared masonry mortars, at $3.09 per barrel.

The long-term trend, as shown by the moving 12-month total production of finished portland cement in the Bureau of Mines Monthly Cement Reports, declined irregularly through the first half of 1952 before turning upward through the last 5 months and reaching a new high in December.

Consumption trends of portland cement in 1952, as indicated in figure 1, continued to be essentially the same as in 1951. The Middle States area was again the leading consumer.

States in the regions shown in figure 1 are as follows: Northeastern—Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont; Southern—Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, Virginia, and West Virginia; Middle—Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota, and Wisconsin; Rocky Mountain—Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, and Wyoming; and Pacific—California, Oregon, and Washington.

---

[1] Commodity-industry analyst.
[2] Statistical clerk.
[3] Barrel as used in this chapter, unless otherwise indicated, refers to a 376-pound barrel.

TABLE 1.—Salient statistics of the cement industry in the United States, 1943–47 (average) and 1948–52 [1]

	1943–47 (average)	1948	1949	1950	1951	1952
Production:						
Portland ... barrels	135, 543, 581	205, 448, 263	209, 727, 417	226, 025, 849	246, 022, 476	249, 256, 154
Masonry, natural, and puzzolan (slag-lime) ... do	1, 997, 301	3, 440, 248	3, 185, 229	4, 246, 299	3, 449, 463	3, 401, 684
Total ... do	137, 540, 882	208, 888, 511	212, 912, 646	230, 272, 148	249, 471, 939	252, 657, 838
Capacity used at portland-cement mills ... percent	55. 8	80. 8	81. 0	84. 3	87. 4	87. 8
Shipments from mills:						
Total ... barrels	139, 084, 875	207, 679, 797	209, 313, 850	231, 975, 216	244, 628, 695	254, 815, 893
Value of shipments [2]	$237, 683, 544	$453, 412, 362	$481, 183, 393	$545, 950, 709	$623, 003, 439	$648, 264, 065
Average value per barrel	$1. 71	$2. 18	$2. 30	$2. 35	$2. 55	$2. 54
Stocks at mills, Dec. 31 ... barrels	16, 279, 926	11, 303, 591	14, 920, 104	13, 308, 190	[3] 18, 223, 906	16, 065, 851
Imports ... do	4, 498	282, 752	109, 821	1, 409, 974	[3] 921, 953	475, 986
Exports ... do	4, 836, 339	5, 922, 163	4, 561, 899	2, 418, 435	2, 932, 787	3, 185, 651
Apparent consumption [4] ... do	134, 253, 034	202, 040, 386	204, 861, 772	230, 966, 755	[3] 242, 617, 861	252, 106, 228
World production (estimated) ... do	391, 484, 000	[3] 598, 056, 000	674, 279, 000	[3] 775, 714, 000	[3] 870, 113, 000	932, 264, 000

[1] Figures include Puerto Rico and Hawaii, 1946; Puerto Rico only, 1947–52. There has been no production in Hawaii since 1946.
[2] Value received f. o. b. mill, excluding cost of containers.
[3] Revised figure.
[4] Shipments from domestic mills minus net exports.

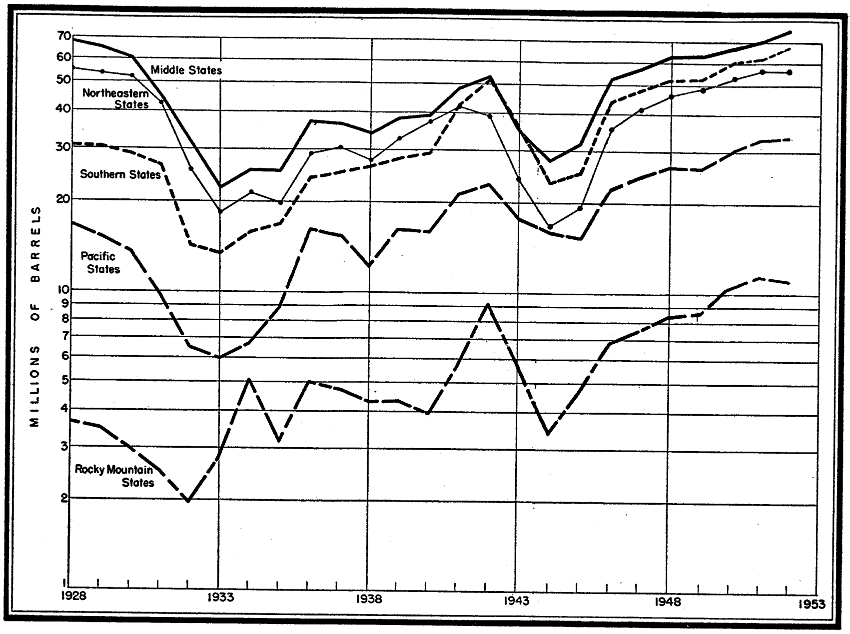

FIGURE 1.—Indicated consumption of portland cement in continental United States, 1928–52, by regions.

PORTLAND CEMENT

PRODUCTION AND SHIPMENTS

Portland cement, which constituted almost 99 percent of the hydraulic cement produced in 1952, was manufactured in 156 active plants in 37 States and Puerto Rico. Production was begun early in the year at a new plant at Brandon, Miss., and near the close of the year at a plant near Bunnell, Fla. The dry-process plant at Devils Slide, Utah, reported that it had no output and made no shipments during the year.

Table 2 is a district breakdown of production, shipments, and stocks in 1951–52. Table 3 shows similar information on a monthly basis. Data in the latter table were compiled from monthly reports—many of which were preliminary estimates by producers—in which totals were rounded to thousands of barrels. No attempt has been made to adjust the data in table 3 to the final annual figures shown in table 2. In all instances, the discrepancy is extremely small percentagewise.

Beginning with this chapter, California has been divided into two cement-producing districts. Plants at Davenport, Permanente, Redwood City, San Andreas, and San Juan Bautista comprise the Northern district, while the Southern district is composed of plants at Colton, Crestmore, Los Angeles, Monolith, Oro Grande, and Victorville.

Output in 1952 was greater in 10 districts and lower in 10 districts, compared to 1951. Changes ranged from a 6-percent decrease in

TABLE 2.—Finished portland cement produced, shipped, and in stock in the United States, 1951–52, by districts

District	Active plants		Production			Shipments from mills								Stocks at mills on Dec. 31		
			Barrels		Change from 1951, percent	1951			1952					Barrels		Change from 1951, percent
						Barrels	Value		Barrels	Value		Change from 1951, percent in—				
	1951	1952	1951	1952			Total	Average		Total	Average	Barrels	Average value	1951 [1]	1952	
Eastern Pennsylvania, Maryland	21	21	36,322,651	34,204,438	−5.8	35,694,374	$91,726,329	$2.57	34,971,324	$90,148,570	$2.58	−2.0	+0.4	2,528,108	1,761,222	−30.3
New York, Maine	11	11	15,351,223	15,995,631	+4.2	15,098,821	37,870,008	2.51	16,081,524	40,429,862	2.51	+6.5	------	1,066,598	980,705	−8.1
Ohio	9	9	11,873,852	11,270,431	−5.1	11,872,278	29,498,956	2.48	11,377,806	28,488,500	2.50	−4.2	+.8	855,548	748,173	−12.6
Western Pennsylvania, West Virginia	7	7	10,849,106	10,554,119	−2.7	11,014,476	27,444,268	2.49	10,471,497	26,156,314	2.50	−4.9	+.4	790,602	873,224	+10.5
Michigan	7	7	14,393,599	14,790,587	+2.8	14,112,639	35,121,324	2.49	14,760,783	36,819,042	2.49	+4.6	------	1,598,105	1,627,909	+1.9
Illinois	4	4	8,483,783	8,514,443	+.4	8,377,387	19,853,132	2.37	8,710,621	20,600,347	2.36	+4.0	−.4	801,886	605,708	−24.5
Indiana, Kentucky, Wisconsin	6	6	14,163,250	13,899,522	−1.9	13,991,472	33,839,689	2.42	14,170,654	34,992,989	2.47	+1.3	+2.1	1,125,303	854,171	−24.1
Alabama	7	7	10,772,991	10,609,234	−1.5	10,586,825	24,523,073	2.32	10,642,409	25,084,379	2.36	+.5	+1.7	584,816	551,641	−5.7
Tennessee	6	6	7,221,968	7,439,873	+3.0	7,162,841	17,203,080	2.40	7,428,604	17,834,060	2.40	+3.7	------	377,021	388,290	+3.0
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi [2]	9	11	10,662,877	14,513,923	+36.1	10,479,709	27,312,775	2.61	14,390,516	37,257,041	2.59	+37.3	−.8	599,456	722,863	+20.6
Iowa	5	5	8,364,692	9,028,350	+7.9	8,024,492	19,800,084	2.47	9,336,727	22,849,597	2.45	+16.4	−.8	1,176,973	868,596	−26.2
Eastern Missouri, Minnesota, South Dakota	6	6	11,807,958	11,406,529	−3.4	11,696,053	29,725,620	2.54	11,528,582	29,416,600	2.55	−1.4	+.4	1,028,367	906,314	−11.9
Kansas	6	6	8,514,521	8,672,883	+1.9	8,163,916	19,413,144	2.38	8,811,762	20,956,886	2.38	+7.9	------	663,739	524,860	−20.9
Western Missouri, Nebraska, Oklahoma, Arkansas	6	6	8,707,964	8,890,216	+2.1	8,126,910	19,936,315	2.45	9,265,497	22,981,413	2.48	+14.0	+1.2	923,718	548,437	−40.6
Texas	13	13	18,132,373	19,997,983	+10.3	17,642,654	42,648,536	2.42	19,849,455	48,042,901	2.42	+12.5	------	987,520	1,136,048	+15.0
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	10	9	8,569,555	8,226,211	−4.0	8,264,888	25,503,189	3.09	8,303,467	24,007,382	2.89	+.5	−6.5	649,876	572,620	−11.9
Northern California	5	5	13,556,921	13,676,126	+.9	12,973,345	35,866,681	2.76	13,714,018	36,958,815	2.69	+5.7	−2.5	1,014,416	976,524	−3.7
Southern California	6	6	16,361,372	15,908,779	−2.8	15,983,125	41,887,016	2.62	16,072,227	42,498,930	2.64	+.6	+.8	761,833	598,385	−21.5
Oregon, Washington	9	9	7,671,760	7,568,677	−1.3	7,589,484	22,744,914	3.00	7,486,547	22,470,706	3.00	−1.4	------	514,260	596,390	+16.0
Puerto Rico	2	2	4,240,060	4,088,199	−3.6	4,297,583	11,252,350	2.62	3,994,483	10,517,894	2.63	−7.1	+.4	16,276	109,992	+575.8
Total	155	156	246,022,476	249,256,154	+1.3	241,153,272	613,170,483	2.54	251,368,503	638,512,228	2.54	+4.2	------	18,064,421	15,952,072	−11.7
Pennsylvania	24	24	41,981,431	39,437,971	−6.1	41,560,431	107,035,506	2.58	40,037,761	103,388,586	2.58	−3.7	------	2,980,404	2,380,614	−20.1
Missouri	5	5	10,230,449	10,007,609	−2.2	10,217,421	25,760,473	2.52	10,086,850	25,523,038	2.53	−1.3	+.4	743,179	663,938	−10.7

[1] Revised figure.

[2] Mississippi was first included as a cement-producing State in 1952.

342070—55——17

Eastern Pennsylvania-Maryland to a 36-percent increase in the Virginia-Georgia-Florida-Louisiana-South Carolina-Mississippi district. Twelve districts reported outputs over 10 million barrels.

TYPES OF CEMENT

A breakdown of total production of portland cement by various types for the 1943–52 period is shown in table 4. Production of low-heat (type IV) declined sharply, while outputs of the white and portland-puzzolan types were somewhat lower than in 1951. Except for production of a comparatively large quantity of sulfate-resisting (type V) cement to take up depleted stocks, output of all other types was moderately higher than in 1951.

Prepared Masonry Mortars.—Prepared masonry mortars are those special cements that are not true portlands but employ portland-cement clinker and finished portland cement as a base. To this base are added considerable quantities of lime or other constituents of various kinds. These specially prepared masonry cements are sold under proprietary names.

Production of prepared masonry mortars was reported by 107 plants in 1952 and totaled 10,612,502 barrels. Shipments were 10,775,304 barrels valued at $33,295,977, an average mill value of $3.09 per barrel. These quantities are shown in equivalent barrels of 376 pounds to maintain uniformity with other data in this chapter.

As the finished portland cement and clinker used in making these types of masonry cement have been reported elsewhere by producers, to avoid duplication these data are not included in the statistical tabulations in this chapter, but the portland cement and clinker used in manufacturing these mixtures is included.

CAPACITY OF PLANTS

The total estimated annual capacity of all portland-cement plants in 1952, as reported to the Bureau of Mines by producers, increased 1 percent over that reported in 1951. The overall rate of operation in 1952 was approximately 0.5 percent of total capacity higher than in 1951.

Opening of the new plant in Mississippi and increased facilities at plants in other States of that district brought capacity in the Virginia-Georgia-Florida-Louisiana-South Carolina-Mississippi district to a figure nearly 4½ million barrels higher than at the end of 1951. The only other district showing marked increases in capacity were Southern California, up 1½ million barrels, and Northern California, up 1 million barrels. Large decreases in capacity were noted in the Indiana-Kentucky-Wisconsin, Western Pennsylvania-West Virginia, and Eastern Missouri-Minnesota-South Dakota districts. Most cement plants listed kiln departments as the factor limiting capacity, while a few reported that their capacities were limited by the raw-grinding or finish-grinding facilities.

As indicated in table 5, the percentage of capacity utilized was higher in 11 and lower in 9 districts, compared to 1951. In continental United States the changes ranged from a 9.5-percent decrease in the

TABLE 3.—Production, shipments from mills, and stocks at mills of finished portland cement in the United States in 1952, by months and districts, in thousands of barrels

District	January	February	March	April	May	June	July	August	September	October	November	December
PRODUCTION												
Eastern Pennsylvania, Maryland	2,743	2,577	2,658	2,852	2,912	2,594	2,625	3,113	3,049	3,191	2,914	2,984
New York, Maine	1,017	944	1,036	1,307	1,513	1,487	1,510	1,498	1,425	1,524	1,385	1,369
Ohio	917	854	894	847	831	921	1,034	1,007	944	1,005	1,089	928
Western Pennsylvania, West Virginia	756	792	917	744	830	508	618	1,084	1,060	1,101	995	943
Michigan	594	461	591	1,268	1,456	1,556	1,619	1,510	1,480	1,628	1,438	1,189
Illinois	525	528	525	610	702	800	808	864	895	832	745	680
Indiana, Kentucky, Wisconsin	901	915	1,176	1,248	1,294	810	828	1,477	1,433	1,475	1,236	1,108
Alabama	802	833	887	930	917	909	871	930	891	940	830	871
Tennessee	584	476	619	630	624	650	693	665	598	639	592	669
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi [1]	975	901	992	993	1,185	1,157	1,234	1,353	1,343	1,360	1,315	1,474
Iowa	707	515	331	562	839	824	1,013	966	900	937	765	670
Eastern Missouri, Minnesota, South Dakota	780	735	830	772	1,003	880	908	1,188	1,148	1,204	1,069	895
Kansas	601	560	598	643	763	810	749	836	796	842	752	722
Western Missouri, Nebraska, Oklahoma, Arkansas	595	631	640	709	780	831	824	926	867	875	766	688
Texas	1,585	1,574	1,688	1,686	1,750	1,643	1,660	1,632	1,670	1,794	1,688	1,637
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	438	389	355	543	844	863	860	816	835	878	793	595
Northern California	916	801	1,129	1,119	1,140	1,147	1,198	1,282	1,210	1,304	1,277	1,162
Southern California	976	1,227	1,278	1,303	1,307	1,316	1,275	1,354	1,410	1,506	1,497	1,457
Oregon, Washington	304	500	589	704	792	689	663	726	703	831	591	475
Puerto Rico	323	332	362	347	347	353	352	346	353	298	311	365
Total: 1952	17,039	16,545	18,095	19,817	21,829	20,748	21,342	23,573	23,010	24,164	22,048	20,881
1951	17,434	15,201	18,708	20,184	21,924	21,984	22,439	22,514	22,269	22,797	20,737	19,874
SHIPMENTS												
Eastern Pennsylvania, Maryland	1,769	2,041	2,484	3,328	3,098	3,441	3,209	3,378	3,639	3,755	2,883	1,949
New York, Maine	600	539	849	1,580	1,614	1,930	1,766	1,663	1,675	1,775	1,331	770
Ohio	498	571	753	893	940	1,241	1,367	1,243	1,168	1,230	942	529
Western Pennsylvania, West Virginia	471	542	602	815	996	702	769	1,347	1,347	1,317	886	452
Michigan	431	453	572	1,217	1,534	1,966	1,890	1,660	1,676	1,694	1,058	609
Illinois	182	290	317	681	892	1,277	1,097	1,035	1,034	974	673	260
Indiana, Kentucky, Wisconsin	570	761	886	1,305	1,442	1,103	1,174	1,784	1,740	1,581	1,174	653
Alabama	879	805	900	957	971	901	903	862	895	972	831	768
Tennessee	563	581	546	726	663	687	709	610	649	698	554	441
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi [1]	965	888	956	1,083	1,226	1,263	1,265	1,316	1,354	1,463	1,251	1,142
Iowa	171	252	326	798	932	1,262	1,333	1,277	1,045	1,183	529	229
Eastern Missouri, Minnesota, South Dakota	421	505	568	942	1,228	1,286	1,241	1,253	1,360	1,352	899	478
Kansas	418	499	460	678	784	928	1,053	910	963	969	731	418
Western Missouri, Nebraska, Oklahoma, Arkansas	416	515	592	833	878	1,017	1,043	991	1,059	1,023	673	415

See footnote at end of table.

TABLE 3.—Production, shipments from mills, and stocks at mills of finished portland cement in the United States in 1952, by months and districts, in thousands of barrels—Continued

District	January	February	March	April	May	June	July	August	September	October	November	December
SHIPMENTS—continued												
Texas	1,641	1,591	1,790	1,680	1,754	1,672	1,659	1,668	1,725	1,868	1,458	1,344
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	323	395	393	709	825	851	824	952	1,030	989	597	417
Northern California	838	994	962	1,101	948	1,175	1,353	1,490	1,319	1,570	1,133	836
Southern California	985	1,352	1,105	1,345	1,457	1,253	1,327	1,378	1,467	1,663	1,355	1,386
Oregon, Washington	247	472	603	796	730	717	728	737	784	820	512	337
Puerto Rico	308	316	329	297	370	395	374	361	311	327	301	307
Total: 1952	12,696	14,362	15,993	21,764	23,282	25,067	25,084	25,915	26,240	27,223	19,771	13,740
1951	12,236	11,294	17,678	20,921	24,867	24,916	24,259	25,841	23,253	26,134	17,994	11,791
STOCKS (END OF MONTH)												
Eastern Pennsylvania, Maryland	3,468	4,004	4,181	3,705	3,524	2,681	2,101	1,840	1,254	693	727	1,762
New York, Maine	1,512	1,915	2,099	1,824	1,720	1,268	1,006	838	581	330	382	981
Ohio	1,274	1,557	1,698	1,651	1,542	1,222	889	652	428	203	350	748
Western Pennsylvania, West Virginia	1,052	1,302	1,616	1,546	1,380	1,186	1,041	778	492	275	384	875
Michigan	1,762	1,770	1,788	1,839	1,761	1,351	1,080	930	734	668	1,048	1,628
Illinois	1,145	1,383	1,592	1,521	1,332	855	565	394	256	114	186	606
Indiana, Kentucky, Wisconsin	1,452	1,607	1,898	1,841	1,693	1,400	1,054	750	441	336	399	854
Alabama	509	537	524	497	443	452	420	487	483	451	449	552
Tennessee	398	293	366	270	232	194	177	233	181	122	160	388
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi [1]	572	585	621	582	541	435	404	441	430	327	391	723
Iowa	1,713	1,976	1,981	1,745	1,652	1,213	894	583	437	192	427	868
Eastern Missouri, Minnesota, South Dakota	1,387	1,617	1,879	1,709	1,483	1,077	744	678	467	319	489	906
Kansas	846	908	1,046	1,011	989	872	567	494	327	200	220	525
Western Missouri, Nebraska, Oklahoma, Arkansas	1,102	1,218	1,266	1,092	993	807	589	523	330	182	276	548
Texas	937	920	817	823	819	790	791	755	701	627	857	1,151
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	765	759	722	555	574	587	623	487	309	198	394	573
Northern California	1,092	898	1,065	1,082	1,274	1,245	1,089	882	773	506	651	977
Southern California	753	629	802	761	610	674	623	599	542	386	528	598
Oregon, Washington	565	593	580	487	549	521	457	446	365	375	453	591
Puerto Rico	32	48	81	131	109	66	44	29	71	42	52	110
Total: 1952	22,336	24,519	26,622	24,672	23,220	18,896	15,158	12,819	9,602	6,546	8,823	15,964
1951	18,222	22,224	23,250	22,511	19,566	16,630	14,812	11,491	10,499	7,162	9,910	17,993

[1] Mississippi was first included as a cement-producing State in January 1952.

TABLE 4.—Portland cement produced and shipped in the United States,[1] 1943–47 (average) and 1948–52, by types

Type and year	Active plants	Production (barrels)	Shipments		
			Barrels	Value	
				Total	Average
General use and moderate heat (types I and II):					
1943–47 [2] (average)	150	118,737,929	120,267,191	$201,714,223	$1.68
1948	150	174,909,904	173,365,414	374,584,386	2.16
1949	150	177,597,585	174,569,746	396,817,234	2.27
1950	150	191,994,091	193,693,533	449,842,513	2.32
1951	155	207,702,941	203,279,206	510,975,002	2.51
1952	156	210,720,294	212,589,258	534,252,252	2.51
High-early-strength (type III):					
1943–47 (average)	96	6,034,374	6,035,039	12,372,116	2.05
1948	87	5,513,312	5,615,894	14,224,177	2.53
1949	87	5,979,435	5,649,482	15,047,036	2.66
1950	90	6,667,974	6,607,172	18,094,386	2.74
1951	96	7,455,107	7,294,686	21,494,894	2.95
1952	95	8,014,918	7,982,072	23,377,812	2.93
Low-heat (type IV):					
1943–47 (average	4	490,562	478,625	684,515	1.43
1948	3	135,871	153,994	306,962	1.99
1949	6	159,739	129,411	329,284	2.54
1950	5	328,879	271,559	682,008	2.51
1951	6	900,624	790,819	2,647,460	3.35
1952	2	252,122	272,062	767,571	2.82
Sulfate-resisting (type V):					
1943–47 (average)	4	31,933	36,333	81,778	2.25
1948	6	204,862	163,127	505,710	3.10
1949	5	95,023	113,370	472,016	4.16
1950	4	4,070	49,152	141,888	2.89
1951	3	9,908	87,635	342,689	3.91
1952	4	99,229	78,276	240,129	3.07
Oil-well:					
1943–47 (average)	16	1,202,638	1,211,780	2,411,041	1.99
1948	14	1,817,746	1,966,854	4,972,499	2.53
1949	17	1,714,938	1,745,908	4,554,603	2.61
1950	17	1,829,651	1,830,167	4,735,423	2.59
1951	15	1,508,252	1,630,305	4,581,109	2.80
1952	18	1,841,470	1,787,786	5,099,335	2.85
White:					
1943–47 (average)	5	535,170	549,689	2,312,866	4.21
1948	4	1,034,500	1,005,356	4,510,169	4.49
1949	4	1,071,100	1,031,408	4,985,107	4.83
1950	5	1,175,490	1,187,202	5,637,101	4.75
1951	4	1,139,500	1,109,088	5,631,518	5.08
1952	4	1,081,122	1,094,276	5,900,986	5.39
Portland-puzzolan:					
1943–47 (average)	4	665,953	667,678	1,141,150	1.71
1948	6	1,545,584	1,693,207	3,733,436	2.20
1949	4	1,080,848	1,147,694	2,602,853	2.27
1950	5	1,369,764	1,321,223	3,232,282	2.45
1951	6	2,279,023	2,250,280	5,602,288	2.49
1952	6	1,861,991	1,856,656	4,646,078	2.50
Air-entrained:					
1945–47 [3] (average)	65	12,230,294	12,174,116	21,102,279	1.73
1948	73	19,421,610	19,453,359	40,322,716	2.07
1949	78	21,266,590	20,940,562	46,091,687	2.20
1950	80	21,717,585	21,860,316	50,107,196	2.29
1951	79	24,201,376	23,885,423	59,247,898	2.48
1952	81	24,484,689	24,796,917	61,432,052	2.48
Miscellaneous: [4]					
1943–47 (average)	19	506,846	512,555	1,102,603	2.15
1948	20	864,874	887,457	2,518,018	2.84
1949	24	762,159	752,744	2,277,212	3.03
1950	24	938,345	936,312	2,848,326	3.04
1951	23	825,745	825,830	2,647,625	3.21
1952	22	900,319	911,200	2,796,013	3.07
Grand total:					
1943–47 (average)	150	135,543,581	137,063,359	234,481,659	1.71
1948	150	205,448,263	204,304,662	445,678,073	2.18
1949	150	209,727,417	206,080,325	473,177,032	2.30
1950	150	226,025,849	227,756,636	535,321,123	2.35
1951	155	246,022,476	241,153,272	613,170,483	2.54
1952	156	249,256,154	251,368,503	638,512,228	2.54

[1] Including Puerto Rico and Hawaii, 1946; Puerto Rico only, 1947–52. There has been no production in Hawaii since 1946.
[2] Includes air-entrained and Vinsol resin cements classed as modified cements by producers in 1944.
[3] Figures reported separately for the first time in 1945.
[4] Includes hydroplastic, plastic, and waterproofed cements.

Southern California district to a 9.5-percent increase in the Indiana-Kentucky-Wisconsin district.

Table 6 shows the percentage of estimated capacity utilized in each month of 1951 and 1952, and the percentage of capacity utilized in the 12-month period ended on the last day of each month of those 2 years.

TABLE 5.—Portland-cement-manufacturing capacity of the United States, 1951–52, by districts

District	Capacity			
	Estimated (barrels)		Percent utilized	
	1951	1952	1951	1952
Eastern Pennsylvania, Maryland	39, 642, 627	38, 895, 393	91. 6	87. 9
New York, Maine	17, 606, 719	17, 692, 491	87. 2	90. 4
Ohio	13, 094, 125	13, 244, 125	90. 7	85. 1
Western Pennsylvania, West Virginia	14, 821, 300	13, 132, 300	73. 2	80. 4
Michigan	16, 452, 410	16, 366, 360	87. 5	90. 4
Illinois	9, 459, 260	9, 549, 290	89. 7	89. 2
Indiana, Kentucky, Wisconsin	18, 431, 172	16, 098, 147	76. 8	86. 3
Alabama	11, 411, 390	11, 443, 150	94. 4	92. 7
Tennessee	7, 822, 000	8, 030, 000	92. 3	92. 7
Virginia, Georgia Florida, Louisiana, South Carolina, Mississippi [1]	14, 129, 745	18, 556, 940	75. 5	78. 2
Iowa	9, 349, 570	9, 396, 280	89. 5	96. 1
Eastern Missouri, Minnesota, South Dakota	14, 022, 400	13, 064, 400	84. 2	87. 3
Kansas	9, 510, 984	9, 552, 608	89. 5	90. 8
Western Missouri, Nebraska, Oklahoma, Arkansas	9, 205, 781	9, 200, 781	94. 6	96. 6
Texas	21, 356, 000	21, 856, 000	84. 9	91. 5
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	10, 241, 800	10, 465, 000	83. 7	78. 6
Northern California	14, 900, 000	15, 900, 000	91. 0	86. 0
Southern California	17, 720, 000	19, 220, 000	92. 3	82. 8
Oregon, Washington	8, 247, 825	8, 251, 151	93. 0	91. 7
Puerto Rico	4, 107, 220	4, 100, 000	103. 2	99. 7
Total	281, 532, 328	284, 014, 416	87. 4	87. 8

[1] Mississippi was first included as a cement-producing State in January 1952.

TABLE 6.—Percentage of capacity used in the finished portland-cement industry in the United States, 1951–52

Month	Monthly		12 months ended—		Month	Monthly		12 months ended—	
	1951	1952	1951	1952		1951	1952	1951	1952
January	79	73	88	90	July	98	90	90	87
February	76	76	88	90	August	98	99	89	87
March	82	78	87	90	September	100	99	90	87
April	91	86	88	88	October	99	101	90	88
May	96	92	89	88	November	93	95	90	88
June	99	90	89	87	December	85	87	90	88

The capacity of plants utilizing the wet process for manufacturing portland cement was 3 percent higher than in 1951 and now make up over 56 percent of the total productive capacity. On the other hand, the capacity of dry-process plants in operation declined 2 percent from 1951. The percentage of cement produced by wet-process plants in 1952 continued its trend of recent years by gaining slightly. Table 7 shows capacity, capacity utilization, and percentage of total output produced for each of these processes.

TABLE 7.—Capacity of portland-cement plants in the United States,[1] Dec. 31, 1950–52, by processes

Process	Capacity, Dec. 31						Percent of capacity utilized			Percent of total finished cement produced		
	Thousands of barrels			Percent of total								
	1950	1951	1952	1950	1951	1952	1950	1951	1952	1950	1951	1952
Wet	147,049	155,430	159,812	54.8	55.2	56.3	86.6	89.3	88.7	56.3	56.4	56.9
Dry	121,224	126,102	124,202	45.2	44.8	43.7	81.4	85.0	86.5	43.7	43.6	43.1
Total	268,273	281,532	284,014	100.0	100.0	100.0	84.3	87.4	87.8	100.0	100.0	100.0

[1] Includes Puerto Rico.

A grouping of the cement plants based on their annual capacity is shown below. The less-than-1,000,000-barrel-capacity and the 2,000,000-to-3,000,000-barrel-capacity groups were 2 plants and 1 plant, respectively, smaller than in 1951, while the 1,000,000-to-2,000,000-barrel-capacity and 3,000,000-to-10,000,000-barrel-capacity groups were each 2 plants larger than in 1951.

Number of portland-cement plants in the United States (including Puerto Rico) in 1952, by size groups

Estimated annual capacity, Dec. 31, barrels:	*Number of plants*
Less than 1,000,000	21
1,000,000 to 2,000,000	88
2,000,000 to 3,000,000	33
3,000,000 to 10,000,000	15
Total	157

The total number of plants shown above is 157 instead of the 156 shown in other tables of this chapter because the dry-process plant of Ideal Cement Co. at Devils Slide, Utah, is included here, although no output or shipments were reported from that plant in 1952.

CLINKER PRODUCTION

Output of clinker—the product intermediate between raw materials and the finished cement—was 1 percent greater in 1952 than in 1951. As in the preceding several years, peak production was attained in October, while stocks reached their greatest accumulation in March. Higher stocks of clinker were on hand throughout 1952 than were maintained through 1951. Stocks of clinker on December 31, 1952, were 12 percent higher than those reported at the end of 1951.

TABLE 8.—Production and stocks of portland-cement clinker at mills in the United States in 1952, by months and districts, in thousands of barrels

District	January	February	March	April	May	June	July	August	September	October	November	December
PRODUCTION												
Eastern Pennsylvania, Maryland	2,940	2,753	2,834	2,773	2,924	2,537	2,555	3,112	2,993	3,159	2,981	3,043
New York, Maine	1,114	1,057	1,206	1,234	1,438	1,296	1,337	1,413	1,396	1,430	1,377	1,456
Ohio	940	898	1,025	847	828	935	1,038	927	893	986	1,049	1,019
Western Pennsylvania, West Virginia	878	774	895	733	762	557	617	960	983	970	958	950
Michigan	1,084	1,054	977	1,325	1,347	1,426	1,346	1,370	1,358	1,520	1,346	1,307
Illinois	712	613	713	653	628	675	763	756	782	829	750	768
Indiana, Kentucky, Wisconsin	1,198	1,139	1,228	1,195	1,229	775	815	1,305	1,332	1,371	1,303	1,228
Alabama	867	851	914	908	934	891	917	919	899	941	866	895
Tennessee	606	503	645	645	646	636	662	668	594	641	613	695
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	1,115	922	1,082	1,034	1,196	1,176	1,329	1,339	1,342	1,396	1,373	1,532
Iowa	769	646	558	527	816	800	797	821	865	877	763	751
Eastern Missouri, Minnesota, South Dakota	853	793	939	876	911	784	869	1,057	1,013	1,099	1,031	928
Kansas	600	545	679	712	752	778	780	812	756	788	746	749
Western Missouri, Nebraska, Oklahoma, Arkansas	745	793	566	538	726	816	841	805	816	851	782	699
Texas	1,619	1,559	1,714	1,678	1,751	1,676	1,669	1,611	1,658	1,803	1,689	1,736
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	637	580	550	536	622	695	753	742	825	886	826	757
Northern California	903	984	1,116	1,160	1,132	1,147	1,208	1,192	1,162	1,234	1,273	1,149
Southern California	1,221	1,205	1,325	1,257	1,317	1,360	1,366	1,410	1,425	1,449	1,396	1,449
Oregon, Washington	433	556	648	657	702	666	549	654	716	695	595	562
Puerto Rico	335	316	345	308	314	324	331	360	327	316	322	347
Total: 1952	19,569	18,541	19,959	19,596	20,975	19,950	20,542	22,233	22,135	23,241	22,039	22,020
1951	19,132	16,995	19,750	20,393	21,341	21,327	21,440	22,010	21,650	22,396	21,164	20,780
STOCKS (END OF MONTH)												
Eastern Pennsylvania, Maryland	624	815	956	827	780	730	600	584	494	421	478	515
New York, Maine	400	530	696	642	597	429	279	216	202	171	189	294
Ohio	263	298	409	401	386	385	360	275	217	189	140	224
Western Pennsylvania, West Virginia	420	416	399	377	329	331	269	208	199	98	117	167
Michigan	849	1,431	1,857	1,882	1,755	1,558	1,218	1,037	904	701	566	555
Illinois	229	314	492	530	445	319	264	151	29	17	13	100
Indiana, Kentucky, Wisconsin	522	706	747	676	604	569	552	380	273	170	237	345
Alabama	120	135	151	126	134	115	148	133	131	127	154	173
Tennessee	92	114	127	125	139	118	72	64	48	38	46	61

Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	167	171	167	145	128	123	197	163	140	142	172	211
Iowa	355	469	686	649	617	590	382	222	177	123	116	197
Eastern Missouri, Minnesota, South Dakota	376	419	553	677	615	537	519	415	301	217	205	254
Kansas	98	87	158	214	202	168	189	169	133	78	72	83
Western Missouri, Nebraska, Oklahoma, Arkansas	371	546	551	399	332	315	325	210	158	142	161	167
Texas	184	159	177	166	161	175	184	155	145	156	155	259
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	459	647	840	893	606	424	309	237	215	205	236	392
Northern California	156	344	339	387	386	393	408	325	283	218	221	223
Southern California	780	737	776	719	713	742	835	917	905	841	717	643
Oregon, Washington	544	605	673	630	547	534	423	357	365	243	254	346
Puerto Rico	76	78	79	55	37	23	15	44	33	63	80	71
Total: 1952	7,085	9,021	10,833	10,520	9,513	8,578	7,548	6,262	5,352	4,360	4,329	5,280
1951	5,473	7,097	8,068	8,194	7,482	6,682	5,601	4,851	4,138	3,544	3,882	[1] 4,729

[1] Revised figure.

TABLE 9.—Portland-cement clinker produced and in stock at mills in the United States,[1] 1951–52, by processes, in barrels [2]

Process	Plants		Production		Stocks on Dec. 31—	
	1951	1952	1951	1952	1951 [3]	1952 [4]
Wet	92	92	139,134,268	141,840,287	2,257,639	2,524,636
Dry	63	64	109,243,568	108,959,477	2,471,106	2,755,294
Total	155	156	248,377,836	250,799,764	4,728,745	5,279,930

[1] Including Puerto Rico.
[2] Compiled from monthly estimates of producers.
[3] Revised figures.
[4] Preliminary figures.

RAW MATERIALS

In table 10, production is classified according to kinds of raw materials from which the cement is manufactured.

Cement produced from argillaceous limestone ("cement rock") or from a mixture of cement rock with pure limestone is shown under the first heading. This is the combination of materials used in all the cement plants of Lehigh and Northampton Counties, Pa. (the so-called "Lehigh district") and at a few plants in certain other States.

Cement manufactured from a mixture of comparatively pure limestone with clay or shale and from mixtures of oystershells (or coquina shells) and clay are shown under the second heading. The

TABLE 10.—Production and percentage of total output of portland cement in the United States,[1] 1904–14, 1926, 1929, 1933, 1935, and 1941–52, by raw materials used

Year	Cement rock and pure limestone		Limestone and clay or shale [2]		Marl and clay		Blast-furnace slag and limestone	
	Barrels	Percent	Barrels	Percent	Barrels	Percent	Barrels	Percent
1904	15,173,391	57.2	7,526,323	28.4	3,332,873	12.6	473,294	1.8
1905	18,454,902	52.4	11,172,389	31.7	3,884,178	11.0	1,735,343	4.9
1906	23,896,951	51.4	16,532,212	35.6	3,958,201	8.5	2,076,000	4.5
1907	25,859,095	53.0	17,190,697	35.2	3,606,598	7.4	2,129,000	4.4
1908	20,678,693	40.6	23,047,707	45.0	2,811,212	5.5	4,535,300	8.9
1909	24,274,047	37.3	32,219,365	49.6	2,711,219	4.2	5,786,800	8.9
1910	26,520,911	34.6	39,720,320	51.9	3,307,220	4.3	7,001,500	9.2
1911	26,812,129	34.1	40,665,332	51.8	3,314,176	4.2	7,737,000	9.9
1912	24,712,780	30.0	44,607,776	54.1	2,467,368	3.0	10,650,172	12.9
1913	29,333,490	31.8	47,831,863	51.9	3,734,778	4.1	11,197,000	12.2
1914	24,907,047	28.2	50,168,813	56.9	4,038,310	4.6	9,116,000	10.3
1926	44,090,657	26.8	101,637,866	61.8	3,324,408	2.0	15,477,239	9.4
1929	51,077,034	29.9	97,623,502	57.2	4,832,700	2.9	17,112,800	10.0
1933	14,135,171	22.3	43,638,023	68.7	1,402,744	2.2	4,297,251	6.8
1935	23,811,687	31.0	45,073,144	58.8	1,478,569	1.9	6,378,170	8.3
1941	46,534,193	28.4	102,285,699	62.3	3,142,021	1.9	12,068,646	7.4
1942	49,479,304	27.0	115,948,373	63.4	3,009,562	1.7	14,343,945	7.9
1943	29,915,157	22.4	92,310,018	69.2	2,300,636	1.7	8,897,977	6.7
1944	17,609,055	19.4	65,478,178	72.0	2,078,530	2.3	5,739,933	6.3
1945	20,383,505	19.8	73,409,831	71.4	2,035,236	2.0	6,976,312	6.8
1946	39,070,643	23.8	112,142,154	68.3	2,720,500	1.7	10,130,891	6.2
1947	43,428,201	23.3	129,338,247	69.3	2,408,845	1.3	11,344,054	6.1
1948	47,559,783	23.1	144,855,487	70.5	2,620,060	1.3	10,412,933	5.1
1949	45,655,516	21.8	150,435,948	71.7	3,310,270	1.6	10,325,683	4.9
1950	47,120,142	20.8	164,811,547	73.0	2,596,962	1.1	11,497,198	5.1
1951	50,328,000	20.4	169,204,269	68.8	2,653,211	1.1	23,836,996	9.7
1952	48,563,411	19.5	177,900,577	71.4	4,037,749	1.6	18,754,417	7.5

[1] Includes Puerto Rico, 1941–51; Hawaii, 1945–46. There has been no production in Hawaii since 1946.
[2] Includes output of 2 plants using oystershells and clay in 1926; 3 plants in 1929, 1933, and 1935; 4 plants in 1941–45; 5 plants in 1946–49 ;6 plants in 1950; 7 plants in 1951; and 8 plants in 1952 (includes 1 plant that uses coquina shells).

former mixture is used at the majority of the plants in the United States, while the number of plants utilizing oystershells increased to eight in 1952.

Cement manufactured from a mixture of marl and clay is listed under the heading "marl and clay." This type of mixture was used at only four plants in 1952; these were in Ohio, Virginia, South Carolina, and Mississippi.

Portland cement made from a mixture of limestone and blast-furnace slag is shown under the last heading. The mixture differs from puzzolan cement in that it is subsequently burned, whereas puzzolan cement is not burned after mixing.

The tonnages of raw materials (exclusive of fuels and explosives) required to produce portland cement in recent years are given in table 11.

TABLE 11.—Raw materials used in producing portland cement in the United States,[1] 1950–52

Raw material	1950	1951	1952
	Short tons	*Short tons*	*Short tons*
Cement rock	12,981,679	13,927,428	13,404,234
Limestone (including oystershells)	49,035,439	53,564,633	53,828,942
Marl	640,462	627,013	1,065,164
Clay and shale [2]	7,169,015	7,857,584	7,939,326
Blast-furnace slag	971,125	1,071,749	1,017,976
Gypsum	1,660,466	1,863,018	1,855,274
Sand and sandstone (including silica and quartz)	769,806	920,183	893,682
Iron materials [3]	379,637	379,818	375,852
Miscellaneous [4]	148,290	173,902	170,104
Total	73,755,919	80,385,328	80,550,554
	Pounds	*Pounds*	*Pounds*
Average total weight required per barrel (376 pounds) of finished cement	653	653	646

[1] Including Puerto Rico.
[2] Includes fuller's earth, diaspore, and kaolin for making white cement.
[3] Includes iron ore, pyrite cinders and ore, and mill scale.
[4] Includes fluorspar, flue dust, pumicite, pitch, red mud and rock, hydrated lime, tufa, calcium chloride, sludge, air-entraining compounds, and grinding aids.

FUEL AND POWER

Of the fuels consumed by the portland-cement industry, coal used declined 5 percent in quantity from the 1951 figure, whereas all other types of fuels were consumed in greater quantity than in the preceding year. Percentage gains for other fuels were: Fuel oil, 2; natural gas, 9; and byproduct gas, 1.

Stocks of coal and oil rarely were adequate at the average monthly consumption rate to maintain operations for more than 2 months.

The number of plants using electric energy, the number of kilowatt-hours generated and purchased, and the average electric energy used per barrel of cement produced are shown in table 14. In 1952 a larger percentage of the total electric energy used was purchased, compared to earlier years.

TABLE 12.—Finished portland cement produced and fuel consumed by the portland-cement industry in the United States,[1] 1951–52, by processes

Process	Finished cement produced			Fuel consumed [2]		
	Plants	Barrels	Percent of total	Coal (short tons)	Oil (barrels of 42 gallons)	Natural gas (M cubic feet)
1951						
Wet	91	138,805,654	56.4	4,000,833	4,649,870	71,637,119
Dry	64	107,216,822	43.6	4,523,886	1,702,442	[3] 31,103,117
Total	155	246,022,476	100.0	[4] 8,524,719	6,352,312	[3] 102,740,236
1952						
Wet	92	141,821,019	56.9	3,789,690	4,859,406	77,583,713
Dry	64	107,435,135	43.1	4,283,519	1,646,990	[3] 34,128,323
Total	156	249,256,154	100.0	[5] 8,073,209	6,506,396	[3] 111,712,036

[1] Includes Puerto Rico.
[2] Figures compiled from monthly estimates of producers.
[3] Includes by product gas: 1951—231,996 M cubic feet; 1952—233,200 M cubic feet.
[4] Comprises 18,081 tons of anthracite and 8,506,638 tons of bituminous coal.
[5] Comprises 170,150 tons of anthracite and 7,903,059 tons of bituminous coal.

TABLE 13.—Portland cement produced in the United States,[1] 1951–52, by kinds of fuel

Fuel	Finished cement produced			Fuel consumed [2]		
	Plants	Barrels	Percent of total	Coal (short tons)	Oil (barrels of 42 gallons)	Natural gas (M cubic feet)
1951						
Coal	74	[3] 117,979,253	48.0	6,760,011		
Oil	14	[3] 22,127,409	9.0		4,562,162	
Natural gas	16	[3] 23,415,074	9.5			33,656,280
Coal and oil	12	17,004,568	6.9	824,485	726,936	
Coal and natural gas	19	28,188,353	11.5	633,417		[4] 27,960,369
Oil and natural gas	9	22,227,639	9.0		763,205	24,237,164
Coal, oil, and natural has	11	15,080,180	6.1	306,806	300,009	16,886,423
Total	155	246,022,476	100.0	[5] 8,524,719	6,352,312	102,740,236
1952						
Coal	74	[3] 116,074,806	46.6	6,550,779		
Oil	15	[3] 22,854,174	9.2		4,653,767	
Natural gas	16	[3] 25,445,073	10.2			35,752,525
Coal and oil	12	17,913,815	7.2	860,852	615,302	
Coal and natural gas	20	31,222,710	12.5	551,284		[6] 33,484,592
Oil and natural gas	11	24,993,566	10.0		1,043,834	27,962,394
Coal, oil, and natural gas	8	10,752,010	4.3	110,294	193,493	14,512,525
Total	156	249,256,154	100.0	[7] 8,073,209	6,506,396	111,712,036

[1] Including Puerto Rico.
[2] Figures compiled from monthly estimates of producers.
[3] Average consumption of fuel per barrel of cement produced was as follows: 1951—Coal, 114.6 pounds; oil, 0.2062 barrel; natural gas, 1,437 cubic feet. 1952—Coal, 112.9 pounds; oil, 0.2036 barrel; natural gas, 1,405 cubic feet.
[4] Includes 231,996 M cubic feet of byproduct gas.
[5] Comprises 18,081 tons of anthracite and 8,506,638 tons of bituminous coal.
[6] Includes 233,200 M cubic feet of byproduct gas.
[7] Comprises 170,150 tons of anthracite and 7,903,059 tons of bituminous coal.

TABLE 14.—Electric energy used at portland-cement-producing plants in the United States,[1] 1951–52, by processes, in kilowatt-hours

Process	Electric energy used						Finished cement produced (barrels)	Average electric energy used per barrel of cement produced (kilowatt-hours)
	Generated at portland-cement plants		Purchased		Total			
	Active plants	Kilowatt-hours	Active plants	Kilowatt-hours	Kilowatt-hours	Percent		
1951								
Wet	31	817, 594, 309	84	2, 137, 534, 857	2, 955, 129, 166	54. 6	138, 805, 654	21. 3
Dry	34	1, 380, 638, 453	54	1, 076, 567, 848	2, 457, 206, 301	45. 4	107, 216, 822	22. 9
Total	65	2, 198, 232, 762	138	3, 214, 102, 705	5, 412, 335, 467	100. 0	246, 022, 476	22. 0
Percent of total electric energy used		40. 6		59. 4	100. 0			
1952								
Wet	30	751, 718, 142	86	2, 262, 480, 825	3, 014, 198, 967	54. 7	141, 821, 019	21. 3
Dry	35	1, 373, 153, 231	54	1, 120, 823, 116	2, 493, 976, 347	45. 3	107, 435, 135	23. 2
Total	65	2, 124, 871, 373	140	3, 383, 303, 941	5, 508, 175, 314	100. 0	249, 256, 154	22. 1
Percent of total electric energy used		38. 6		61. 4	100. 0			

[1] Including Puerto Rico.

EMPLOYMENT AND PRODUCTIVITY

Trends in employment and output per man in the portland-cement industry over the period 1945–49 are shown in tables 15 through 17; table 18 gives a breakdown of output per man-hour on the basis of hours of labor per day for 1947–49, and tables 19 through 21 show breakdowns of employment figures on a producing-district basis for 1948 and 1949.

TABLE 15.—Employment in the portland-cement industry, finished cement produced, and average output per man in the United States,[1] 1945–49

Year	Employment					Production			Percent of industry represented[2]
	Average number of men	Time employed				Finished portland cement (barrels)	Average per man (barrels)		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
1945	20, 695	287	5, 937, 680	8. 0	47, 612, 919	101, 340, 500	17. 07	2. 13	100. 0
1946	25, 044	313	7, 836, 818	8. 0	62, 384, 279	162, 296, 274	20. 71	2. 60	100. 0
1947	26, 962	318	8, 569, 626	7. 9	67, 836, 375	184, 644, 179	21. 55	2. 72	100. 0
1948	27, 648	329	9, 088, 519	8. 0	72, 291, 915	203, 007, 875	22. 34	2. 81	100. 0
1949	28, 430	328	9, 327, 919	7. 8	72, 840, 384	207, 535, 473	22. 25	2. 85	100. 0

[1] Exclusive of Puerto Rico and Hawaii. There has been no production in Hawaii since 1946.
[2] Calculated for each year by dividing quantity of finished cement produced at mills included in the employment survey by total production as determined by the production survey.

TABLE 16.—Mill employees in the portland-cement industry, finished cement produced, and average output per man in the United States,[1] 1945–49

Year	Employment—cement mills only					Production			Percent of industry represented [2]
	Average number of men	Time employed				Finished portland cement (barrels)	Average per man (barrels)		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
1945	16,142	299	4,820,735	8.0	38,551,413	101,340,500	21.02	2.63	100.0
1946	18,101	325	5,874,801	7.9	46,610,834	162,296,274	27.63	3.48	100.0
1947	18,327	330	6,056,358	7.9	47,716,276	184,644,179	30.49	3.87	100.0
1948	18,060	345	6,235,094	7.9	49,437,335	203,007,875	32.56	4.11	100.0
1949	18,304	351	6,427,853	7.8	49,984,152	207,535,473	32.29	4.15	100.0

[1] Exclusive of Puerto Rico and Hawaii. There has been no production in Hawaii since 1946.
[2] See footnote 2, table 15.

TABLE 17.—Quarry and crusher employees in the portland-cement industry, material handled, and average output of material per man in the United States,[1] 1945–49

Year	Employment—quarries and crushers only					Material handled—quarry rock			Percent of industry represented [2]
	Average number of men	Time employed				Short tons	Average per man (short tons)		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
1945	3,500	245	857,117	8.1	6,954,881	29,122,715	33.98	4.19	90.8
1946	4,307	271	1,166,537	8.0	9,370,921	45,065,371	38.63	4.81	90.9
1947	4,704	282	1,328,625	8.0	10,638,458	51,493,686	38.76	4.84	90.0
1948	4,631	287	1,330,780	8.0	10,664,655	57,344,472	43.09	5.38	89.3
1949	4,697	276	1,294,625	8.0	10,405,767	57,462,023	44.39	5.52	89.3

[1] Exclusive of Puerto Rico and Hawaii. There has been no production in Hawaii since 1946.
[2] Calculated for each year by dividing quantity of finished cement produced at mills for which quarry employment reported, by total production as determined by production survey.

TABLE 18.—Number of men employed in the portland-cement industry in the United States,[1] and output per man-hour, 1947–49, classified according to hours of labor per day

Hours per day	1947			1948			1949		
	Men employed		Production per man-hour (barrels)	Men employed		Production per man-hour (barrels)	Men employed		Production per man-hour (barrels)
	Number	Percent of total		Number	Percent of total		Number	Percent of total	
Less than 6	403	1.5	2.82	202	0.7	3.23	225	0.8	2.41
6 and less than 7	1,129	4.2	2.93	305	1.1	2.22	2,759	9.7	2.84
7 and less than 8	877	3.2	3.36	2,216	8.0	2.79	1,320	4.6	2.84
8 and less than 9	24,388	90.5	2.64	24,925	90.2	2.76	24,126	84.9	2.81
9 and less than 10	165	.6	3.60						
Total	26,962	100.0	2.72	27,648	100.0	2.81	28,430	100.0	2.85

[1] Exclusive of Puerto Rico.

TABLE 19.—Employment in the portland-cement industry, finished cement produced, and average output per man in the United States,[1] 1948–49, by districts

District	Employment					Production			Percent of industry represented [2]
	Average number of men	Time employed				Finished portland cement (barrels)	Average per man (barrels)		
		Average number of days	Total man-shifts	Man-hours					
				Average per man per day	Total		Per shift	Per hour	
1948									
Eastern Pennsylvania and Maryland	4,465	339	1,512,733	8.0	12,098,427	33,589,877	22.20	2.78	100.0
New York and Maine	1,927	325	626,641	7.8	4,889,335	13,504,096	21.55	2.76	100.0
Ohio	1,358	331	448,859	8.0	3,603,482	10,035,211	22.36	2.78	100.0
Western Pennsylvania and West Virginia	1,650	338	557,864	8.0	4,467,098	8,940,151	16.03	2.00	100.0
Michigan	1,456	318	462,869	7.7	3,552,662	11,410,085	24.65	3.21	100.0
Illinois	1,143	314	359,188	8.0	2,874,790	7,570,536	21.08	2.63	100.0
Indiana, Kentucky, and Wisconsin	1,981	343	680,027	8.0	5,455,390	12,333,325	18.14	2.26	100.0
Alabama	991	336	332,580	8.0	2,677,153	9,908,219	29.79	3.70	100.0
Tennessee	884	328	289,693	8.0	2,326,764	6,727,160	23.22	2.89	100.0
Virginia, Georgia, Florida, and Louisiana	1,156	329	379,766	8.0	3,041,951	7,134,091	18.79	2.35	100.0
Iowa	971	317	307,678	8.0	2,461,431	6,807,214	22.12	2.77	100.0
Eastern Missouri, Minnesota, and South Dakota	1,454	321	467,168	7.9	3,713,562	9,654,828	20.67	2.50	100.0
Kansas	1,226	307	376,294	7.6	2,867,129	7,933,899	21.08	2.77	100.0
Western Missouri, Nebraska, Oklahoma, and Arkansas	963	342	329,100	8.0	2,630,168	6,960,336	21.15	2.65	100.0
Texas	1,547	342	529,414	8.0	4,239,150	13,700,633	25.88	3.23	100.0
Colorado, Wyoming, Montana, Utah, and Idaho	761	350	266,679	7.8	2,092,572	5,456,272	20.46	2.61	100.0
Northern California	1,264	301	380,845	8.0	3,044,243	11,120,313	29.20	3.65	100.0
Southern California	1,523	321	488,778	8.0	3,907,796	13,481,579	27.58	3.45	100.0
Oregon and Washington	928	315	292,343	8.0	2,348,812	6,740,050	23.06	2.87	100.0
Total	27,648	329	9,088,519	8.0	72,291,915	203,007,875	22.34	2.81	100.0
1949									
Eastern Pennsylvania and Maryland	4,416	333	1,469,756	8.0	11,704,346	33,799,369	23.00	2.89	100.0
New York and Maine	1,979	317	626,942	7.7	4,855,793	13,838,715	22.07	2.85	100.0
Ohio	1,461	323	471,840	8.0	3,784,116	10,313,496	21.86	2.73	100.0
Western Pennsylvania and West Virginia	1,753	312	546,856	7.6	4,176,281	8,930,125	16.33	2.14	100.0
Michigan	1,481	351	519,960	7.2	3,725,601	12,767,500	24.55	3.43	100.0
Illinois	1,141	347	395,553	7.0	2,781,914	8,127,656	20.55	2.92	100.0
Indiana, Kentucky, and Wisconsin	1,977	338	668,447	8.1	5,392,839	12,683,409	18.97	2.35	100.0
Alabama	1,033	302	312,123	8.0	2,502,352	9,721,542	31.15	3.88	100.0
Tennessee	836	322	269,030	8.0	2,153,088	6,077,549	22.59	2.82	100.0
Virginia, Georgia, Florida, Louisiana, and South Carolina [3]	1,335	335	447,508	7.6	3,387,175	8,505,552	19.01	2.51	100.0
Iowa	1,120	327	366,625	8.0	2,933,341	6,834,445	18.64	2.33	100.0
Eastern Missouri, Minnesota, and South Dakota	1,379	329	454,085	8.0	3,647,829	9,867,811	21.73	2.71	100.0
Kansas	1,149	332	381,366	7.6	2,908,438	7,824,620	20.52	2.69	100.0
Western Missouri, Nebraska, Oklahoma, and Arkansas	1,015	340	344,907	7.7	2,649,703	7,412,145	21.49	2.80	100.0
Texas	1,555	343	533,429	8.0	4,279,668	14,949,812	28.03	3.49	100.0
Colorado, Arizona,[4] Wyoming, Montana, Utah, and Idaho	1,079	344	370,778	8.0	2,966,531	6,261,861	16.89	2.11	100.0
Northern California	1,240	301	373,411	8.0	2,987,334	10,956,612	29.34	3.67	100.0
Southern California	1,356	308	418,135	8.0	3,345,096	12,261,744	29.32	3.67	100.0
Oregon and Washington	1,125	317	357,168	7.4	2,658,939	6,401,510	17.92	2.41	100.0
Total	28,430	328	9,327,919	7.8	72,840,384	207,535,473	22.25	2.85	100.0

[1] Exclusive of Puerto Rico.
[2] See footnote 2, table 15.
[3] South Carolina began full-scale commercial operations in early 1949.
[4] Arizona first began operating in December 1949.

TABLE 20.—Mill employees in the portland-cement industry, finished cement produced, and average output per man in the United States,[1] 1948–49, by districts

District	Employment—cement mills only					Production			Percent of industry represented[2]
	Average number of men	Time employed				Finished portland cement (barrels)	Average per man (barrels)		
		Average number of days	Total man-shifts	Man-hours			Per shift	Per hour	
				Average per man per day	Total				
1948									
Eastern Pennsylvania and Maryland	3,002	360	1,080,446	8.0	8,639,172	33,589,877	31.09	3.89	100.0
New York and Maine	1,265	332	420,193	7.7	3,219,007	13,504,096	32.14	4.20	100.0
Ohio	759	357	271,175	8.0	2,172,538	10,035,211	37.01	4.62	100.0
Western Pennsylvania and West Virginia	990	363	359,208	8.0	2,874,220	8,940,151	24.89	3.11	100.0
Michigan	1,040	338	351,870	7.4	2,597,260	11,410,085	32.43	4.39	100.0
Illinois	672	338	226,994	8.0	1,816,675	7,570,536	33.35	4.17	100.0
Indiana, Kentucky, and Wisconsin	1,602	359	574,692	8.0	4,607,536	12,333,325	21.46	2.68	100.0
Alabama	660	361	238,062	8.0	1,913,522	9,908,219	41.62	5.18	100.0
Tennessee	564	334	188,502	8.0	1,508,065	6,727,160	35.69	4.46	100.0
Virginia, Georgia, Florida, and Louisiana	844	338	285,431	7.9	2,263,997	7,134,091	24.99	3.15	100.0
Iowa	724	335	242,234	8.0	1,937,872	6,807,214	28.10	3.51	100.0
Eastern Missouri, Minnesota, and South Dakota	832	344	286,413	8.0	2,290,094	9,654,828	33.71	4.22	100.0
Kansas	790	324	256,338	7.6	1,955,107	7,933,899	30.95	4.06	100.0
Western Missouri, Nebraska, Oklahoma, and Arkansas	586	361	211,328	8.0	1,693,530	6,960,336	32.94	4.10	100.0
Texas	1,176	357	419,656	8.0	3,368,187	13,700,633	32.65	4.07	100.0
Colorado, Wyoming, Montana, Utah, and Idaho	498	351	174,598	8.0	1,396,802	5,456,272	31.25	3.91	100.0
Northern California	528	298	157,337	8.0	1,258,693	11,120,313	70.68	8.83	100.0
Southern California	904	315	284,468	8.0	2,275,743	13,481,579	47.39	5.92	100.0
Oregon and Washington	624	330	206,149	8.0	1,649,315	6,740,050	32.70	4.09	100.0
Total	18,060	345	6,235,094	7.9	49,437,335	203,007,875	32.56	4.11	100.0
1949									
Eastern Pennsylvania and Maryland	2,960	357	1,056,700	8.0	8,418,596	33,799,369	31.99	4.01	100.0
New York and Maine	1,240	347	430,207	7.6	3,271,022	13,838,715	32.17	4.23	100.0
Ohio	834	340	283,874	8.0	2,274,563	10,313,496	36.33	4.53	100.0
Western Pennsylvania and West Virginia	979	337	329,607	7.7	2,530,311	8,930,125	27.09	3.53	100.0
Michigan	1,061	354	375,893	7.2	2,710,594	12,767,500	33.97	4.71	100.0
Illinois	751	365	273,772	6.7	1,825,573	8,127,656	29.69	4.45	100.0
Indiana, Kentucky, and Wisconsin	1,534	360	552,442	8.1	4,453,869	12,683,409	22.96	2.85	100.0
Alabama	573	333	191,008	8.0	1,533,587	9,721,542	50.90	6.34	100.0
Tennessee	499	350	174,438	8.0	1,395,519	6,077,549	34.84	4.36	100.0
Virginia, Georgia, Florida, Louisiana, and South Carolina[3]	952	351	334,439	7.4	2,476,698	8,505,552	25.43	3.43	100.0
Iowa	763	357	272,411	8.0	2,179,563	6,834,445	25.09	3.14	100.0
Eastern Missouri, Minnesota, and South Dakota	858	358	307,578	8.0	2,461,673	9,867,811	32.08	4.01	100.0
Kansas	713	366	260,734	7.6	1,985,022	7,824,620	30.01	3.94	100.0
Western Missouri, Nebraska, Oklahoma, and Arkansas	556	360	200,077	7.9	1,580,863	7,412,145	37.05	4.69	100.0
Texas	1,186	362	429,286	8.0	3,443,825	14,949,812	34.82	4.34	100.0
Colorado, Arizona,[4] Wyoming, Montana, Utah, and Idaho	732	347	253,704	8.0	2,029,617	6,261,861	24.68	3.09	100.0
Northern California	457	339	155,035	8.0	1,240,287	10,956,612	70.67	8.83	100.0
Southern California	874	319	278,495	8.0	2,227,966	12,261,744	44.03	5.50	100.0
Oregon and Washington	782	343	268,153	7.3	1,945,004	6,401,510	23.87	3.29	100.0
Total	18,304	351	6,427,853	7.8	49,984,152	207,535,473	32.29	4.15	100.0

[1] Exclusive of Puerto Rico.
[2] See footnote 2, table 15.
[3] South Carolina began full-scale commercial operations in early 1949.
[4] Arizona first began operating in December 1949.

TABLE 21.—Quarry and crusher employees in the portland-cement industry, material (quarry rock) handled, and average output of material per man in the United States,[1] 1948–49, by districts

District	Employment—quarry and crusher only					Material handled—quarry rock			Percent of industry represented[2]
	Average number of men	Time employed				Short tons	Average per man (short tons)		
		Average number of days	Total man-shifts	Man-hours					
				Average per man per day	Total		Per shift	Per hour	
1948									
Eastern Pennsylvania and Maryland	755	277	208,798	8.0	1,672,117	9,541,896	45.70	5.71	94.5
New York and Maine	272	275	74,773	8.2	616,260	3,339,706	44.66	5.42	100.0
Ohio	261	269	70,324	8.1	572,059	2,556,036	36.35	4.47	100.0
Western Pennsylvania and West Virginia	432	303	130,949	8.0	1,050,436	4,375,445	33.41	4.17	57.6
Michigan	64	274	17,535	8.5	148,387	748,159	42.67	5.04	51.9
Illinois	199	303	60,217	8.0	481,714	2,380,802	39.54	4.94	100.0
Indiana, Kentucky, and Wisconsin	207	284	58,754	8.1	478,728	2,342,773	39.87	4.89	58.1
Alabama	208	255	52,943	7.9	418,182	2,732,008	51.60	6.53	84.9
Tennessee	197	313	61,727	8.1	499,893	1,803,773	29.22	3.61	89.0
Virginia, Georgia, Florida, and Louisiana	251	301	75,602	8.1	614,517	2,472,577	32.71	4.02	100.0
Iowa	172	255	43,930	8.0	351,445	2,231,625	50.80	6.35	100.0
Eastern Missouri, Minnesota, and South Dakota	180	286	51,440	8.2	420,924	2,431,969	47.28	5.78	84.9
Kansas	190	268	50,925	7.9	401,843	2,445,030	48.01	6.08	100.0
Western Missouri, Nebraska, Oklahoma, and Arkansas	200	302	60,451	7.9	478,062	2,327,845	38.51	4.87	100.0
Texas	159	301	47,908	7.8	375,631	3,166,025	66.09	8.43	92.9
Colorado, Wyoming, Montana, Utah, and Idaho	122	360	43,962	7.1	311,228	1,835,368	41.75	5.90	96.3
Northern California	234	281	65,783	8.0	523,754	4,026,374	61.21	7.69	100.0
Southern California	290	306	88,822	8.0	712,032	4,334,212	48.80	6.09	95.6
Oregon and Washington	238	277	65,937	8.2	537,443	2,252,849	34.17	4.19	100.0
Total	4,631	287	1,330,780	8.0	10,664,655	57,344,472	43.09	5.38	89.3
1949									
Eastern Pennsylvania and Maryland	727	272	197,544	8.0	1,579,484	9,678,881	49.00	6.13	95.4
New York and Maine	272	247	67,131	8.3	554,090	3,289,291	49.00	5.94	100.0
Ohio	303	292	88,335	8.1	712,220	2,849,466	32.26	4.00	100.0
Western Pennsylvania and West Virginia	443	274	121,451	7.7	934,723	3,782,667	31.15	4.05	58.5
Michigan	61	304	18,539	7.9	146,529	881,619	47.55	6.02	55.9
Illinois	188	291	54,724	7.7	419,807	2,494,043	45.57	5.94	100.0
Indiana, Kentucky, and Wisconsin	147	254	37,293	8.1	303,507	1,894,722	50.81	6.24	59.1
Alabama	189	247	46,616	7.9	367,406	2,672,770	57.34	7.27	83.8
Tennessee	214	272	58,102	8.0	465,405	1,688,430	29.06	3.63	86.2
Virginia, Georgia, Florida, Louisiana, and South Carolina[3]	262	294	76,939	8.0	616,460	3,004,277	39.05	4.87	100.0
Iowa	172	253	43,499	8.0	348,059	2,266,369	52.10	6.51	100.0
Eastern Missouri, Minnesota, and South Dakota	240	285	68,337	8.1	551,697	2,511,335	36.75	4.55	85.5
Kansas	187	275	51,484	7.9	406,464	2,440,568	47.40	6.00	100.0
Western Missouri, Nebraska, Oklahoma, and Arkansas	217	297	64,457	7.7	496,732	2,465,495	38.25	4.96	100.0
Texas	149	317	47,291	8.0	380,464	3,386,667	71.61	8.90	92.2
Colorado, Arizona,[4] Wyoming, Montana, Utah, and Idaho	151	340	51,269	8.0	410,471	2,100,830	40.98	5.12	99.3
Northern California	237	228	54,133	9.7	527,092	3,958,595	73.13	7.51	100.0
Southern California	271	295	80,055	8.0	640,450	3,985,491	49.78	6.22	95.7
Oregon and Washington	267	253	67,426	8.1	544,707	2,110,507	31.30	3.87	91.7
Total	4,697	276	1,294,625	8.0	10,405,767	57,462,023	44.39	5.52	89.3

[1] Exclusive of Puerto Rico.
[2] See footnote 2, table 17.
[3] South Carolina began full-scale commercial operations in early 1949.
[4] Arizona first began operating in December 1949.

TRANSPORTATION

The quantity and proportion of portland cement shipped in 1950–52 by each of the methods of transportation and mode of packing or packaging are given in table 22. The most important 1952 changes shown in the table are an increase in the percentage shipped in bulk and a corresponding decrease in the percentage shipped in bags. Study of producers' reports shows that principal 1952 percentage gains in bulk shipments, as compared to percentages shipped in containers, were made in the Eastern Missouri-Minnesota-South Dakota, Iowa, Illinois, and Kansas districts.

Little change from 1951 was noted in the respective percentages shipped by truck, railroad, and boat.

TABLE 22.—Shipments of portland cement from mills in the United States,[1] 1950–52, in bulk and in containers, by types of carriers

Type of carrier	In bulk		In containers				Total shipments	
	Barrels	Percent	Bags: Paper (barrels)	Bags: Cloth (barrels)	Other containers [2] (barrels)	Total (barrels)	Barrels	Percent
1950								
Truck	[3]32, 813, 799	26. 4	21, 554, 555	357, 547	--------	21, 912, 102	54, 725, 901	24. 0
Railroad	89, 209, 877	71. 6	77, 911, 406	2, 979, 928	11, 318	80, 902, 652	170, 112, 529	74. 7
Boat	2, 495, 582	2. 0	400, 752	21, 418	454	422, 624	2, 918, 206	1. 3
Total	124, 519, 258	100. 0	99, 866, 713	3, 358, 893	11, 772	103, 237, 378	227, 756, 636	100. 0
Percent of total	54. 7	--------	43. 8	1. 5	(4)	45. 3	100. 0	--------
1951								
Truck	[3]42, 899, 170	29. 2	22, 366, 199	186, 924	--------	22, 553, 123	65, 452, 293	27. 2
Railroad	102, 233, 611	69. 5	70, 327, 861	673, 634	8, 558	71, 010, 053	173, 243, 664	71. 8
Boat	1, 940, 483	1. 3	496, 895	18, 416	1, 521	516, 832	2, 457, 315	1. 0
Total	147, 073, 264	100. 0	93, 190, 955	878, 974	10, 079	94, 080, 008	241, 153, 272	100. 0
Percent of total	61. 0	--------	38. 6	0. 4	(4)	39. 0	100. 0	--------
1952								
Truck	[3]45, 690, 842	28. 8	22, 948, 530	138, 702	--------	23, 087, 232	68, 778, 074	27. 3
Railroad	109, 566, 554	69. 1	68, 891, 460	446, 361	8, 218	69, 346, 039	178, 912, 593	71. 2
Boat	3, 248, 587	2. 1	392, 025	36, 340	884	429, 249	3, 677 836	1. 5
Total	158, 505, 983	100. 0	92, 232, 015	621, 403	9, 102	92, 862, 520	251, 368, 503	100. 0
Percent of total	63. 1	--------	36. 7	0. 2	(4)	36. 9	100. 0	--------

[1] Includes Puerto Rico.
[2] Includes steel drums and iron and wood barrels.
[3] Includes cement used at mills by producers as follows—1950: 929,451 barrels; 1951: 1,368,117 barrels; 1952: 1,212,495 barrels.
[4] Less than 0.05 percent.

CONSUMPTION

Quantities shown in table 24 are the total number of barrels of portland cement reported by domestic producers to have been shipped to destinations in the respective States and the District of Columbia. They represent shipments both from plants in the State in question and from all other States. These data are often termed "apparent-consumption" or "indicated-consumption" figures.

Of course, at any time a variable but considerable quantity of cement is in transit, in warehouses at distributing points, and awaiting

TABLE 23.—Destination of shipments of finished portland cement from mills in the United States, 1950–52, by States

Destination	1950 (barrels)	1951 (barrels)	1952	
			Barrels	Change from 1951 percent
Continental United States:				
Alabama	3, 395, 505	3, 736, 413	3, 920, 511	+4. 9
Arizona	1, 572, 137	1, 681, 846	2, 121, 492	+26. 1
Arkansas	2, 406, 455	1, 854, 107	1, 941, 519	+4. 7
California	23, 508, 046	25, 191, 516	25, 361, 032	+. 7
Colorado	2, 432, 616	2, 858, 840	2, 824, 978	−1. 2
Connecticut [1]	2, 629, 280	2, 770, 756	2, 977, 458	+7. 5
Delaware [1]	806, 434	783, 892	906, 245	+15. 6
District of Columbia [1]	1, 484, 834	1, 457, 896	1, 155, 923	−20. 7
Florida	4, 998, 502	6, 051, 603	6, 680, 385	+10. 4
Georgia	3, 313, 750	3, 513, 978	4, 116, 620	+17. 1
Idaho	1, 004, 858	1, 154, 434	1, 110, 295	−3. 8
Illinois	11, 557, 409	12, 286, 321	13, 324, 065	+8. 4
Indiana	5, 611, 993	6, 354, 398	6, 222, 861	−2. 1
Iowa	4, 828, 232	4, 948, 586	4, 976, 010	+. 6
Kansas	4, 793, 853	4, 477, 884	5, 852, 155	+30. 7
Kentucky	2, 559, 713	2, 925, 136	3, 621, 414	+23. 8
Louisiana	4, 551, 836	5, 282, 319	5, 868, 630	+11. 1
Maine	549, 577	711, 192	692, 055	−2. 7
Maryland	4, 406, 182	4, 398, 730	4, 362, 945	−. 8
Massachusetts [1]	4, 161, 610	4, 153, 399	4, 346, 378	+4. 6
Michigan	9, 645, 331	10, 693, 060	11, 310, 322	+5. 8
Minnesota	4, 896, 145	4, 520, 518	4, 748, 175	+5. 0
Mississippi [2]	1, 676, 409	1, 670, 933	1, 704, 719	+2. 0
Missouri	5, 852, 265	5, 663, 459	6, 319, 588	+11. 6
Montana	1, 405, 328	1, 576, 885	1, 358, 350	−13. 9
Nebraska	2, 538, 361	2, 356, 433	2, 626, 741	+11. 5
Nevada [1]	325, 997	389, 815	618, 392	+58. 6
New Hampshire [1]	520, 977	442, 168	456, 691	+3. 3
New Jersey [1]	7, 239, 023	8, 231, 613	8, 084, 668	−1. 8
New Mexico [1]	2, 101, 080	1, 745, 162	1, 645, 426	−5. 7
New York	15, 537, 337	16, 248, 279	16, 898, 736	+4. 0
North Carolina [1]	3, 699, 380	3, 683, 471	3, 885, 629	+5. 5
North Dakota [1]	928, 766	1, 004, 990	1, 071, 422	+6. 6
Ohio	0, 307, 833	12, 967, 938	13, 095, 380	+1. 0
Oklahoma	4, 425, 102	3, 781, 008	4, 651, 344	+23. 0
Oregon	2, 603, 223	3, 349, 725	2, 927, 040	−12. 6
Pennsylvania	15, 093, 106	16, 133, 233	15, 132, 930	−6. 2
Rhode Island [1]	845, 092	956, 077	923, 860	−3. 4
South Carolina	2, 069, 957	2, 313, 122	2, 961, 293	+28. 0
South Dakota	1, 354, 744	1, 012, 080	1, 108, 810	+9. 6
Tennessee	4, 565, 588	4, 792, 334	4, 701, 963	−1. 9
Texas	16, 671, 621	16, 518, 808	17, 257, 467	+4. 5
Utah	1, 279, 828	1, 191, 237	1, 342, 998	+12. 7
Vermont [1]	317, 345	330, 400	316, 066	−4. 3
Virginia	4, 068, 441	4, 719, 467	4, 649, 768	−1. 5
Washington	4, 210, 197	4, 518, 034	4, 954, 171	+9. 7
West Virginia	1, 898, 334	1, 802, 919	1, 804, 409	+. 1
Wisconsin	5, 274, 002	5, 226, 527	5, 667, 282	+8. 4
Wyoming	649, 695	606, 912	561, 486	−7. 5
Unspecified	35, 049	7, 536	8, 840	+17. 3
Total continental United States	222, 608, 378	235, 047, 389	245, 176, 937	+4. 3
Outside continental United States [3]	5, 148, 258	6, 105, 883	6, 191, 566	+1. 4
Total shipped from cement plants	227, 756, 636	241, 153, 272	251, 368, 503	+4. 2

[1] Non-cement-producing State.
[2] Mississippi was first included as a cement-producing State in 1952.
[3] Direct shipments by producers to foreign countries and to noncontiguous Territories (Alaska, Hawaii, Puerto Rico, etc.), including distribution from Puerto Rican mills.

use at jobs. In certain instances much of the cement shipped to a distributing point near a State line is subsequently used in a State other than that listed as its "destination." Some coastal and border States receive cement from foreign countries, and the quantities are not included here. Although shipments into a State in a year do not equal its consumption during that year, shipments over a long period should afford a fair index of consumption.

As shown in table 23, indicated consumption of portland cement in 1952 increased in 33 States and decreased in 15 States and the District of Columbia, compared to 1951. The major percentage gain was registered by Nevada, but marked increases were indicated in Kansas, South Carolina, Arizona, Kentucky, and Oklahoma. Declines were sharpest in the District of Columbia, Montana, and Oregon. California, Texas, New York, Pennsylvania, Illinois, Ohio, and Michigan, in that order, were the largest consumers of cement in 1952. These 7 States reported 46 percent of the total consumption in continental United States, while the 11 non-cement-producing States and the District of Columbia reported 11 percent.

LOCAL SUPPLY

The surplus or deficiency in the quantity of portland cement locally available is indicated in table 25. The comparison is based on shipments from mills and on consumption as shown by State receipts of mill shipments. The 1952 deficiencies occurred in 2 States and in all 6 divisions.

The total surplus of producing States in 1952 was distributed as follows: 27,286,601 barrels to non-cement-producing States, Alaska, and Hawaii; 2,790,265 barrels to destinations outside continental United States (excluding local consumption of Puerto Rican production); and 8,840 barrels to unspecified destinations.

STOCKS

Shipments in 1952 were considerably higher than production and absorbed a large part of the excess stocks accumulated at the end of 1951. However, stocks in Puerto Rico increased almost sixfold.

Through the first 8 months of the year, stocks of finished portland cement on hand at the end of each month followed essentially the 1951 pattern but at a higher level. However, through the last 4 months they were increasingly lower than in 1951 and by the end of December reached a figure 2 million barrels below that for December 31, 1951.

TABLE 24.—Destination of shipments of finished portland cement from mills in the United States in 1952, by months, in barrels

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Alabama	309, 389	294, 042	307, 761	330, 960	340, 688	297, 936	319, 328	340, 915	371, 894	378, 396	314, 589	277. 387
Arizona	187, 764	184, 405	164, 285	186, 429	200, 351	176, 956	161, 183	157, 031	169, 621	187, 275	155, 108	188, 806
Arkansas	113, 546	108, 324	135, 778	140, 311	194, 663	187, 809	173, 594	201, 275	229, 348	215, 993	155, 343	83, 519
California	1, 419, 207	1, 974, 615	1, 747, 495	2, 095, 437	2, 043, 104	2, 056, 381	2, 252, 230	2, 434, 682	2, 434, 363	2, 810, 751	2, 214, 683	1, 884, 034
Colorado	144, 212	180, 088	163, 660	238, 107	260, 033	305, 399	274, 935	304, 448	317, 785	298, 433	194, 738	144, 193
Connecticut	127, 741	129, 731	195, 580	293, 822	270, 555	321, 233	305, 965	298, 874	314. 841	307, 734	263, 792	147, 340
Delaware	40, 324	46, 144	50, 095	60, 889	77, 443	63, 414	66, 370	74, 763	118, 285	137, 117	85, 844	40, 776
District of Columbia	101, 702	93, 752	83, 712	92, 070	92. 250	93, 385	96, 659	95, 943	114, 009	117, 315	91, 917	83, 164
Florida	503, 032	521, 306	545, 778	550, 481	587, 769	578, 131	579, 744	526, 941	528, 699	503, 985	606, 414	647, 871
Georgia	292, 789	273, 402	273, 180	347, 657	377, 831	381, 745	394, 178	401, 734	396, 468	428, 089	337, 053	256, 954
Idaho	58, 405	90, 023	119, 077	121, 542	102, 383	90, 047	95, 961	95, 770	96, 369	113, 926	77, 650	54, 421
Illinois	388, 910	595, 957	652, 035	1, 150, 102	1, 361, 202	1, 373, 586	1, 339, 501	1, 687, 450	1, 678, 652	1, 531, 121	1, 072, 249	496, 092
Indiana	218, 489	297, 437	383, 158	558, 481	605, 587	630, 881	683, 641	757, 943	677, 603	649, 032	507, 723	236, 828
Iowa	64, 283	95, 419	135, 490	317, 913	478, 139	612, 843	664, 884	760, 914	663, 639	734, 609	268, 887	92, 982
Kansas	263, 957	338, 506	298, 459	536, 224	556, 558	595, 882	605, 706	618, 634	664, 570	627, 403	558, 394	274, 447
Kentucky	173, 518	232, 679	236, 900	324, 427	348, 291	360, 087	351, 927	360, 535	364, 859	383, 563	312, 991	171, 242
Louisiana	459, 883	412, 875	479, 333	452, 769	443, 505	564, 709	507, 262	517, 043	561, 744	584, 710	482, 687	402, 159
Maine	15, 203	10, 776	15, 265	62, 393	90, 299	95, 284	86, 365	82. 538	91, 668	76, 888	37, 437	27, 915
Maryland	210, 465	307, 131	303, 782	397, 381	417, 627	425, 922	439, 208	432, 657	424, 846	435, 913	329, 695	237, 881
Massachusetts	192, 905	161, 833	267, 598	461, 872	412, 331	450, 053	422, 506	430, 785	438, 478	455, 970	396, 300	256, 134
Michigan	350, 037	387, 118	502, 690	971, 462	1, 179, 416	1, 387, 701	1, 370, 379	1, 236, 753	1, 246, 721	1, 283, 794	846, 044	493, 046
Minnesota	92, 085	114, 545	147, 114	356, 364	490, 180	603, 083	690, 068	657, 893	616, 779	561, 670	281, 288	137, 183
Mississippi	122, 224	117, 277	128, 650	146, 823	145, 587	152, 161	141, 287	153, 597	155, 524	160, 057	157, 754	123, 715
Missouri	253, 575	341, 691	349, 013	522, 668	615, 101	655, 631	646, 016	636, 166	686, 304	806, 917	504, 789	301, 482
Montana	11, 756	20, 864	47, 889	173, 321	209, 352	215, 333	195, 177	163, 802	124, 504	117, 057	53, 119	26, 129
Nebraska	49, 484	78, 452	84, 923	213, 087	286, 928	292, 957	334, 474	340, 532	352, 440	349, 171	196, 729	49, 354
Nevada	32, 794	32, 425	33, 435	40, 097	35, 739	37, 024	54, 990	68, 032	87, 615	94, 079	61, 142	47, 477
New Hampshire	15, 914	14, 400	20, 849	51, 511	45, 766	51, 432	47, 285	47, 975	48, 814	53, 391	33, 457	19, 982
New Jersey	418, 182	448, 106	586, 306	783, 944	746, 068	811, 494	715, 179	774, 502	822, 803	868, 749	685, 672	423, 225
New Mexico	118, 949	113, 262	125, 017	142, 643	151, 504	160, 593	148, 650	142, 126	146, 720	157, 442	127, 329	110, 351
New York	632, 621	669, 909	1, 001, 925	1, 572, 398	1, 644, 470	1, 925, 271	1, 718, 875	1, 761, 006	1, 844, 443	1, 881, 807	1, 427, 800	824, 784
North Carolina	284, 598	277, 903	310, 899	388, 363	384, 021	361, 147	359, 910	339, 747	338, 603	339, 966	292, 246	219, 095
North Dakota	5, 898	9, 484	25, 174	119, 062	135, 906	168, 797	168, 631	140, 401	128, 715	94, 809	49, 841	14, 958
Ohio	540, 968	590, 851	773, 843	1, 042, 164	1, 122, 612	1, 381, 632	1, 449, 639	1, 543, 878	1, 473, 821	1, 475, 140	1, 043, 866	582, 736
Oklahoma	279, 521	314, 723	330, 136	358, 632	342, 006	388, 592	418, 098	479, 420	512, 690	549, 210	379, 413	324, 393
Oregon	227, 360	282, 639	270, 465	284, 792	240, 343	231, 930	270, 181	266, 371	252, 154	293, 461	141, 837	140, 881
Pennsylvania	688, 304	843, 208	918, 023	1, 321, 207	1, 313, 041	1, 401, 136	1, 437, 893	1, 585, 428	1, 706, 281	1, 844, 835	1, 200, 315	795, 660
Rhode Island	35, 854	28, 053	54, 994	120, 441	184, 636	98, 896	97, 618	82, 067	92, 666	96, 106	80, 595	43, 440
South Carolina	263, 165	232, 797	238, 892	281, 025	269, 349	263, 160	258, 710	231, 526	235, 829	268, 999	231, 524	186, 084
South Dakota	13, 189	18, 884	25, 880	88, 170	142, 385	166, 961	141, 631	129, 633	140, 907	141, 514	76, 294	27, 871

TABLE 24.—Destination of shipments of finished portland cement from mills in the United States in 1952, by months, in barrels—Con.

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Tennessee	323, 834	360, 139	359, 578	436, 354	421, 820	457, 893	413, 568	359, 991	411, 312	465, 240	360, 626	331, 441
Texas	1, 434, 589	1, 362, 175	1, 556, 206	1, 509, 773	1, 601, 465	1, 468, 590	1, 460, 384	1, 430, 039	1, 441, 036	1, 578, 013	1, 230, 623	1, 176, 322
Utah	23, 409	38, 348	39, 560	114, 080	136, 769	133, 501	142, 355	155, 610	164, 006	226, 955	113, 156	55, 415
Vermont	4, 372	2, 981	8, 666	29, 773	28, 467	43, 201	41, 972	42, 001	36, 159	42, 549	26, 554	14, 133
Virginia	275, 670	306, 953	347, 305	463, 316	455, 015	427, 732	431, 010	438, 005	446, 168	446, 565	342, 566	271, 530
Washington	149, 471	285, 426	362, 910	508, 841	478, 766	466, 488	501, 619	524, 241	521, 404	547, 334	341, 218	266, 058
West Virginia	91, 736	95, 137	123, 911	157, 454	151, 750	188, 108	195, 076	192, 516	187, 142	186, 191	144, 112	77, 935
Wisconsin	127, 726	159, 460	177, 110	329, 305	558, 153	814, 748	771, 719	705, 388	753, 548	678, 911	417, 212	179, 854
Wyoming	19, 241	22, 077	26, 065	51, 499	57, 411	75, 244	65, 109	77, 601	44, 566	62, 345	37, 287	22, 927
Unspecified	1, 254	0	698	5, 490	0	29	2, 646	433	10, 166	369	0	1, 337
Continental United States	12, 173, 504	13, 917, 732	15, 536, 547	21, 303, 326	22, 834, 635	24, 492, 148	24, 511, 296	25, 287, 555	25, 687, 581	26, 650, 869	19, 347, 902	13, 292, 943
Outside continental United States [1]	522, 496	444, 268	456, 453	460, 674	447, 365	574, 852	572, 704	627, 445	552, 419	572, 131	423, 098	447, 057
Total	12, 696, 000	14, 362, 000	15, 993, 000	21, 764, 000	23, 282, 000	25, 067, 000	25, 084, 000	25, 915, 000	26, 240, 000	27, 223, 000	19, 771, 000	13, 740, 000

[1] Shipments by producers to foreign countries and to noncontiguous Territories of the United States (Alaska, Hawaii, Puerto Rico, etc.), including distribution from Puerto Rican mills.

TABLE 25.—Estimated surplus or deficiency in local supply of portland cement in cement-producing States, 1951–52, in barrels

State or division	1951			1952		
	Shipments from mills	Estimated consumption	Surplus or deficiency	Shipments from mills	Estimated consumption	Surplus or deficiency
Alabama	10, 586, 825	3, 736, 413	+6, 850, 412	10, 642, 409	3, 920, 511	+6, 721, 898
California	28, 956, 470	25, 191, 516	+3, 764, 954	29, 786, 245	25, 361, 032	+4, 425, 213
Illinois	8, 377, 387	12, 286, 321	−3, 908, 934	8, 710, 621	13, 324, 065	−4, 613, 444
Iowa	8, 024, 492	4, 948, 586	+3, 075, 906	9, 336, 727	4, 976, 010	+4, 360, 717
Kansas	8, 163, 916	4, 477, 884	+3, 686, 032	8, 811, 762	5, 852, 155	+2, 959, 607
Michigan	14, 112, 639	10, 693, 060	+3, 419, 579	14, 760, 783	11, 310, 322	+3, 450, 461
Missouri	10, 217, 421	5, 663, 459	+4, 553, 962	10, 086, 850	6, 319, 588	+3, 767, 262
Ohio	11, 872, 278	12, 967, 938	−1, 095, 660	11, 377, 806	13, 095, 380	−1, 717, 574
Pennsylvania	41, 560, 431	16, 133, 233	+25,427,198	40, 037, 761	15, 132, 930	+24, 904, 831
Puerto Rico	4, 297, 583	2, 519, 095	+1, 778, 488	3, 994, 483	2, 502, 858	+1, 491, 625
Tennessee	7, 162, 841	4, 792, 334	+2, 370, 507	7, 428, 604	4, 701, 963	+2, 726, 641
Texas	17, 642, 654	16, 518, 808	+1, 123, 846	19, 849, 455	17, 257, 467	+2, 591, 988
Colorado, Arizona, Wyoming, Montana, Utah, and Idaho	8, 264, 888	9, 070, 154	−805, 266	8, 303, 467	9, 319, 599	−1, 016, 132
Oregon and Washington	7, 589, 484	7, 867, 759	−278, 275	7, 486, 547	7, 881, 211	−394, 664
Georgia, Kentucky, Virginia, Florida, Louisiana, South Carolina, and Mississippi [1]	11, 913, 915	24, 805, 625	−12,891,710	15, 955, 205	29, 602, 829	−13, 647, 624
Indiana, Wisconsin, Minnesota, Nebraska, Oklahoma, South Dakota, and Arkansas	22, 162, 808	25, 105, 071	−2, 942, 263	23, 313, 194	26, 966, 732	−3, 653, 538
Maryland and West Virginia	5, 148, 419	6, 201, 649	−1, 053, 230	5, 405, 060	6, 167, 354	−762, 294
New York and Maine	15, 098, 821	16, 959, 471	−1, 860, 650	16, 081, 524	17, 590, 791	−1, 509, 267
Total	241, 153, 272	209, 938, 376	+31,214,896	251, 368, 503	221, 282, 797	+30, 085, 706

[1] Mississippi was first included as a cement-producing State in 1952.

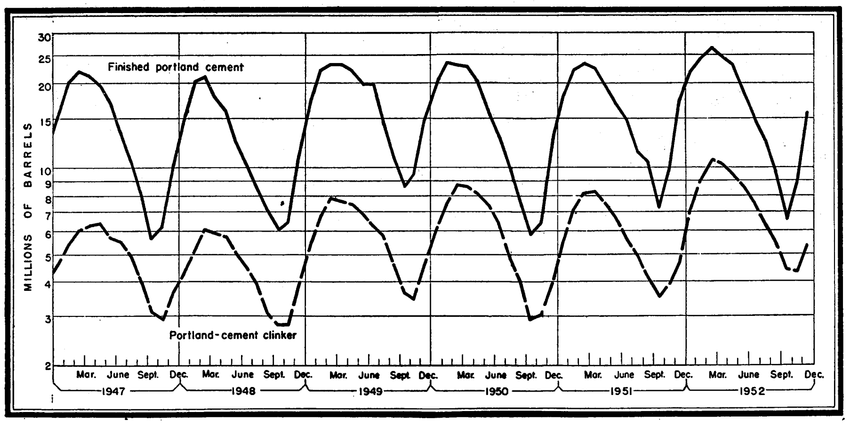

FIGURE 2.—End-of-month stocks of finished portland cement and portland-cement clinker, 1947–52.

TABLE 26.—Stocks of finished portland cement and portland-cement clinker at mills in the United States[1] on Dec. 31, and yearly range in end-of-month stocks, 1948–52

	Dec. 31 (barrels)	Range			
		Low		High	
		Month	Barrels	Month	Barrels
1948—Cement	11,093,690	October	6,094,000	March	20,886,000
Clinker	3,781,250	November	2,781,000	do	6,072,000
1949—Cement	14,758,499	October	8,569,000	do	23,104,000
Clinker	4,586,746	November	3,387,000	do	7,764,000
1950—Cement	13,118,867	October	5,945,000	February	23,583,000
Clinker	3,924,801	do	2,852,000	March	8,821,000
1951—Cement	[2] 18,064,421	do	7,162,000	do	23,250,000
Clinker	[2] 4,728,745	do	3,544,000	April	8,194,000
1952—Cement	15,952,072	do	6,546,000	March	26,622,000
Clinker	5,279,930	November	4,329,000	do	10,833,000

[1] Includes Puerto Rico.
[2] Revised figure.

PRICES

The average net mill realization of all portland cement shipped from mills in 1952 remained unchanged from 1951 at $2.54 per barrel. Quarterly canvasses conducted during the year showed an average net mill realization of $2.55 in each quarter. The discrepancy is accounted for by adjustments made by producers in their annual reports and by rounding fractions to the nearest cent.

The composite wholesale price index of portland cement, f. o. b. destination, according to the Bureau of Labor Statistics index (1947–49 average=100) was 116.4 in 1952, the same as in 1951.

Average mill value per barrel, in bulk, of portland cement in the United States,[1] 1943–47 (average) and 1948–52

1943–47 (average)	$1.71	1950	$2.35
1948	2.18	1951	2.54
1949	2.30	1952	2.54

[1] Includes Puerto Rico and Hawaii, 1946; Puerto Rico only, 1947–52.

NATURAL, MASONRY (NATURAL), AND PUZZOLAN CEMENTS

Natural, masonry (natural), and puzzolan cements were produced in 8 plants in 1952 compared to 9 plants in each of the preceding several years. Discontinuance of production was reported by the Carney Co., of Mankato, Minn. Puzzolan cements were produced in 1952 by Southern Cement Co., Birmingham, Ala., and Cheney Lime & Cement Co., Graystone, Ala. Masonry (natural) and/or natural cements were manufactured by Louisville Cement Co., Inc., Speed, Ind.; Fort Scott Hydraulic Cement Co., Fort Scott, Kans.; Century

Cement Manufacturing Co., Inc., Rosendale, N. Y., and Louisville Cement Co. of New York, Akron, N. Y. Hydraulic lime, which is included in this classification, was produced by Riverton Lime & Stone Co., Inc., Riverton, Va., and The Western Lime & Cement Co., High Cliff, Wis.

Output, shipments, and stocks during the year were, respectively, 1, 1, and 29 percent lower than in 1951. Producers of this group reported consumption of 39,542 short tons of coal and 139,523,000 cubic feet of gas (equivalent to approximately 2,918 short tons of coal).

The 8 producing plants reported a total estimated annual capacity on December 31,1952, of 4,007,341 equivalent barrels of 376 pounds each. Raw materials used during 1952 in the production of these cements were 297,858 short tons of cement rock and 298,465 short tons of other materials, principally slag, shale, and lime and limestone.

Quantities in table 27 are shown in equivalent barrels of 376 pounds to maintain uniformity with other data in this chapter.

TABLE 27.—Natural, masonry (natural), and puzzolan (slag-lime) cements produced, shipped, and in stock at mills in the United States, 1943–47 (average) and 1948–52

Year	Production		Shipments		Stocks on Dec. 31, (barrels)
	Active plants	Barrels	Barrels	Value	
1943–47 (average)	9	1,997,301	2,021,516	$3,201,884	164,361
1948	9	3,440,248	3,375,135	7,734,289	209,901
1949	9	3,185,229	3,233,525	8,006,361	161,605
1950	9	4,246,299	4,218,580	10,629,586	189,323
1951	9	3,449,463	3,475,423	9,832,956	[1] 159,485
1952	8	3,401,684	3,447,390	9,751,837	113,779

[1] Revised figure.

FOREIGN TRADE [4]

Imports.—Imports of hydraulic cement amounted to 475,986 barrels in 1952, slightly more than half of the quantity imported in 1951. Imports from Belgium-Luxembourg increased sharply, while imports from West Germany were less than one-fifth as much as in 1951 and purchases from the United Kingdom declined 35 percent. For the first time in recent years, Sweden exported cement to the United States.

TABLE 28.—Hydraulic cement imported for consumption in the United States, 1948–52

[U. S. Department of Commerce]

Year	Barrels	Value	Year	Barrels	Value
1948	282,752	$785,120	1951	[1] 921,953	$3,162,960
1949	109,821	329,969	1952	475,986	1,397,239
1950	1,409,974	3,610,056			

[1] Revised figure.

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

Imports of all hydraulic cement, except white, nonstaining, and other special cements, for 1950-52 are listed by country of origin in table 29. Imports of white, nonstaining cement in 1952 amounted to 5,917 barrels valued at $31,644.

TABLE 29.—Roman, portland, and other hydraulic cement imported for consumption in the United States, 1950–52, by countries [1]

[U. S. Department of Commerce]

Country	1950		1951		1952	
	Barrels	Value	Barrels	Value	Barrels	Value
Belgium-Luxembourg	38,286	$102,774	10,856	$26,187	194,350	$518,617
Canada	16,896	79,324	929	4,176	1,731	11,246
Colombia	42,510	146,439	12,449	26,632		
Denmark			53	231	3,963	18,617
France	7	35				
Germany, West	746,426	1,981,880	722,478	2,494,679	132,710	328,141
Japan	71,797	205,897	84	285	1	6
Mexico	77,118	153,717	2,567	5,326		
Netherlands	6,250	12,564				
Sweden					33,146	105,375
United Kingdom	405,772	902,306	[2] 159,314	536,269	103,289	379,222
Yugoslavia			1,085	7,845	879	4,371
Total	1,405,062	3,584,936	[2] 909,815	3,101,630	470,069	1,365,595

[1] Excludes "white, nonstaining, and other special cements."
[2] Revised figure.

Exports.—Exports of hydraulic cement in 1952 were 9 percent higher than in 1951. Exports to Canada continued to increase and were 45 percent higher in 1952 than in the previous year. Only Mexico and Cuba showed other important increases. Sharp declines were noted in the quantities shipped to the principal cement-importing nations of Central America, Dominican Republic, Venezuela, and Turkey.

Shipments of hydraulic cement to noncontiguous Territories of the United States for 1949–51 are shown in table 32. Beginning in August 1951, comparable data are not available, so this table will be discontinued in future chapters of Minerals Yearbook.

TABLE 30.—Hydraulic cement exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Barrels	Value	Percent of total shipments from mills
1948	5,922,163	$20,917,176	2.9
1949	4,561,899	15,960,954	2.2
1950	2,418,435	7,274,564	1.0
1951	2,932,787	9,963,721	1.2
1952	3,185,651	11,196,535	1.3

TABLE 31.—Hydraulic cement exported from the United States, 1950–52, by countries of destination

[U. S. Department of Commerce]

Country	1950		1951		1952	
	Barrels	Value	Barrels	Value	Barrels	Value
North America:						
Bermuda			1, 324	$5, 861	1, 250	$5, 021
Canada	456, 418	$1, 598, 622	971, 824	3, 767, 895	1, 407, 735	5, 163, 635
Central America:						
British Honduras	1, 180	5, 424	325	1, 219	2, 049	9, 418
Canal Zone	132	881	514	2, 501	396	2, 318
Costa Rica	41, 457	142, 838	38, 604	144, 031	8, 893	35, 451
El Salvador	10, 260	48, 006	25, 574	99, 490	8, 716	37, 918
Guatemala	3, 814	25, 581	4, 905	30, 436	1, 888	14, 459
Honduras	40, 904	141, 971	74, 866	267, 561	58, 437	198, 674
Nicaragua	8, 947	35, 254	5, 558	21, 432	6, 692	26, 359
Panama	1, 885	8, 846	674	4, 601	1, 388	10, 091
Mexico	141, 795	560, 791	218, 845	878, 481	285, 277	1, 128, 373
West Indies:						
British:						
Bahamas	1, 741	7, 668	7, 282	37, 760	15, 147	68, 306
Barbados					375	1, 754
Jamaica	582	2, 245	18, 493	58, 141	1, 985	7, 464
Leeward and Windward Islands	1, 158	3, 671	1, 880	6, 576	1, 936	7, 146
Trinidad and Tobago	1, 078	4, 644	3, 050	11, 260	1, 232	9, 989
Cuba	394, 460	1, 115, 206	611, 360	1, 632, 358	667, 981	2, 054, 866
Dominican Republic	24, 722	92, 699	33, 993	124, 642	10, 403	31, 240
French West Indies	1, 375	5, 075	6, 625	21, 945	8, 550	27, 917
Haiti	42, 448	116, 683	102, 220	266, 691	118, 848	269, 695
Netherlands Antilles	72, 734	179, 311	99, 036	249, 297	99, 647	280, 014
Total North America	1, 247, 090	4, 095, 416	2, 226, 952	7, 632, 178	2, 708, 825	9, 390, 108
South America:						
Argentina	373	6, 370	518	4, 997	780	2, 942
Bolivia	628	5, 257	462	2, 777	704	4, 103
Brazil	3, 892	16, 285	10, 558	85, 763	3, 156	15, 090
Chile	4, 340	27, 480	2, 695	21, 082	2, 937	21, 793
Colombia	26, 701	193, 526	9, 103	72, 857	17, 473	107, 285
Ecuador	8, 400	25, 786	3, 157	14, 883	3, 000	13, 260
Paraguay	370	1, 032	250	3, 000		
Peru	1, 133	9, 982	1, 335	10, 527	13, 629	52, 895
Surinam	1, 172	3, 827	1, 368	5, 007	6, 325	18, 355
Uruguay	22	625	50	693		
Venezuela	1, 027, 011	2, 444, 041	558, 721	1, 597, 675	375, 880	1, 285, 239
Total South America	1, 074, 042	2, 734, 211	588, 217	1, 819, 261	423, 884	1, 520, 962
Europe:						
Belgium-Luxembourg	294	2, 096	396	3, 888	795	6, 333
France	7	106	1, 507	6, 446	1, 766	13, 233
Italy	1, 712	12, 172	339	2, 705	149	1, 999
Norway			68	214	135	11, 013
Turkey	39, 862	123, 184	59, 532	206, 830	4, 238	21, 870
Other Europe	529	4, 298	859	9, 064	639	10, 364
Total Europe	42, 404	141, 856	62, 701	229, 147	7, 722	64, 812
Asia:						
Bahrein	3, 154	12, 920	1, 372	7, 276	3, 231	12, 998
India	15	1, 512	9	230	1, 160	4, 873
Indonesia	4, 902	19, 200	6, 249	30, 043	2, 750	12, 092
Iran			2, 980	13, 000		
Iraq	2, 175	9, 152	3, 992	19, 128	9, 781	45, 659
Israel	25, 698	173, 715	7, 035	43, 147	109	2, 019
Japan	60	1, 771			243	9, 667
Kuwait	3, 500	14, 600			38	188
Philippines	3, 783	30, 438	6, 171	62, 838	314	3, 147
Saudi Arabia	8, 503	27, 363	18, 323	72, 451	22, 095	104, 087
Other Asia	79	1, 147			175	957
Total Asia	51, 869	291, 818	46, 131	248, 113	39, 896	195, 687

TABLE 31.—Hydraulic cement exported from the United States, 1950–52, by countries of destination—Continued

[U. S. Department of Commerce]

Country	1950		1951		1952	
	Barrels	Value	Barrels	Value	Barrels	Value
Africa:						
Ethiopia					1,250	$5,455
Liberia			362	$1,910	313	1,995
Tunisia					625	3,325
Other Africa	92	$387	333	2,827	276	1,125
Total, Africa	92	387	695	4,737	2,464	11,900
Oceania:						
French Pacific Islands	1,094	4,107	3,693	13,582		
New Zealand	856	2,998	3,499	12,460	2,530	9,845
Other Oceania	988	3,771	899	4,243	330	3,221
Total, Oceania	2,938	10,876	8,091	30,285	2,860	13,066
Grand total	2,418,435	7,274,564	2,932,787	$9,963,721	3,185,651	11,196,535

TABLE 32.—Hydraulic cement shipped to noncontiguous Territories of the United States, 1949–51

[U. S. Department of Commerce]

Territory	1949		1950		1951 [1]	
	Barrels	Value	Barrels	Value	Barrels	Value
American Samoa	436	$1,687	280	$1,151	527	$2,209
Guam	2,189	10,510	3,750	22,794	6,550	38,383
Puerto Rico	94,955	315,311	14,939	91,125	6,915	41,791
Virgin Islands	31,074	123,471	36,043	123,340	16,123	55,065
Wake Island	83	359			463	1,632

[1] Data cover period January through July; beginning August not separately classified.

TECHNOLOGY

Technical trends in the cement industry include the improvement of methods for feeding materials into mills and kilns, closed-circuiting of secondary crushers with vibrating screens for better regulated range of particle sizes as fed into raw grinding mills, the increased application of control devices for kiln operation, the installation of clinker crushers ahead of finish grinding mills, and introduction of new methods of dust recovery and material handling.[5]

A new process used by Permanente Cement Co. was reported to correct stack dust chemically in making nodules. Dust losses and costs were reduced and clinker output was increased.[6]

The use of clinker grit (coarse-ground cement clinker) was reported to be of value in certain concrete mixes, particularly road concretes, as a means of increasing ultimate strength.[7]

[5] Nordberg, B., Progress in Cement Manufacture: Rock Products, vol. 55, No. 1, January 1952, pp. 110–121, 201–203.

[6] Hass, P. S., Nodulizing Stack Dust for Kiln Feed: Rock Products, vol. 55, No. 1, January 1952, pp. 164–166. Permanente's Dust-Nodulizing Process Effects Economies and Higher Output: Pit and Quarry, vol. 45, No. 7, January 1952, pp. 96–98, 101, 152, 164.

[7] Wadia, D. A., Addition of Clinker Grit to Concrete: Rock Products, vol. 55, No. 3, March 1952, pp. 92–93, 110.

Theories and practices for steam-tempering cement were discussed;[8] the advantages of steam tempering are said to include more stable and permanent retardation of setting time, reduction in water requirement for normal consistency, lowering of heat of hydration, complete slaking of free lime, and improving resistance to actions of carbon dioxide.

A study of the chemical composition of cements resulted in the conclusion by one investigator that the permissible limit of tricalcium aluminate in a sulfate-resistant cement is 5.5 percent.[9]

Articles published in trade magazines described in detail the cement-manufacturing plants of Peerless Cement Corp. at Port Huron and Detroit, Mich.;[10] Penn-Dixie Cement Corp., Kingsport, Tenn.;[11] Louisville Cement Co., Speed, Ind.;[12] Lone Star Cement Corp., Lone Star, Va., and Maryneal, Tex.;[13] and Ideal Cement Co., Baton Rouge, La.[14]

Several articles described construction of the new plant of Marquette Cement Manufacturing Co. at Brandon, Miss., the geology of the deposits of raw materials being used, and the production technology.[15]

Among the papers presented at a meeting of the American Institute of Mining and Metallurgical Engineers in 1952 were several of interest to the cement industry, including discussions of the economy of froth flotation, economic aspects of forcing capacity, and the reuse of stack dusts.[16]

A study of the effect of phosphorus pentoxide on the burning of portland-cement clinker and the setting and hardening of the resultant cement showed that the P_2O_5 formed a solid solution with the dicalcium silicate of the clinker and reduced the content of tricalcium silicate. When the P_2O_5 reaches 2.25 percent of the clinker, the cement fails to meet British Standard Specifications.[17]

Technical developments in the design and use of sinter-grate kilns in Europe were reviewed;[18] it is stated that no quality differences exist between clinker produced by the rotary kiln and the sinter-band kiln from the same raw slurry feed.

A study was made of the advantages that might be gained by grinding gypsum retarder separate from portland-cement clinker and

[8] Wadia, D. A., Steam Tempering of Cement: Rock Products, vol. 55, No. 4, April 1952, pp. 140, 142, 171–173.

[9] Miller, D. G., Sulfate-Resistant Cement—Primary Requirement for Sulfate Resistant Concrete Pipe: Jour. Am. Concrete Inst., vol. 24, No. 3, November 1952, pp. 217–224.

[10] Nordberg, B., More Cement for Detroit Market: Rock Products, vol. 55, No. 10, October 1952, pp. 84–89.

[11] Avery, W. M., Penn-Dixie Switches from Dry to Wet Process at Kingsport, Tennessee: Pit and Quarry vol. 45, No. 3, September 1952, pp. 82–87.

[12] Nordberg, B., America's Largest Dry Process Cement Kiln: Rock Products, vol. 55, No. 8, August 1952, pp. 132–138, 211.

[13] Van Zandt, C. D., Features Incorporated in the Design of Lone Star's New Dry-Process Cement Plant: Min. Eng., vol. 4, No. 12, December 1952, pp. 1244–1250.
Lenhart, W. B., Lone Star's New Texas Plant: Rock Products, vol. 55, No. 8, August 1952, pp. 142–151.

[14] Lenhart, W. B., Producing Cement From Oyster Shells: Rock Products, vol. 55, No. 9, September 1952, pp. 76–80.

[15] Trauffer, W. E., Marquette's New Mississippi Plant Designed for Unusual Raw Materials: Pit and Quarry, vol. 45, No. 1, July 1952, pp. 104–118.
Webb, S., 4-Component Graphic Control System Used To Make Marquette Cement From "Mississippi Mud": Pit and Quarry, vol. 45, No. 1, July 1952, pp. 140–144.
Nordberg, B., Marquette Builds Mississippi's First Cement Plant: Rock Products, vol. 55, No. 8, August 1952, pp. 116–131, 190.

[16] Bowles, Oliver, Cement, Lime, and Gypsum Papers Dominate AIME Meeting: Rock Products, vol. 55, No. 4, April 1952, pp. 132–136, 138, 167.

[17] Nurse, R. W., The Effect of Phosphate on the Constitution and Hardening of Portland Cement: Jour. Appl. Chem. (London), vol. 2, part 12, December 1952, pp. 708–716.

[18] Pearson, B. M., Calcining Cement Slurry on Continuous Conveyor Grate: Rock Products, vol. 55 No. 10, October 1952, pp. 102–104, 138.

subsequently blending the ground material.[19] The report explores the possibility of using the practice to minimize false set in the cement and to improve control of particle size gradation in the finished product.

Underground mining of cement rock in highly fractured beds, using tungsten carbide bits and millisecond-delay blasting, was described in an article.[20]

Finish-mill grinding practices at the Trident, Mont., plant of Ideal Cement Co. were described.[21]

A trade magazine launched a series of articles on the theoretical chemistry of cement and concrete. It is declared that modern concepts of structural and colloidal chemistry must be applied if progress is to be made toward understanding cement research data. Early articles in the series were devoted to discussions of the chemical elements involved, structure of molecules, chemical combinations that form complex molecular structures, and the structural chemistry of aggregates in and out of concrete.[22]

Incomplete combustion is reported to be the primary cause of rings in rotary cement kilns. Other factors contributing to ring formation include chemical composition of raw materials, humidity, fineness of grinding, volatile materials, combustion time, heat value of coal, and insufficient excess air.[23]

An article on the operation of wet-process rotary kilns states that one of the most decisive factors affecting sulfate (SO_3) content of the clinker seems to be the degree to which maximum capacity of a kiln is utilized;[24] the greater the percentage of capacity utilized, the lower the SO_3 content. Other factors affecting sulfate content include the quantity of excess air available, size of nodules, and degree of clinkering.

Hollow-flight screw conveyors were reported to cool cement clinker rapidly and effectively.[25] An increase in mill output was ascribed to the fact that cool clinker was made available for finishing. The hot clinker formerly ground caused excessive coating of grinding balls, besides having a detrimental effect on the gypsum retarder.

The technology of fine-grinding cement in tube mills was discussed in a paper.[26] Methods of preventing particle agglomeration and development of static electricity were described.

A number of papers relating to the cement industry were presented at a convention of the Japan Cement Engineering Association.[27] Twenty-six papers of interest to the cement chemist and engineer were briefly abstracted in an article in an American trade magazine.

---

19 Wadia, D. A., Grinding Gypsum Separate From Clinker: Rock Products, vol. 55, No. 5, May 1952, pp. 85–86.

20 Rambosek, A. F., Underground Mining of Cement Rock: Rock Products, vol. 55, No. 10, October 1952, pp. 100–101.

21 Lamont, H., Finish Mill Grinding at Trident, Mont.: Rock Products, vol. 55, No. 8, August 1952, pp. 155–157, 211–212, 214, 216.

22 Rockwood, N. C. "Prospective" Chemistry of Cement and Concrete: Rock Products, vol. 55, No. 7, July 1952, pp. 57–59; vol. 55, No. 8, August 1952, pp. 139–141, 206, 208; vol. 55, No. 9, September 1952, pp. 72–73, 114; vol. 55, No. 11, November 1952, pp. 90–92.

23 Pearson, B. M., Ring Formation in Cement Kilns: Rock Products, vol. 55, No. 8, August 1952, pp. 158–159.

24 Rutle, J., Notes on Burning of Cements in Wet-Process Rotary Kilns: Pit and Quarry, vol. 45, No. 1, July 1952, pp. 135–136, 138–139, 147–149.

25 Utley, H. F., Hollow-Flight Screw Conveyor Cools Clinker at Monolith's California Plant: Pit and Quarry, vol. 45, No. 1, July 1952, pp. 122–123.

26 Pearson, B. M., Fine Grinding in Tube Mills: Rock Products, vol. 55, No. 12, December 1952, pp. 106–108.

27 Rock Products, Cement Research in Japan: Vol. 55, No. 10, October 1952, pp. 122, 124, 126, 128.

A published article discussed the effect of major components of cement on its sulfate-resistance ability and the durability in fresh water of mortar and concrete produced from cements of varying chemical compositions.[28] The report also touched briefly on theories of sulfate resistance and on the effect of puzzolans on the strength of portland-cement concrete.

WORLD REVIEW

Available statistics on world production of cement in 1948–52 are shown in table 33.

TABLE 33.—World production of hydraulic cement, by countries, 1948–52 in thousands of metric tons [1]

[Compiled by Helen L. Hunt]

Country	1948	1949	1950	1951	1952
North America:					
Canada (sold or used by producers)	2,243	2,527	2,658	2,700	2,940
Cuba	285	312	316	[2] 383	420
Dominican Republic	43	54	70	104	137
Guatemala	32	36	42	57	60
Jamaica					75
Mexico	1,080	1,228	1,528	1,615	1,640
Nicaragua	16	16	17	20	19
Panama	41	54	51	75	93
United States	35,626	36,313	39,273	42,548	43,091
South America:					
Argentina	1,252	1,452	1,572	1,543	1,536
Bolivia	39	42	38	39	37
Brazil	1,112	1,281	1,386	1,456	1,616
Chile	540	495	513	698	838
Colombia	364	475	580	648	707
Ecuador	40	52	58	79	89
Paraguay					4
Peru	282	289	331	367	370
Uruguay	287	293	305	301	300
Venezuela	215	285	501	621	840
Europe:					
Austria	721	1,091	1,289	1,475	1,402
Belgium	3,331	2,925	3,557	4,395	4,111
Bulgaria	[2] 325	(3)	(3)	(3)	(3)
Czechoslovakia	1,650	1,738	[4] 1,875	[4] 2,000	[4] 2,520
Denmark	769	834	873	985	1,211
Finland	556	656	743	829	778
France	5,379	6,443	7,208	8,125	8,645
Germany:					
West	5,581	8,460	10,877	12,204	12,886
East	765	1,000	(3)	(3)	(3)
Greece	278	330	399	433	596
Hungary [2]	300	550	800	800	800
Ireland	398	431	444	426	(3)
Italy	3,144	4,037	5,004	5,578	6,652
Luxembourg	102	121	125	132	114
Netherlands	589	552	593	702	813
Norway	526	593	582	720	725
Poland	1,824	2,342	2,512	2,688	2,660
Portugal	498	521	573	644	727
Rumania	452	560	650	733	(3)
Saar	160	206	208	234	238
Spain	2,331	2,248	2,522	2,742	2,463
Sweden	1,486	1,698	1,936	2,035	2,054
Switzerland	1,022	977	1,078	1,315	(3)
U. S. S. R.[2]	6,600	8,000	10,500	12,400	[4] 15,420
United Kingdom	8,657	9,364	9,913	10,388	11,314
Yugoslavia	1,188	1,288	1,219	1,159	1,313

For footnotes, see end of table.

[28] Chemical Age (London), Chemical Aspects of Cement Durability: Vol. 67, No. 1733, Sept. 27, 1952, pp. 427–432.

TABLE 33.—World production of hydraulic cement, by countries, 1948–52 in thousands of metric tons [1]—Continued

Country	1948	1949	1950	1951	1952
Asia:					
Ceylon				63	61
China [2]	200	450	800	1,300	2,000
Hong Kong	53	59	68	72	70
India	1,578	2,136	2,652	3,252	3,612
Indochina	97	154	144	212	235
Indonesia	38	(3)	(3)	[2] 100	137
Iran	[5] 65	[5] 59	[5] 64	[5] 65	65
Iraq		7	66	[6] 75	[2] 200
Israel	160	241	380	439	446
Japan	1,859	3,277	4,463	6,548	7,117
Korea, Republic of	17	24	10	7	36
Lebanon	209	233	263	303	281
Pakistan	329	429	421	507	544
Philippines, Republic of the	120	201	292	309	310
Syria	54	58	68	64	151
Taiwan (Formosa) [2]	236	291	332	389	446
Thailand (Siam)	83	127	166	312	247
Turkey	345	375	388	396	459
Africa:					
Algeria	130	128	324	448	470
Belgian Congo	127	144	174	205	240
Egypt	768	889	900	1,145	947
Ethiopia [2]	8	8	6	6	6
French Morocco	262	264	321	377	435
French West Africa		44	60	55	80
Madagascar	4	7	5	5	(3)
Mozambique	37	46	50	78	[2] 80
Northern Rhodesia				55	55
Southern Rhodesia	71	83	156	163	[2] 216
Tunisia	162	168	169	187	208
Union of South Africa	1,308	1,363	1,847	1,954	2,027
Oceania:					
Australia	[7] 1,030	1,076	1,278	1,236	1,357
New Zealand	247	254	256	163	(3)
Total (estimate)	102,000	115,000	132,300	148,400	159,000

[1] This table incorporates a number of revisions of data published in previous Cement chapters.
[2] Estimate.
[3] Data not available; estimate by senior author of chapter included in total.
[4] Planned production.
[5] Year ended March 20 of year following that stated.
[6] Year ended March 31 of year following that stated.
[7] Year ended June 30 of year stated.

Chromium

By Charles Katlin[1] and Hilda V. Heidrich[2]

WORLD output of chromite reached a new peak of 3½ million short tons in 1952; almost half was imported by the United States to satisfy the continued high rate of consumption and to raise inventory levels.

An expanded domestic chromite production originated in California and Oregon. Most of the ore was shipped to the Government Purchase Depot at Grants Pass, Oreg., but a relatively small tonnage of California ore was sold to industry for refractory use. Reactivation of the Mouat mine in Montana gave promise of a much greater domestic output in the future. An additional step toward fuller utilization of domestic resources was represented by the negotiations underway at the close of the year between the Government and a private company for developing and producing from the Red Mountain chromite deposit in Alaska.

Metallurgical consumption of chrome ore increased considerably as the metallurgical applications of chromium became more diversified. Reversals in trend were evident, however, in the refractory and chemical industries, which consumed smaller quantities of ore than during the previous year. Consumers' stocks of chromite were higher in quantity as well as in terms of months' supply.

Toward the end of the year, the Government increased ceiling prices for ferrochromium, chromium metal other than electrolytic, and other chromium products. Quoted prices for most chromite were relatively steady throughout the year.

Although Turkey retained its position as the world's largest chromite producer, the Republic of the Philippines made the most spectacular output record of the year by increasing its production 62 percent over 1951 to bring the total tonnage over the half-million mark.

TABLE 1.—Salient statistics of chromite in the United States, 1943–47 (average) and 1948–52, in short tons

	1943–47 (average)	1948	1949	1950	1951	1952
Domestic production (shipments)	[1] 44,955	3,619	433	404	7,056	21,304
Imports for consumption	913,285	1,542,125	1,203,852	1,303,713	1,427,900	1,700,097
Total new supply	958,240	1,545,744	1,204,285	1,304,117	1,434,956	1,721,401
Exports	9,047	2,894	2,382	2,044	2,030	18,639
Consumption	837,857	875,033	672,773	980,369	1,212,480	1,185,460
Stocks Dec. 31 (consumers')	335,691	602,491	756,995	606,271	637,453	754,299
World production	1,600,000	2,300,000	2,300,000	2,500,000	3,100,000	3,500,000

[1] Average of annual totals as widely divergent as 160,120 tons in 1943 and 948 tons in 1947.

[1] Commodity-industry analyst.
[2] Statistical clerk.

342070—55——19

DOMESTIC PRODUCTION

With the Government committed to buy specification-grade domestic chrome ore at premium prices at least through 1954, the United States production of chromite during 1952 rose to three times the previous year's output. Although California supplied 69 percent of the United States output, the 105 shippers of chromite were divided almost evenly between California (52) and Oregon (53). Five operators (Ruth Robertson, operating the Cyclone Gap mine in Siskiyou County, Calif.; E. R. Brown, operating the High Plateau mine in Del Norte County, Calif.; Chrome Milling Co. in Josephine County, Oreg.; International Metallurgical Chrome Corp., operating the Sweetwater and Norcross mines in San Luis Obispo County, Calif.; and Helmke, Thomas & Janssen, operating the Lambert mine in Butte County, Calif.) supplied 49 percent of the total ore shipped during the year. Most domestic shipments were received at the Grants Pass Chrome Purchase Depot in Oregon, but a relatively small percentage of the total production was shipped to a private company for refractory use.

The average grade of the chrome ore shipped during 1952 from both Oregon and California was 47 percent Cr_2O_3.

TABLE 2.—Chromite production (shipments) in the United States, 1948–52, by States, in short tons

State	1948	1949	1950	1951		1952	
				Shipments	Value [1]	Shipments	Value
California	274	433	404	6,302	$447,769	14,713	[2] $1,269,000
Oregon	3,345			754	62,972	6,591	507,981
Total	3,619	433	404	7,056	510,741	21,304	[2] 1,777,000

[1] Bureau of Mines not at liberty to publish values for previous years.
[2] Partially estimated.

No chromite was produced in Montana in 1952, although the State contains the major portion of the United States reserves. Under terms of a Government contract signed in April, however, the American Chrome Co. was actively engaged in developing and equipping the Mouat chrome mine in Stillwater County, with production expected to begin in 1953. Defense Materials Procurement Agency, signer of the contract for the Government, agreed to supply up to $1,815,000 worth of equipment on a loan basis, in addition to lending $950,000 at 4-percent interest as an advance against production for construction purposes. The American Chrome Co. agreed to provide $950,000 as working capital. Once production has begun, the company has agreed to supply the Government with 900,000 tons of chrome ore during an 8-year period. Base price for the ore will be $34.97 per ton of 38 percent Cr_2O_3 minimum grade.

When development work is completed, the mine will be capable of producing 1,000 tons of ore per day, while the mill is expected to have a daily output capacity of 370 tons of chrome concentrate.

Negotiations were underway between the Kenai Chrome Co. and the United States Government, represented by the Defense Materials Procurement Agency, for the production of chromite from the Red Mountain deposit on the Kenai Peninsula of Alaska. A development and production loan was being sought by the company, to be repaid with production.

TABLE 3.—Chromite shipped from mines in the United States, from before 1880 through 1952

Year	Short tons	Year	Short tons	Year	Short tons
Before 1880	224,000	1921–38 [1]	[1] 9,143	1947	948
1880–1913 [1]	[1] 45,215			1948	3,619
		1939	4,048	1949	433
1914	662	1940	2,982	1950	404
1915	3,675	1941	14,259	1951	7,056
1916	52,679	1942	112,876	1952	21,304
1917	48,972	1943	160,120	Grand total	876,916
1918	92,322	1944	45,629		
1919	5,688	1945	13,973		
1920	2,802	1946	4,107		
Total 1914–20	206,800	Total 1939–46	357,994		

[1] Annual totals published separately in Minerals Yearbooks, 1947–50.

General Services Administration.—As of April 23, 1952, the maximum quantity of ore acceptable to the Government from any one source under the Purchase Program for Domestic Chrome Ore and Concentrates at Grants Pass, Oreg., was raised from 2,000 to 5,000 tons a year. Five tons of ore remained the minimum shipment accepted. Prices paid were based on the chromic oxide content of the ore and the ratio of chromium to iron. The program will terminate on (1) June 30, 1955, or on (2) December 31, 1954, provided that 1 year's public notice is given in advance of that date, or (3) when 200,000 tons of material is received and accepted. Regulations governing the program as well as a table of prices offered by grade, appeared in the Chromium chapter of Minerals Yearbook, 1951.

Defense Minerals Exploration Administration.—Although the DMEA, an agency of the United States Department of the Interior, would finance 50 percent of a sound domestic chromite exploration project, only three loan applications were received during 1952; all were denied.

CONSUMPTION AND USES

Despite strikes in the steel industry during 1952, the total consumption of chromite remained at a high level; it was only 2 percent below the 1951 record. Of the total consumed during the year (1951 percentages for comparison shown in parentheses), metallurgical use accounted for 57 percent (47), refractories 33 percent (37), and chemicals 10 percent (16).

Actual comparison of 1952 consumption of chromite by end use with the record highs of 1951 indicates an 18-percent increase in metallurgical use (in the manufacture of ferrochromium, stainless steel, etc.) to set a new record. For refractory purposes (in the manufacture of chromium bricks, refractory cement, etc.), 12 percent less ore was used. Chemical use of chromite dropped 39 percent. Most of the chromite was consumed in the six adjoining States: Maryland, New Jersey, New York, Ohio, Pennsylvania, and West Virginia. The average chromic oxide content of all grades combined was estimated to have decreased from 42.6 percent in 1951 to 41.9 percent in 1952.

TABLE 4.—Consumption of chromite and tenor of ore used by primary consumer groups in the United States, 1943–47 (average) and 1948–52, in short tons

Year	Metallurgical		Refractory		Chemical		Total	
	Gross weight (short tons)	Average Cr_2O_3 (percent)	Gross weight (short tons)	Average Cr_2O_3 (percent)	Gross weight (short tons)	Average Cr_2O_3 (percent)	Gross weight (short tons)	Average Cr_2O_3 (percent)
1943–47 (average)	440,781	48.5	267,659	34.3	129,417	45.0	837,857	43.2
1948	395,417	48.2	327,795	33.8	151,821	45.5	875,033	42.7
1949	288,518	47.6	268,925	33.5	115,330	44.1	672,773	41.3
1950	491,685	47.8	353,642	34.0	135,042	44.6	980,369	42.4
1951	573,075	48.1	440,771	34.7	198,634	44.3	1,212,480	42.6
1952	676,624	[1] 46.1	387,085	[1] 34.7	121,751	[1] 44.3	1,185,460	[1] 41.9

[1] Estimated.

Consumption of chromium alloys and metal in the United States in 1952 totaled 259,000 short tons, 12 percent more than in 1951. Ferrochromium composed the major portion of this tonnage (189,000 tons), while low-carbon ferrochrome silicon and chrome silicide, relatively new steel additivies and substitutes for ferrochromium (no data available for previous years) comprised 35,000 tons. The remaining consumption was in the form of exothermic additives used in steelmaking (such as Chrom–X), chromium briquets (crushed and bonded ferrochromium), miscellaneous chromium alloys, and chromium metal. Of the total consumption of chromium alloys and metal in 1952, 63.3 percent was consumed in making stainless steels (steels containing over 10 percent chromium), 0.4 percent in high-speed steels, 30.3 percent in other alloy steels, 4.1 percent in high-temperature alloys, and 1.9 percent in other uses. (Consumption data by end uses for previous years are not available.)

Specifications.—Chromite, the only chromium ore mineral, theoretically is composed of chromic and ferrous oxides ($Cr_2O_3.FeO$). In the natural state, however, the mineral has a wide range of chemical compositions and contains varying proportions of alumina, magnesia, lime, and silica; the percentages of magnesia and alumina generally are greater than that of ferrous oxide. These additional elements, although usually lowering the grade of the ore in terms of chromium content, are essential to certain applications.

For metallurgical use, as in the manufacture of ferrochromium, chromite should contain a minimum of 48 percent Cr_2O_3, with a chromium-iron ratio of 3 : 1. Silica is undesirable, and combined alumina and magnesia of over 25 percent may be objectionable. Ore of these specifications, however, is not always obtainable, and the practice is to blend high- and low-grade ores to obtain the most desirable mixture practicable.

TABLE 5.—Chromite purchase specifications for National Stockpile in 1952

[General Services Administration, Emergency Procurement Service]

Grade	Percent by weight, dry basis						
	Cr_2O_3, minimum	Fe, maximum	Cr-Fe, ratio minimum	$Al_2O_3+Cr_2O_3$ minimum	SiO_2, maximum	S, maximum	P, maximum
Metallurgical:[1]							
Low-grade[2]	42	--------	1.5:1	--------	10	0.10	0.04
High-grade	46	--------	2.7:1	--------	8	.08	.04
Refractory:[3]							
Masinloc	31	12	--------	60	5.5	--------	--------
Camaguey	30	12	--------	58	7	--------	--------
Moa Bay	34	12	--------	60	5.5	--------	--------
Chemical:[4] Friable ore	44	--------	--------	--------	5	--------	--------

[1] Specification P-11, June 13, 1951, covers chromite ore suitable for the manufacture of commercial ferrochromium and special chromium alloys. Lumpy ore shall be hard, dense, nonfriable material, of which not more than 25 percent shall pass a 1-inch Tyler Standard screen. Material of friable nature, regardless of an initially lumpy appearance, will be classified as fines. No size restrictions apply to fines or concentrates.

[2] Guaranteed analyses superior to that stated are desired, and no offers will be considered unless the chemical analyses are at least within the stated limits in all respects. The right is reserved to reject any proposal for which the proposed guaranteed analysis is inferior to that shown for high grade chromite.

[3] Specification P-12, October 31, 1950, covers refractory-grade chromium ore that is suitable for the production of all chromium-type refractories. Restricted to Philippine Islands and Cuba, although material from other sources will be considered. Material shall consist of "lump ore," of which not more than 20 percent shall pass a Tyler Standard 10-mesh screen.

[4] Specification P-65, June 1, 1949, covers chromium ore intended for the manufacture of chromium chemicals.

A standard sample of metallurgical chrome ore containing 50.96 percent chromic oxide was established for industry. The standard was the outgrowth of a cooperative study by 11 laboratories in the United States, Canada, and the Union of South Africa.[3]

Refractory-grade chromite usually contains about 63 percent combined Cr_2O_3 and Al_2O_3. Iron and silica should be low, usually around 10 and 5 percent, respectively. A typical Cr-Fe ratio is 2.2:1. Ores containing 17 to 18 percent magnesia (Philippines and Cuba) are preferred to those containing less than 15 percent (Southern Rhodesia and Union of South Africa). Hard lump ore is desirable for making bricks, and ground material is suitable for cement. Refractory properties of Pacific Northwest (United States) chromites were described by the Bureau of Mines.[4]

Chemical-grade chromite usually contains 44 to 34 percent Cr_2O_3, with 43 percent the customary minimum. High iron is not harmful within reasonable limits; 1.6:1 is a common Cr-Fe ratio. Silica should be less than 5 percent. In the production of chromium chemicals, lower chromic oxide and higher silica contents than those stated would reduce furnace capacity and increase costs (for soda ash). Fines and concentrates are often preferred because they disintegrate readily in processing.

A summary of General Services Administration chromite purchase specifications, by grades, is given in table 5.

Metallurgical Uses.—The most apparent use of chromium is for decorative electroplated finishes, but such finishes are very thin and require insignificant quantities of chromium. Heavy electroplating

[3] Hartford, Winslow H., Certificate of Analyses of Metallurgical Chrome Ore: Mutual Chemical Co. of America, March 1952, Baltimore, Md., 1 p.

[4] Kelly, H. J., Skinner, K. G., Tyrell, M. E., and Goring, A. W., Refractory Properties of Pacific Northwest Chromites: Bureau of Mines Rept. of Investigations 4929, 1952, 38 pp.

has important military uses, however, and industry is making wider use of chromium plate as a wear-, friction-, corrosion-, and heat-resistant surface. Chromium-plating processes for various industrial applications [5] and its many engineering uses in steel mills [6] were described.

Chromium is an important constituent of stainless steel (steel containing 10 percent or more Cr), in which a large proportion of the available chromium is consumed as low-carbon ferrochrome. Low-carbon ferrochrome silicon is also used in stainless-steel manufacture, as well as high-carbon ferrochromium and chrome ore. Stainless steel has many essential uses, such as for chemical containers, equipment for manufacturing chemicals, marine parts, turbine blades, valve steel, petroleum-processing equipment, and many other applications where the metal is subjected to corrosive attack. When chromium only is used in steel for purposes other than corrosion resistance, the principal effects are to increase hardness and tensile strength, with high ductility, permitting heat treatment of many products that must be shaped by rolling and forging. Chromium also increases creep strength of steel.

Chromium is added to steel in the furnace and in the ladle. Selection of either low-carbon or high-carbon ferrochrome, low-carbon ferrochrome silicon, or chrome ore as an additive depends on destined use and economic factors.

Refractory Uses.—Chromite from the Philippines, Cuba, and (in smaller quantities) from other sources is suitable for use as a neutral furnace lining. Most of the ore is manufactured into brick, used chiefly in basic open-hearth steel furnaces. Because chromite refractories resist both acid and basic attacks at high temperatures, common practice is to use a course of chromite brick near the slag line in open-hearth furnaces separating the silica brick of the roof and side and the dolomite or magnesite brick of the hearth and banks. Other chrome refractory uses include ramming mixtures for furnace bottoms and finely ground ore for patching furnace walls.

Chemical Uses.—The chemical industry converts chromite into sodium bichromate, which in turn is made into various compounds. On an average, 1.4 tons of chromite was used in 1952 per ton of chemicals produced. Chromium chemicals are consumed principally in the manufacture of pigments, in metal processing, and in leather tanning; to a lesser extent, they are used in textiles and in chemical and dye manufacture. Chromium metal, also made from chromium chemicals, is employed in making high-temperature alloys for jet engines.

STOCKS

At the end of 1952 consumers' stocks of all grades of chromite were 18 percent higher than they were at the end of 1951. Based on the annual rates of consumption for those years, the 1952 year-end inventory was equivalent to 7.6-month supply compared with 6.3 months in 1951.

[5] Steel, vol. 130, No. 13, Mar. 31, 1952, pp. 76–77.
[6] Steel, vol. 131, No. 21, Nov. 24, 1952, pp. 108, 111–112.

TABLE 6.—Stocks of chromite at consumers' plants, December 31, 1943–47 (average) and 1948–52, in short tons

Grade	1943-47 (average)	1948	1949	1950	1951	1952
Metallurgical	154, 835	256, 770	325, 881	248, 872	305, 134	364, 013
Refractory	107, 718	236, 724	303, 110	251, 663	247, 673	269, 933
Chemical	73, 138	108, 997	128, 004	105, 736	84, 646	120, 353
Total	335, 691	602, 491	756, 995	606, 271	637, 453	754, 299

PRICES

With one exception, the prices of foreign chromite in 1952 were only slightly higher at the year end than on January 1, according to E&MJ Metal and Mineral Markets. Indian high-grade ore, quoted concurrently with Rhodesian material until December 1952, rose a full 17 percent in that month. Rhodesian high-grade chromite experienced a momentary rise of 20 percent during March but immediately dropped to a point slightly above its former level.

Although the prices listed in table 7 are fairly representative for Metallurgical- and Chemical-grade chromite, no figures are quoted for Refractory-grade ore, which represented over one-third of the United States imports. It is estimated that refractory-ore prices were about $25–$35 per long ton, f. o. b. east coast ports, with the material originating in the Philippines, Cuba, the Union of South Africa, Southern Rhodesia, and India.

Incentive prices paid to domestic producers shipping Metallurgical-grade chromite to the Government depot at Grants Pass, Oreg., are listed on table 8 in Minerals Yearbook, 1951.

Increased ceiling prices for ferrochromium, chromium metal other than electrolytic, and other chromium products were established by the Office of Price Stabilization effective November 25, 1952, under authority of Ceiling Price Regulation 180. Granted to stimulate production, the new price code increased high-carbon ferrochromium (65–69 percent Cr, 4–9 percent C) from the former 21.75 cents per pound to 24.75 cents per pound, f. o. b. destination, Continental United States, according to E&MJ Metal and Mineral Markets; low-carbon ferrochrome rose from 30.5 cents to 34.5 cents per pound. During November the quoted contract price for 97-percent-grade chromium metal increased first from the formerly stable $1.07 per pound to $1.14 per pound, then rose again with the new ceiling to $1.18 per pound; spot prices were 5 cents higher. Electrolytic chromium metal powder, 99 percent minimum, remained at $3–$4.50 per pound (depending on mesh size), f. o. b. Niagara Falls, N. Y. Basic chrome-brick prices were unchanged at $73–$78 per short ton for burned brick and $77–$82 for chemical-bonded brick, f. o. b. shipping point.

TABLE 7.—Price quotations for various grades of foreign chromite in 1952

[Engineering and Mining Journal]

Source	Cr_2O_3 (percent)	Cr-Fe ratio	Price per long ton[1]	
			Jan. 1	Dec. 31
Indian	48	[2] 3:1	$43-$45	$53-$54
Rhodesian	48	[2] 3:1	43- 45	44- 46
Do	48	2.8:1	40- 42	40- 42
Do	48		31- 32	32- 33
South African (Transvaal)	48		34- 35	34- 35
Do	44		27- 28	27- 28
Turkish	48	[2] 3:1	53- 54	55- 56

[1] Quotations are on a dry basis, subject to penalties if guarantees are not met. f. o. b. cars, east coast ports.
[2] Lump ore.

FOREIGN TRADE [7]

Imports.—Record chromite imports of 1.7 million short tons were received by the United States in 1952, an increase of 19 percent over 1951. Of this total, 54 percent was metallurgical grade, 35 percent refractory, and 11 percent chemical. The Philippines were the leading source of United States imports, supplying 32 percent of the total. Turkey and the Union of South Africa followed with 27 percent and 18 percent respectively.

Metallurgical ore was supplied by 13 countries, the major ones being Turkey and Southern Rhodesia. Most refractory-grade imports originated in the Philippines, and all chemical-grade ore came from the Union of South Africa. Total imports were valued at foreign ports at an average of $22.40 a short ton, 25 percent higher than in 1951. Of the three grades of ore, the chromic oxide content averaged 46.1 percent for metallurgical, 34.7 percent for refractory, and 44.3 for chemical in 1952. This represented a slight decrease for metallurgical ore, and slight increases for refractory and chemical grades compared with the previous year's averages.

Ferrochromium imports were 22 percent lower than in 1951 and came almost entirely from Canada (91 percent) and Sweden; Japan shipped a fractional percentage. A total of 21,355 short tons of ferrochromium was received, containing 12,105 tons of chromium, valued at $4,850,507. The alloy averaged 57 percent chromium contained, compared with 60 percent the previous year.

Tariff.—Chromium ores enter the United States duty free, but products do not. The tariff on high-carbon ferrochromium (3 percent C or over) is 5/8 cent per pound of contained chromium. Tariff rates on other chromium metallurgical products—low-carbon ferrochromium, chromium metal, chromium carbide, ferrochrome silicon, etc.—is 12½ percent ad valorem.

Exports.—Over 9 times as much chromite left the United States in 1952 as in 1951, most of it destined for Canada; 18,639 short tons of chromite valued at $1,041,621 was exported in 1952 compared with 2,030 tons in 1951.

[7] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

Ferrochromium exports in 1952 totaled 1,274 short tons valued at $518,721, over 5 times the 1951 total of 240 tons. Canada and Belgium received the major portion of the 1952 tonnage, which was shipped to 12 countries in all.

Chromic acid exports amounted to 622,424 pounds valued at $178,528.

Exports of chromite, chromium alloys and metal, and chromic acid are subject to United States export licensing control.

TABLE 8.—Chromite imported for consumption in the United States, 1951–52, by countries, and by grades

[U. S. Department of Commerce]

Country	Chemical grade			Metallurgical grade			Refractory grade			Total		
	Short tons		Value	Short tons		Value	Short tons		Value	Short tons		Value
	Gross weight	Cr_2O_3 content		Gross weight	Cr_2O_3 content		Gross weight	Cr_2O_3 content		Gross weight	Cr_2O_3 content	
1951												
Cuba				[1] 11,424	[1] 4,426	[1] $197,175	[1] 75,667	[1] 26,869	[1] $1,101,449	87,091	31,295	$1,298,624
India				6,211	2,988	154,985				6,211	2,988	154,985
New Caledonia [2]				68,406	33,813	1,626,393				68,406	33,813	1,626,393
Philippines				2,016	968	37,381	[1] 315,725	[1] 106,525	[1] 3,360,131	[1] 317,741	[1] 107,493	[1] 3,397,512
Sierra Leone [3]				8,400	3,808	204,776				8,400	3,808	204,776
Southern Rhodesia				[1] 193,977	[1] 90,621	[1] 3,263,426	15,161	6,670	284,266	[1] 209,138	[1] 97,291	[1] 3,547,692
Turkey				336,045	159,039	11,279,797				336,045	159,039	11,279,797
Union of South Africa	275,846	121,713	$2,348,882	[1] 68,019	[1] 31,301	[1] 644,000	26,160	11,351	222,568	[1] 370,025	[1] 164,365	[1] 3,215,450
Yugoslavia				24,843	10,275	768,580				24,843	10,275	768,580
Total	275,846	121,713	2,348,882	[1] 719,341	[1] 337,239	[1] 18,176,513	[1] 432,713	[1] 151,415	[1] 4,968,414	[1] 1,427,900	[1] 610,367	[1] 25,493,809
1952												
Afghanistan				1,006	464	25,875				1,006	464	25,875
Cuba				40,421	15,939	1,134,550	56,333	20,515	966,979	96,754	36,454	2,101,529
Greece				246	118	7,920				246	118	7,920
Guatemala				1,458	846	51,050				1,458	846	51,050
India				6,581	2,931	205,748				6,581	2,931	205,748
New Caledonia [2]				58,776	29,778	2,072,175				58,776	29,778	2,072,175
Pakistan				3,372	1,577	132,355				3,372	1,577	132,355
Philippines				41,175	19,490	1,117,833	502,527	170,662	6,790,447	543,702	190,152	7,908,280
Sierra Leone [3]				26,846	10,769	850,810				26,846	10,769	850,810
Southern Rhodesia				172,515	82,514	4,813,553	11,057	4,784	214,831	183,572	87,298	5,028,384
Turkey				453,000	208,153	15,773,619	3,343	1,313	33,441	456,343	209,466	15,807,060
Union of South Africa	189,065	83,732	1,731,856	88,106	40,174	1,076,865	22,609	9,355	217,147	299,780	133,261	3,025,868
Yugoslavia				21,661	9,511	865,699				21,661	9,511	865,699
Total	189,065	83,732	1,731,856	915,163	422,264	28,128,052	595,869	206,629	8,222,845	1,700,097	712,625	38,082,753

[1] Revised figure.
[2] Assumed source; classified in import statistics under "French Pacific Islands."
[3] Assumed source; classified in import statistics under "British West Africa."

TECHNOLOGIC DEVELOPMENTS

The introduction and successful use of low-carbon ferrochrome silicon is one of the outstanding recent developments in steelmaking.[8] The alloy is produced in electric furnaces by carbon reduction of selected ores. A common analysis carries 40 percent chromium, 40 percent silicon, and less than 0.05 percent carbon. Virtually all stainless-steel producers use the alloy to reduce melting time and costs and to improve product quality. The price of the alloy is substantially lower than the price of the low-carbon ferrochrome that it displaces, because the chromium contained in the alloy is charged for at the same rate as in high-carbon ferrochrome—24.75 cents per pound—instead of 34.5 cents a pound for chromium in low-carbon ferrochrome of the same carbon content.

A high-purity chromium metal, malleable enough to forge at low temperatures, has been produced by the Federal Bureau of Mines.[9] Ingots of arc-melted hydrogen-reduced electrolytic chromium were successfully hot-forged, and cylinders machined from the ingots were reduced 93 percent in area by rotary swaging with production of sound 2-mm.-diameter rods. The metal was also drilled, sawed, ground, topped, turned and filed in the cold state. Chromium metal sheet was successfully spot welded to chromium and to iron.

A chrome-manganese alloy containing less than 1 percent nickel was developed as a substitute for the nickel-bearing stainless steels.[10] Savings of 79 percent in nickel and 72 percent in molybdenum were reported achieved by the use of chromium-boron steel alloys in the manufacture of crawler-tractor parts.[11]

Physical properties and applications of chrome carbide grade 608, first of the new series 600 cemented chrome carbides made available by the Carboloy Department of General Electric Co. and described in Minerals Yearbook, 1951, Chromium chapter were discussed.[12] [13]

A powdered chromium-bearing base coat for molybdenum was developed by the National Bureau of Standards as a protection against rapid oxidation at the high temperatures encountered in jet-engine use.[14] The scaling characteristics of three Fe–Cr alloys and the nature of the scales were described.[15]

Steel silo storage facilities for indoor stockpiling of refractory chrome ore were installed at the General Refractory Co., Baltimore works. The new system eliminates certain preparation processes formerly necessitated by exposure of the ore to the elements.[16]

---

8 McFarlane, W. B., Low-Carbon Ferrochrome-Silicon Cuts Stainless Ingot Costs: Iron Age, vol. 169, No. 8, Feb. 21, 1952, pp. 108–110.
9 Gilbert, H. L., Johansen, H. A., and Nelson, R. G., Malleable Chromium and its Alloys: Bureau of Mines Rept. of Investigations 4905, 1952, 22 pp.
10 Daily Metal Reporter, vol. 52, No. 143, July 25, 1952, pp. 1, 4.
11 E&MJ Metal and Mineral Markets, vol. 23, No. 34, Aug. 21, 1952, p. 7.
12 Steel, vol. 131, No. 5, Aug. 4, 1952, pp. 92–94.
13 Chemical Engineering, vol. 59, No. 9, September 1952, pp. 288, 290, 292.
14 Moore, D. G., Bolz, L. H., Pitts, J. W., Harrison, W. N., Study of Chromium-Frit-Type Coatings for High Temperature Protection of Molybdenum: Nat. Adv. Committee for Aeronautics Tech. Note 2422, July 1951.
15 Caplan, D., and Cohen, M., High-Temperature Oxidation of Some Iron-Chromium Alloys: Jour. Metals, October 1952, pp. 1057–1065.
16 American Metal Market, vol. 59, No. 133, July 11, 1952, p. 1.

WORLD REVIEW

Continuing its steady climb upward, world chromite production passed the 3-million-ton mark in 1952, exceeding the previous year's high by 400,000 metric tons. The most important single production gain of the year was made by the Republic of the Philippines, with an output increase of 62 percent over 1951, making it easily the third largest chromite producer known. Turkey surpassed the previous year's total to retain its position as the world's leading producer of chromite. The Union of South Africa remained one of the great world chrome sources.

Chromite production throughout the Non-Soviet World was being fostered actively by the United States Government through the Defense Materials Procurement Agency. Agreements for development loans and purchase contracts were negotiated and under discussion in many countries.

Brazil.—A contract calling for exploitation of the chromite deposits at Mazagao was signed by the Governor of Amapá Territory and a Brazilian mining company. Ore reserves at Mazagao have been estimated at 150,000 tons.[17]

TABLE 9.—World production of chromite, by countries,[1] 1943–47 (average) and 1948–52, in metric tons [2]

[Compiled by Lee S. Peterson]

Country [1]	1943–47 (average)	1948	1949	1950	1951	1952
North America:						
Canada	12,279	1,556	327			
Cuba	214,020	116,624	97,368	65,820	79,065	61,808
Guatemala	430	444	300	289	1,138	[3] 60
United States	40,783	3,283	393	367	6,401	19,327
South America: Brazil (exports)	2,840	1,626	3	(4)		(4)
Europe: [5]						
Albania	(6)	[7] 16,500	(4)	(4)	(4)	(4)
Greece	9,582	1,500	3,381	12,631	25,333	28,883
Portugal	974	176	88	45	33	(4)
Yugoslavia	50,583	62,613	109,120	114,736	99,639	107,700
Asia:						
Afghanistan			1,000	550	75	1,000
Cyprus (exports)	3,193	6,899	14,875	18,441	12,653	12,082
India	[8] 41,689	22,917	19,728	16,998	16,056	(4)
Japan	33,536	9,340	27,003	31,953	40,407	[3] 47,000
Pakistan	(8)	18,160	17,194	18,416	18,006	17,545
Philippines	[3] 88,800	256,854	246,744	250,511	334,571	543,514
Turkey	148,870	285,725	451,566	420,792	602,220	[3] 635,000
U. S. S. R.[3 5]	345,000	600,000	350,000	500,000	600,000	600,000
Africa:						
Egypt	295	191	50	36		
Sierra Leone	10,761	7,886	22,101	7,518	16,425	23,870
Southern Rhodesia	211,481	230,703	243,506	291,525	300,267	322,666
Union of South Africa	187,316	412,783	404,351	496,324	545,306	580,024
Oceania:						
Australia	414	564	642	905	1,402	(4)
New Caledonia	47,497	75,021	88,992	84,801	88,792	107,660
Total (estimate)	1,450,000	2,100,000	2,100,000	2,300,000	2,800,000	3,200,000

[1] In addition to countries listed, Argentina, Bulgaria, Iran, and United Kingdom produce chromite, but data on output are not available; estimates by senior author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous chromite chapters.
[3] Estimate.
[4] Data not available; estimate by senior author of chapter included in total.
[5] Output from U. S. S. R. in Europe included with U. S. S. R. in Asia.
[6] Production in 1943 only.
[7] Planned production as reported.
[8] Pakistan included with India.

[17] Mining Journal (London), vol. 238, No. 6094, June 6, 1952, p. 584.

Canada.—A program of diamond drilling on areas previously outlined by a magnetometer survey of chrome properties in the Bird River region of Manitoba was announced by Gunnar Gold Mines, Ltd. In addition, a satisfactory method for producing chromium metal from the ore will be sought through metallurgical work.[18]

New Caledonia.—Five companies produced chrome ore from seven operations during 1952. By far the largest production was attained by the Tiebaghi mine. Of the total chrome exports, 45 percent was shipped to the United States and 36 percent to France. Total production increased 21 percent over 1951.

After achieving the third highest production of chrome ore in New Caledonia during 1952, the Calmet Co., working the Plaine Gaiacs alluvial deposits, ceased operations at the end of the year.

Pakistan.—Pakistan Industries, Ltd., was granted chromite-mining leases at Mamand in the Hindu Bagh area, Baluchistan. According to the director of the company, a 1,500-ton monthly output would be possible by use of the current mining methods, but actual output will be no more than 500 tons a month until transportation difficulties are eliminated.[19]

Phillipines.—Rapid strides were being taken toward attaining ever-greater production of chromite, as the 62-percent rise over the 1951 output indicated. Acoje Mining Co. installed a large concentrating plant. A new high-grade metallurgical chromite deposit in Lourdes, Oriental Misamis, was being developed by Luzon Stevedoring Co.[20] Benguet Consolidated Mining Co. planned to improve the mine-to-wharf chromite haulage system at the Consolidated Mines to increase production. A railroad from the mines to the pier was being constructed to eliminate the heavy cost of truck haulage. Over 1 million dollars worth of improvements was planned to cope with the ever-increasing production from the mines.[21]

Southern Rhodesia.—Three companies produced 95 percent of the chromite output of Southern Rhodesia. They were Rhodesia Chrome Mines, Ltd., at Selukwe, the largest producer in the Colony; African Chrome Mines, Ltd., at Banket; and Panadium Corp. of Rhodesia. Mine production is apparently limited only by the availability of transportation, never adequate. Toward the end of 1952, six diesel engines were received by the Rhodesia Railways, thus supplying hope that the chronic rail shortages will be alleviated.

During 1952 eluvial deposits on the slopes and in the valleys adjoining the Great Dyke were successfully mined and milled by a company operating under the name Rhodesian Mining Enterprises near Kildonan. A concentration of chromite is found in the top 16 inches of soil, which contains 10 to 30 percent of the mineral. The soil is washed, deslimed, and screened, and the feed sent to flotation cells. It is then concentrated further by magnetic separation into a product assaying a reported 55 percent Cr_2O_3 with a chrome-iron ratio of 2.6:1. Other such operations were planned.

Turkey.—Again in 1952, as in the previous year, Turkey was the world's greatest chromite producer. The Etibank, organ of the

[18] Engineering and Mining Journal, September 1952, vol. 153, No. 9, p. 179.
[19] State Department Dispatch 1466: American Embassy, Karachi, Pakistan, May 19, 1952, 2 pp.
[20] Mining World, vol. 14, No. 6, May 1952, p. 65.
[21] Engineering and Mining Journal, vol. 153, No. 11, November 1952, p. 70.

Turkish Government, mined 27 percent of the total output; independent operators accounted for 73 percent. Chromite mining and export have become factors of considerable importance in the Turkish economy.

Turkish exports of chrome ore during 1952 increased 26 percent compared with 1951. The United States received 67 percent of the total.

Export totals for recent years are shown on table 10.

A promising new chrome deposit was being operated by the Kromit Mine Co. at Pozanti in the Toros Mountains.[22]

Union of South Africa.—One of the principal sources of chromite in the world, the Union of South Africa is the only current producer of Chemical-grade ore. The ore is found in the Transvaal in the Bushveld complex and reserves are estimated in the hundreds of millions of tons.

Chrome oxide green pigment was being produced in a new plant at Germiston, Transvaal.[23]

TABLE 10.—Exports of chromite from Turkey, by destination, 1943–47 (average) and 1948–52, in metric tons [1]

Destination	1943–47 (average)	1948	1949	1950	1951	1952
Austria	679	[2] 22,458	37,325	29,233	35,472	39,708
Belgium			390			50
Canada	302	1,118		6,696		2,032
Czechoslovakia		940				
France	7,933	24,596	17,676	10,729	27,288	39,382
Germany (Western)	14,643		8,196	8,743	38,828	49,771
Hungary			3,452	58	100	
Italy	2,089	1,509	5,750	3,702	6,140	7,025
Norway	6,454	7,245	500	12,900	7,774	14,357
Sweden	11,269	2,681	16,280	23,128	12,821	16,166
Switzerland			50		2,595	16,115
United Kingdom	6,084	6,385	11,017	16,556	15,959	8,790
United States	52,695	239,675	252,610	241,415	356,246	424,983
Other	406			[3] 1,016	[4] 1,386	[5] 8,029
Total	102,554	[2] 306,607	353,246	354,176	504,609	626,408

[1] United States consular reports, Ankara, and other sources.
[2] Revised figure.
[3] Greece.
[4] Netherlands (276 tons) and Spain (1,110 tons).
[5] Lebanon (500 tons) and Netherlands (7,529).

Yugoslavia.—Discovery of extensive chrome deposits in southwestern Serbia with estimated reserves of 500,000 tons of ore was announced in 1952. This new deposit increases Yugoslavia's estimated reserves of chrome ore to 2 million tons.[24]

[22] Mining World, vol. 14, No. 9, August 1952, p. 78.
[23] Chemical Age (London), vol. 67, No. 1736, Oct. 18, 1952, p. 546.
[24] Mining Engineering, vol. 4, No. 6, June 1952, p. 543.

Clays

By Brooke L. Gunsallus[1] and Bernice V. Russ[2]

TOTAL clay sold or used by producers in 1952 decreased 3 percent in tonnage compared with 1951. Of the six major classifications of clay—namely, china clay or kaolin, ball clay, fire clay, bentonite, fuller's earth, and miscellaneous clays—only bentonite showed an increase over 1951.

Kaolin output decreased 2 percent in quantity and less than 1 percent in value. Ball-clay output decreased 12 percent in quantity but increased 6 percent in value. Significant increases in kaolin consumption were as follows: Paper coating, 14 percent; linoleum, 10 percent; paint, 40 percent; filtering and clarifying oils, 24 percent; and fertilizers, 12 percent. Decreases in consumption included pottery, 11 percent; high-grade tile, 25 percent; paper filler, 14 percent; cement, 44 percent; and insecticides and fungicides, 30 percent. Of the three largest consumers of ball clay, pottery and high-grade tile showed decreases and refractories an increase in 1952 compared with 1951.

TABLE 1.—Salient statistics of clays in the United States, 1951–52

	1951		1952	
	Short tons	Value	Short tons	Value
Domestic clay sold or used by producers:				
Kaolin or china clay	1,866,299	$25,324,554	1,829,102	$25,205,836
Ball clay	344,981	3,725,930	305,083	3,955,958
Fire clay, including stoneware clay	11,852,517	48,740,596	11,285,173	48,383,470
Bentonite	1,218,868	13,006,645	1,421,902	15,431,214
Fuller's earth	483,623	8,131,761	422,853	6,875,483
Miscellaneous clays	27,649,491	29,692,830	27,022,960	31,180,202
Total sold or used by producers	43,415,779	128,622,316	42,287,073	131,032,163
Imports:				
Kaolin or china clay	110,475	1,581,378	103,937	1,526,920
Common blue and Gross Almerode	35,613	360,319	28,666	299,597
Fuller's earth	405	7,929	157	3,698
Other clay	4,763	71,629	10,296	86,941
Total imports	151,256	2,021,255	143,056	1,917,156
Exports:				
Kaolin or china clay	36,435	671,058	40,303	706,111
Fire clay	101,146	1,028,719	88,025	916,425
Other clay (including fuller's earth)	185,963	5,744,490	175,663	5,391,956
Total exports	323,544	7,444,267	303,991	7,014,492

Except for a small decrease in 1949, bentonite sold or used by producers has increased each successive year for the past 14 years. In 1952 the tonnage output exceeded the previous peak year, 1951, by 17 percent. The petroleum and foundry industries consumed 94

[1] Commodity-industry analyst.
[2] Statistical clerk.

percent of the total tonnage in 1952. Rotary-drilling mud and foundry-sand bond reported increases but filtering and decolorizing oils a decrease in 1952 from 1951.

Fuller's earth sold or used by producers decreased 13 percent in tonnage in 1952 compared with 1951, but output was the second largest on record. In 1952 mineral-oil refining was the largest consumer, with 32 percent of the total, followed by absorbent uses, 24 percent; insecticides, 18 percent; rotary-drilling mud, 15 percent; and vegetable-oil refining, 4 percent.

Although fire clay sold or used by producers decreased 5 percent in 1952 compared with the peak year, 1951, output was the second largest in the history of the industry. The leveling national economy and slackening demand for refractories in the steel trade and heavy clay products in the construction industries were factors governing the decrease.

Price quotations for clay and clay products in 1952, as shown in trade papers, remained steady in most instances.

Imports of kaolin for 1952 decreased 6 percent from 1951 and represented only 6 percent of the total domestic consumption of kaolin.

Imports of ball clay (including common blue and Gross Almerode clays) in 1952 decreased 20 percent in tonnage and 17 percent in value compared with 1951.

Exports of kaolin or china clay in 1952 increased 11 percent over 1951; 73 percent of the quantity was shipped to Canada. Exports of fire clay in 1952 decreased 13 percent in tonnage and 11 percent in value compared with 1951. Canada received 77 percent of the total exports.

CONSUMPTION AND USES

Heavy clay products (building brick, structural tile, sewer pipe, etc.) in 1952 consumed 7 percent less clay than in 1951 and comprised 52 percent of the total clay output compared with 55 percent in 1951. Clays used in portland and other hydraulic cements in 1952 consumed 20 percent of the total clay output; refractories, 17 percent; paper filling, paper coating, and rotary-drilling mud, 2 percent each; and filtering and decolorizing oils and pottery, 1 percent each. The remainder was consumed for a large number of miscellaneous purposes.

Although the total tonnage of clay consumed in 1952 was less than in 1951, many uses gained in 1952. The increases for some of the more important classifications were as follows: High-grade tile, 31 percent; kiln furniture, 7 percent; paper coating, 14 percent; rubber, 8 percent; cement, 8 percent; paints, 43 percent; rotary-drilling mud, 23 percent; chemicals, 3 percent; and absorbent uses, 5 percent. The following uses decreased: Pottery, 13 percent; paper filling, 14 percent; refractories, 5 percent; heavy clay products, 7 percent; filtering and decolorizing oils, 22 percent; and insecticides and fungicides, 17 percent.

TABLE 2.—Clay sold or used by producers in the United States in 1952, by kinds and uses, in short tons

Use	Kaolin	Ball clay	Fire clay and stoneware clay	Bentonite	Fuller's earth	Miscellaneous clay, including slip clay	Total
Pottery and stoneware:							
Whiteware, etc	95,281	212,631	8,059	-----	-----	-----	315,971
Stoneware, including chemical stoneware	24,712	400	29,644	-----	-----	-----	54,756
Art pottery and flowerpots	5,424	10,164	42,739	-----	-----	18,834	77,161
Slip for glazing	500	500	209	-----	-----	-----	1,209
Total	125,917	223,695	80,651	-----	-----	18,834	449,097
Tile, high-grade	25,246	36,255	152,811	-----	-----	44,959	259,271
Kiln furniture:							
Saggers, pins, stilts	5,927	7,925	15,623	-----	-----	-----	29,475
Wads	-----	-----	3,527	-----	-----	-----	3,527
Total	5,927	7,925	19,150	-----	-----	-----	33,002
Architectural terra cotta	-----	1,195	30,091	-----	-----	-----	31,286
Paper:							
Filling	459,184	-----	424	-----	-----	-----	459,608
Coating	492,491	-----	-----	-----	-----	-----	492,491
Total	951,675	-----	424	-----	-----	-----	952,099
Rubber	240,982	-----	9,322	-----	-----	-----	250,304
Linoleum	39,781	-----	10,427	-----	-----	-----	50,208
Paints:							
Filler or extender	29,142	-----	1,749	-----	-----	898	31,789
Calcimine	2,642	-----	-----	-----	-----	-----	2,642
Total	31,784	-----	1,749	-----	-----	898	34,431
Portland and other hydraulic cements	43,113	-----	274	-----	-----	8,396,077	8,439,464
Refractories:							
Firebrick and block	160,035	19,003	5,465,734	-----	-----	40,550	5,685,322
Bauxite, high-alumina brick	-----	-----	19,799	-----	-----	-----	19,799
Fire-clay mortar, including clay processed for laying firebrick	30,427	2,850	235,670	-----	-----	2,104	271,051
Clay crucibles	210	-----	-----	-----	-----	-----	210
Glass refractories	1,250	-----	460	-----	-----	-----	1,710
Zinc retorts and condensers	-----	-----	20,921	-----	-----	-----	20,921
Foundries and steelworks	1,981	800	664,533	322,746	-----	19,594	1,009,654
Other refractories	6,514	-----	28,533	-----	-----	-----	35,047
Total	200,417	22,653	6,435,650	322,746	-----	62,248	7,043,714
Heavy clay products: Common brick, face brick, paving brick, drain tile, sewer pipe, and kindred products	-----	-----	4,444,807	-----	-----	17,587,646	22,032,453
Miscellaneous:							
Rotary-drilling mud	-----	-----	11,399	705,280	64,072	35,992	816,743
Filtering and decolorizing oils (raw and activated earths)	-----	-----	-----	307,685	[1]154,558	-----	462,243
Other filtering and clarifying	65,417	-----	-----	5,257	8,675	-----	79,349
Artificial abrasives	233	-----	56	-----	-----	-----	289
Absorbent uses	1,470	-----	-----	-----	101,081	-----	102,551
Asbestos products	1,561	-----	-----	-----	-----	-----	1,561
Chemicals	17,589	280	82,156	8,267	-----	-----	108,292
Enameling	-----	2,500	-----	-----	-----	-----	2,500
Fertilizers	5,456	300	-----	-----	-----	450	6,206
Filler (other than paper or paint)	9,340	10,280	1,187	-----	12,336	4,946	38,089
Insecticides and fungicides	27,945	-----	-----	4,073	76,116	160	108,294
Plaster and plaster products	4,764	-----	-----	-----	-----	-----	4,764
Concrete admixture, sealing dams, etc	-----	-----	-----	2,122	-----	-----	2,122
Other uses	30,485	-----	5,019	66,472	6,015	870,750	978,741
Total	164,260	13,360	99,817	1,099,156	422.853	912,298	2,711,744
Grand total:							
1952	1,829,102	305,083	11,285,173	1,421,902	422,853	27,022,960	42,287,073
1951	1,866,299	344,981	11,852,517	1,218,868	483,623	27,649,491	43,415,779

[1] Comprises the following: Mineral oils, 136,199; vegetable oils, 18,359 short tons.

CHINA CLAY OR KAOLIN

The upward trend in kaolin production that began in 1945 and continued through 1951 terminated in 1952. A 2-percent decrease from the record high of 1951 in tonnage of kaolin sold or used by producers was reported in 1952. The value decrease was less than 1 percent.

As has been the pattern for the past several years, the paper, rubber, pottery, and refractory industries were the principal consumers. Paper consumed 52 percent of the total kaolin, 25 percent for filling, and 27 percent for coating. The rubber industry consumed 13 percent; refractories, 11 percent; and pottery, 7 percent. The remaining 17 percent was consumed for a wide variety of purposes, including cement, high-grade tile, fertilizers, chemicals, insecticides, paint filler or extender, calcimine, and linoleum. The following users reported increases: Paper coating, 14 percent; rubber, 4 percent; linoleum, 10 percent; paint, 40 percent; refractories, less than 1 percent; filtering and clarifying oils, 24 percent; chemicals, 1 percent; and fertilizers, 12 percent. Decreases in consumption were reported for pottery, 11 percent; high-grade tile, 25 percent; paper filling, 14 percent; cement, 44 percent; asbestos products, 39 percent; insecticides and fungicides, 30 percent; and plaster products, 13 percent.

TABLE 3.—Kaolin sold or used by producers in the United States, 1951–52, by States

State	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1951						
Alabama, Florida, and North Carolina	65,776	$1,227,365			65,776	$1,227,365
California	(1)	(1)	(1)	(1)	24,285	381,650
Georgia	1,191,767	17,840,265	132,043	$859,470	1,323,810	18,699,735
Pennsylvania	(1)	(1)	(1)	(1)	75,415	306,045
South Carolina	(1)	(1)	(1)	(1)	322,208	4,095,912
Other States [2]	434,937	5,273,176	41,776	124,278	54,805	613,847
Total	1,692,480	24,340,806	173,819	983,748	1,866,299	25,324,554
1952						
Alabama, Florida, and North Carolina	58,579	1,067,883			58,579	1,067,883
California	(1)	(1)	(1)	(1)	21,589	256,906
Georgia	1,189,457	17,921,448	138,798	880,745	1,328,255	18,802,193
South Carolina	(1)	(1)	(1)	(1)	322,778	4,079,112
Other States [2]	428,938	5,281,903	13,330	53,857	97,901	999,742
Total	1,676,974	24,271,234	152,128	934,602	1,829,102	25,205,836

[1] Included with "Other States."
[2] Includes States indicated by footnote 1 and Illinois, Pennsylvania, Utah, and Virginia.

Ten States shipped kaolin in 1952, the same number as in 1951. As has been the case for several years, Georgia remained first with 73 percent compared with 71 percent in 1951, and South Carolina was second with 18 percent. The Alabama, Florida, and North Carolina group and California each decreased 11 percent compared with 1951. Georgia and South Carolina registered small increases in 1952 over 1951.

No quotations were reported by E&MJ Metal and Mineral Markets on domestic kaolin in 1952. The last quotations, given in June 1951, were as follows: Georgia kaolin, for filler and ceramic grades, $8.50 to $9.50 per ton, depending upon grade for crushed material, and $13 to $17 for pulverized, in paper bags. North Carolina china clays, ceramic grades, in bulk, carlots, were quoted at $20.25 to $22.25 per ton. Florida kaolins were quoted by the same source at $18.75 per ton for purified and crushed; $24.75 for washed and air-floated clays; and $38.50 for air-floated enamel grade. Crude Pennsylvania kaolin was quoted at $5 to $7.50 per ton and "purified" kaolin at $21 to $24. These prices were the same as those quoted in December 1950 and are substantially the same as those for 1949.

TABLE 4.—Georgia kaolin sold or used by producers, 1943–47 (average) and 1948–52, by uses

Year	China clay, paper clay, etc.			Refractory uses			Total kaolin		
	Short tons	Value		Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton		Total	Average per ton
1943–47 (average)	698, 805	$7, 754, 121	$11. 10	113, 024	$479, 402	$4. 24	811, 829	$8, 233, 523	$10. 14
1948	1, 006, 325	13, 866, 799	13. 78	129, 115	775, 899	6. 01	1, 135, 440	14, 642, 698	12. 90
1949	902, 433	13, 229, 888	14. 66	100, 958	576, 448	5. 71	1, 003, 391	13, 806, 336	13. 76
1950	1, 087, 174	16, 533, 582	15. 21	133, 481	806, 946	6. 05	1, 220, 655	17, 340, 528	14. 21
1951	1, 147, 865	17, 615, 634	15. 35	175, 945	1, 084, 101	6. 16	1, 323, 810	18, 699, 735	14. 13
1952	1, 227, 756	18, 155, 248	14. 79	100, 499	646, 945	6. 44	1, 328, 255	18, 802, 193	14. 16

Prices for imported china clay in December 1952 were quoted by the Oil, Paint and Drug Reporter as follows: White lump, carlots, ex dock (Philadelphia, Pa., and Portland, Maine), $20 to $40 per long ton; powdered, ex dock, in bags, $50 per net ton; and powdered, l. c. l., ex warehouse, $60. The average value of domestic kaolin sold or used as reported to the Bureau of Mines in 1952 was $13.78, compared with $13.57 in 1951, $13.68 in 1950, and $13.43 in 1949.

Imports of kaolin for 1952 decreased 6 percent from 1951 figures and represented only 6 percent of the total domestic consumption for 1952. Imports represented a like amount in 1951, 7 percent in 1950, and 5 percent in 1949. Over 99 percent of the 1952 imports came from the United Kingdom and the remainder from Canada, Sweden, and Italy.

Exports of kaolin or china clay in 1952 rose 11 percent over 1951; 82 percent was shipped to Canada and 3 percent each to Mexico and Venezuela. Small tonnages also were sent to Central and South America, Europe, Union of South Africa, Japan, and Australia.

The Dragon mine at Eureka, Utah, mined about half of its 300-ton daily output of halloysite by the open-pit method in 1952. Previously all of its halloysite output was mined underground.[3]

Control of United Clay Mines, with kaolin mines and plants in Georgia, Florida, South Carolina, and Maryland was purchased by W. J. Smith and Associates of Sandersville, Ga.[4]

[3] Mining World, vol. 14, No. 1, January 1952, p. 85.
[4] Engineering and Mining Journal, vol. 153, No. 12, December 1952, p. 166.

The effect of water vapor on the decomposition temperature of kaolinite, halloysite, and dickite was investigated.[5]

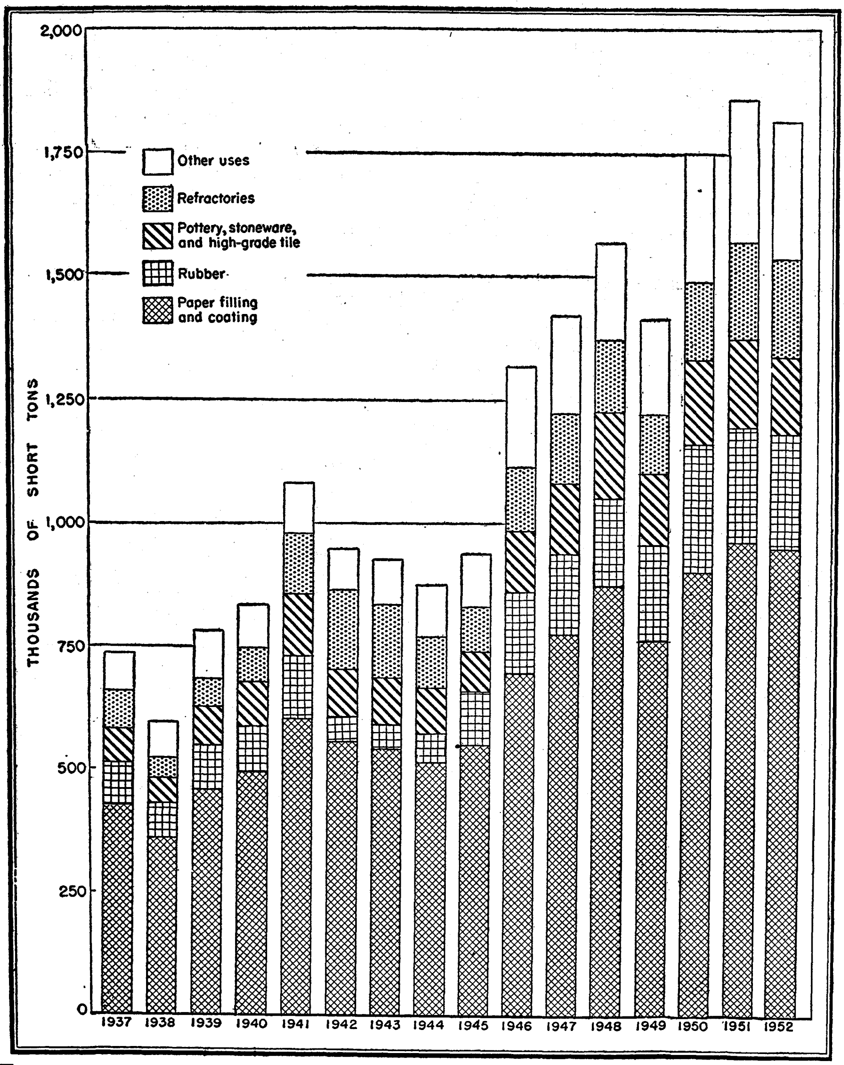

FIGURE 1.—Kaolin sold or used by domestic producers for specified uses, 1937–52.

BALL CLAY

Ball clay sold or used by producers in 1952 decreased 12 percent in tonnage but increased 6 percent in value compared with 1951. For the tenth consecutive year, Tennessee led in tonnage output, with 54 percent of the United States total compared with 56 percent in 1951. Kentucky was second with 35 percent in 1952 compared with 32 per-

[5] Stone, R. L., Differential Thermal Analysis of Kaolin-Group Minerals Under Controlled Partial Pressures of H_2O: Jour. Am. Ceram. Soc., vol. 35, No. 4, April 1952, pp. 90–99.

cent in 1951. Other States, in order of decreasing output, were Maryland, Mississippi, and New Jersey, the same order as in 1951. Compared with 1951, Tennessee decreased 16 percent and Kentucky 4 percent, respectively, in tonnage in 1952.

TABLE 5.—Ball clay sold by producers in the United States, 1950–52, by States

State	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Kentucky	105,690	$1,325,161	111,215	$1,411,175	107,211	$1,372,695
Maryland, Mississippi, and New Jersey	34,290	424,480	39,575	532,113	34,010	455,989
Tennessee	184,434	2,230,526	194,191	1,782,642	163,862	2,127,274
Total	324,414	3,980,167	344,981	3,725,930	305,083	3,955,958

The pottery industry consumed 73 percent of the ball clay sold or used in 1952 compared with 78 percent in 1951. The balance of the output was consumed by high-grade tile, 12 percent (12 percent in 1951); refractories, 7 percent (6 percent); and other uses, 8 percent (4 percent). Decreases in ball-clay consumption were reported in 1952 by the following industries: Whiteware, 18 percent; high-grade tile, 14 percent; and architectural terra cotta, 8 percent compared with 1951. The following industries showed increases in 1952 compared with 1951: Enameling, 52 percent; refractories, 14 percent; and filler other than paper or paint, 2 percent.

Quotations on ball clay did not appear in E&MJ Metal and Mineral Markets in 1952. Quotations in 1951 were unchanged from 1950 and 1949 and were as follows: Tennessee—crude ball clay, $10 per short ton, and air-floated and pulverized, $19.50 per ton; and Maryland—shredded, in bulk, $7 to $9, and air-floated, in bags, $14 to $17.50 per ton. No quotations on Kentucky ball clay have been published since 1949. In 1952 the average value per ton for all ball clay as reported by producers to the Bureau of Mines was $12.97, compared to $10.80 in 1951, $12.27 in 1950, and $12.31 in 1949. In 1952 the average value for ball clay in Tennessee was $12.98, compared with $9.18 in 1951. In Kentucky the average in 1952 was $12.80, compared with $12.69 in 1951; and in Maryland, Mississippi, and New Jersey, $13.40 compared with $13.45 in 1941.

Imports of common blue and ball clay and Gross Almerode clays in 1952 decreased 20 percent in tonnage and 17 percent in value compared with 1951. Unmanufactured blue and ball clays represented the major share of imports; the United Kingdom supplied 98 percent of this classification and virtually all of the imports of manufactured blue and ball clay. Small tonnages of imports of blue and ball clay came from Canada and West Germany. Imports of Gross Almerode clays (from United Kingdom) in 1952 totaled only 6 short tons. Exports, if any, are not separately shown in official foreign trade returns.

Mining methods and processes used in preparing ball clay for the market were given in detail in an article.[6]

[6] Ceramic Industry, vol. 58, No. 2, February 1952. pp. 84–86, 107.

FIRE CLAY

Although fire clay sold or used in 1952 decreased 5 percent compared with the peak year 1951 it was the second largest production in the history of the industry. Leveling of the national economy and slackening demand for refractories in the steel trade and heavy clay products in the construction industries were the factors governing the decrease.

The principal uses of fire clay in 1952 were refractories manufacture, which consumed 57 percent of the national output, and heavy clay products, which consumed 39 percent. These two uses absorbed 96 percent of the 1952 tonnage, compared with 97 percent in 1951. In 1952 fire clay consumed for refractories decreased 7 percent and that consumed by the heavy clay products industry decreased 4

TABLE 6.—Fire clay, including stoneware clay, sold or used by producers in the United States, 1951–52, by States [1]

State	Sold by producer		Used by producer		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1951						
Alabama	128,781	$239,201	74,558	$467,829	203,339	$707,030
Arkansas	(2)	(2)	(2)	(2)	319,941	1,022,326
California	209,070	567,777	301,151	868,595	510,221	1,436,372
Colorado	201,746	422,065	131,679	406,246	333,425	828,311
Illinois	248,482	1,187,344	243,645	587,526	492,127	1,774,870
Indiana	358,292	517,792	141,431	303,880	499,723	821,672
Kentucky	140,466	622,838	442,825	3,037,788	583,291	3,660,626
Maryland	10,812	51,381	169,490	580,798	180,302	632,179
Missouri [3]	401,057	1,250,331	1,171,465	8,448,387	1,572,522	9,698,718
New Jersey	81,403	702,209	344,658	1,070,522	426,061	1,772,731
Ohio	939,822	2,789,217	2,214,130	8,351,767	3,153,952	11,140,984
Pennsylvania	327,381	1,322,847	1,878,413	10,330,887	2,205,794	11,653,734
Tennessee	(2)	(2)	(2)	(2)	23,759	226,009
Texas	2,845	19,607	317,393	744,621	320,238	764,228
Utah	5,375	28,125	29,968	80,130	35,343	108,255
Washington	18,109	24,505	47,368	117,828	65,477	142,333
West Virginia	(2)	(2)	(2)	(2)	732,492	1,923,872
Other States [4]	86,026	441,365	1,184,676	3,157,188	194,510	426,346
Total	3,159,667	10,186,604	8,692,850	38,553,992	11,852,517	48,740,596
1952						
Alabama	145,567	292,788	74,442	464,663	220,009	757,451
Arkansas	(2)	(2)	(2)	(2)	386,111	1,337,542
California	196,954	631,351	365,181	1,086,613	562,135	1,717,964
Colorado	159,972	377,635	140,902	410,979	300,874	788,614
Illinois	193,076	962,605	257,368	582,063	450,444	1,544,668
Indiana	280,629	440,010	116,707	292,015	397,336	732,025
Kentucky	96,308	418,111	429,930	3,031,935	526,238	3,450,046
Maryland	9,937	45,319	165,465	503,539	175,402	548,858
Missouri [3]	585,691	1,776,186	1,265,111	8,683,401	1,850,802	10,459,587
New Jersey	80,225	721,960	199,538	877,789	279,763	1,599,749
Ohio	792,894	2,814,155	2,074,563	8,124,919	2,867,457	10,939,074
Pennsylvania	245,062	972,854	1,718,173	9,594,840	1,963,235	10,567,694
South Carolina	(2)	(2)	(2)	(2)	7,547	18,250
Tennessee	(2)	(2)	(2)	(2)	21,290	203,845
Texas	15,716	168,242	342,750	895,763	358,466	1,064,005
Utah	5,215	28,682	29,254	78,689	34,469	107,371
Washington	8,300	12,338	71,671	143,317	79,971	155,655
West Virginia	(2)	(2)	(2)	(2)	621,996	2,072,688
Other States [4]	147,452	599,078	1,071,120	3,351,631	181,628	318,384
Total	2,962,998	10,261,314	8,322,175	38,122,156	11,285,173	48,383,470

[1] Includes stoneware clay as follows: 1951—85,331 tons, $271,625; 1952—80,651 tons, $326,408.
[2] Included with "Other States."
[3] Includes diaspore and burley clay as follows: 1951—diaspore, 45,020 tons, $704,151; burley, 73,781 tons, $745,032; 1952—diaspore, 44,757 tons, $705,269; burley, 71,433 tons, $664,358.
[4] Includes States indicated by footnote 2 above and Georgia (1952 only), Idaho, Iowa, Kansas, Michigan, Minnesota, Mississippi, Montana, Nebraska, Nevada, New Mexico, Oregon, and South Carolina (1951 only).

percent, compared with 1951. About 1 percent was consumed in the manufacture of high-grade tile, a little less than 1 percent in chemicals, and the remainder in a wide variety of uses. The principal refractory use of fire clay was for firebrick and block manufacture. This division of the fire-clay industry used 3 percent less fire clay in 1952 than in 1951. Of the less important uses, high-grade tile and architectural terra cotta increased and chemicals decreased in 1952 compared with 1951. Rubber consumed 9,322 short tons of fire clay in 1952 compared with none in 1951.

In 1952 Ohio ranked first in fire-clay output, followed by Pennsylvania, Missouri, West Virginia, California, Kentucky, and Illinois. These States supplied 78 percent of the total quantity. The remainder was produced in 23 States. Of the 18 principal producing States shown in table 6, Alabama, Arkansas, California, Missouri, Texas, and Washington reported increases, and the other 12 reported decreases. Price quotations on fire clay do not appear in trade journals. However, the average realization per ton reported to the Bureau of Mines by producers indicated that the average value of fire clay sold in 1952 was $3.46, compared with $3.22 in 1951, $3 in 1950, and $2.91 in 1949. The average value of all fire clay, including both sales and captive tonnage, was $4.29 in 1952, compared with $4.11 in 1951, $3.04 in 1950, and $2.96 in 1949. Quotations on brick manufactured from fire clay were reported in 1952 in E&MJ Metal and Mineral Markets (comparable 1951 prices in parentheses) as follows: Missouri, Kentucky, and Pennsylvania, superquality, $116.60 per thousand ($116.50); high-heat quality, $94.60 ($99.60); Ohio firebrick, intermediate grade, $88 ($88); and second grade, $79.20 ($79.20) per thousand.

Imports of fire clay are not shown separately in foreign trade statistics. Exports of fire clay in 1952 decreased 13 percent in tonnage and 11 percent in value compared with 1951. Canada received 86 percent of the total exports and Mexico, 7 percent. The remainder (7 percent) comprised small tonnages to many destinations in Central and South America, Europe, Asia, and Africa.

BENTONITE

Bentonite sold or used by producers in 1952 exceeded the previous peak year of 1951 by 17 percent in tonnage and 19 percent in value. The upswing in oil-well drilling activity and the bringing into production of large bentonite deposits in Wyoming were mainly responsible for the large bentonite output. Bentonite was the only classification of clay discussed in the Minerals Yearbook that advanced in 1952 compared with 1951.

The foundry and petroleum industries consumed 94 percent of the total tonnage in 1952—the same percentage as in 1951. Rotary-drilling mud consumed 50 percent (38 percent in 1951); filtering and decolorizing oils, 21 percent (33 percent); foundry-sand bond, 23 percent (23 percent); and the remaining 6 percent was used for a wide variety of purposes. Bentonite tonnage employed as rotary-drilling mud increased 53 percent and foundry-sand bond tonnage increased 14 percent in 1952, but filtering and decolorizing oils tonnage decreased 23 percent, compared with 1951.

Eleven States reported bentonite production in 1952, compared with nine in 1951. Of the States that reported in 1952 and 1951, tonnage increased in Arizona, California, and Wyoming and decreased in South Dakota, Mississippi, Texas, and Utah.

The Wyoming-South Dakota district supplied 63 percent of the total bentonite sold or used by producers in 1952 (Wyoming 49 per-

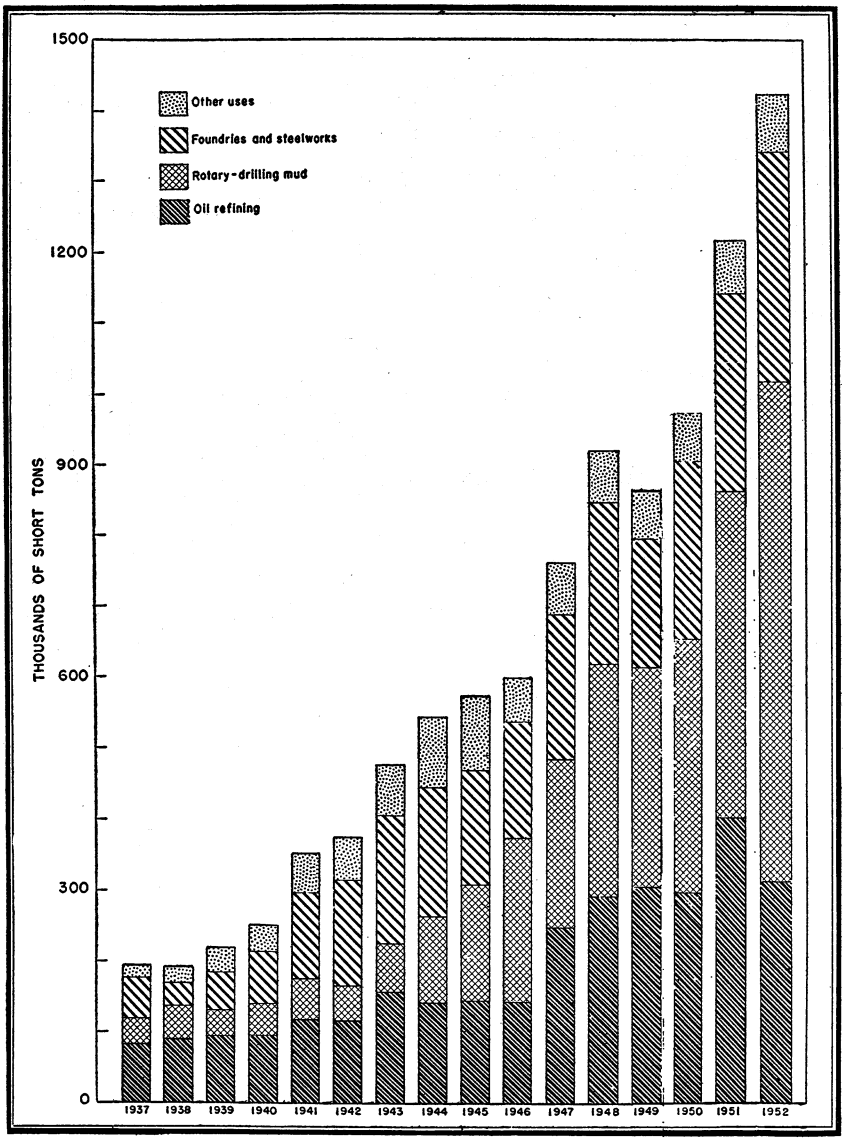

FIGURE 2.—Bentonite sold or used by domestic producers for specified uses, 1937–52.

TABLE 7.—Bentonite sold or used by producers in the United States, 1950–52, by States

State	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Montana					2,000	$24,000
South Dakota	192,591	$2,194,894	246,585	$2,926,756	205,934	2,553,783
Texas	24,574	321,345	38,425	212,670	31,386	584,938
Wyoming	394,939	4,091,571	465,254	5,981,655	692,853	9,168,708
Other States [1]	361,729	1,952,859	468,604	3,885,564	489,729	3,099,785
Total	973,833	8,560,669	1,218,868	13,006,645	1,421,902	15,431,214

[1] Arizona, California, Colorado (1950–51 only), Idaho (1950–51), Louisiana (1952 only), Mississippi, Nevada (1952 only), Oklahoma (1952 only) and Utah.

cent and South Dakota 14), compared with 58 percent in 1951 and 60 in 1950. Texas furnished 2 percent in 1952 compared with 3 in 1951 and 1950. Trends in sales for principal uses are shown in figure 2.

In 1952 bentonite was not quoted in E&MJ Metal and Mineral Markets. The following quotations were given for 1951 on Wyoming bentonite: Dried, crushed, in bulk, $9 per short ton; and 200-mesh, pulverized, in 100-pound bags, $12.50. Oil-well grade was quoted at $14 per short ton. The average value per short ton, as reported by the producers to the Bureau of Mines in 1952, was $10.85, compared with $10.67 in 1951, $8.79 in 1950, and $8 in 1949.

Bentonite imported in 1952 comprised 100 short tons from Canada and 54 tons from Italy.

Exports of bentonite are not shown separately in foreign trade statistics but are included under the blanket classification of "Other clays or earths, not especially provided for." It is understood, however, that some domestic producers export part of their production to destinations throughout the world.

Extensive deposits of bentonite east of Greybull, Wyo., were placed in production by the Magnet Cove Barium Corp. This development was made possible by building a 1,600-foot-long, 2-bucket, reversible tramway across the Big Horn River to the plant and transportation facilities.[7]

FULLER'S EARTH

Even though the output of fuller's earth decreased 13 percent in tonnage in 1952 compared with 1951, the high year, it was the second largest in the history of the industry.

In 1952 mineral-oil refining was the largest consumer, although it decreased 22 percent in tonnage compared with 1951. The consumption in 1952 represented 32 percent of the total production compared with 36 percent in 1951, 40 in 1950, and 47 in 1949. It is the consensus that this trend resulted in part from changed methods of oil refining and the marketing of a higher quality of fuller's earth.

Absorbent uses consumed 24 percent of the total in 1952, compared with 20 percent in 1951, 21 in 1950, and 22 in 1949; insecticides, 18 percent, the same as in 1951 and 1950, compared with 12 percent in

[7] Engineering and Mining Journal, vol. 153, No. 10, October 1952, p. 36.
Mines Magazine, vol. 42, No. 3, March 1952, p. 42.

1949; rotary-drilling mud, 15 percent, compared with 16 percent in 1951, 10 in 1950, and 9 in 1949; and vegetable-oil refining, 4 percent, compared with 4 in 1951, 5 in 1950, and 6 in 1949. The remainder was used in other filtering and clarifying, filler other than paper and paint, and other unspecified uses.

The following States reported decreases in 1952 compared with 1951: Florida, Georgia, Nevada, Tennessee, and Texas. States showing increases were California, Mississippi, and Utah. The Florida-Georgia area consumed 64 percent of the total tonnage sold or used by producers in 1952, compared with 62 percent in 1951 and the same percentage in 1950. Production in Texas represented 25 percent of the total production in 1952, compared with 29 percent in 1951 and 28 in 1950.

Quotations on fuller's earth were not listed in E&MJ Metal and Mineral Markets in 1952. Prices, which had not changed since 1949, were quoted in 1951 as follows: 14- to 30-mesh, $14 per short ton; 30- to 60-mesh, $14.50; 100-mesh up, $7; and 200-mesh up, $10. The average value of fuller's earth sold or used, as reported to the Bureau of Mines by producers, was $16.26, compared with $16.81 in 1951, $16.42 in 1950, and $16.20 in 1949.

TABLE 8.—Fuller's earth sold or used by producers in the United States, 1950–52, by States

State	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Florida and Georgia	247, 390	$4, 273, 890	299, 071	$5, 258, 330	270, 261	$4, 829, 552
Tennessee	(1)	(1)	(1)	(1)	25, 974	358, 752
Texas	112, 466	1, 393, 773	142, 273	1, 952, 304	105, 565	1, 030, 005
Other States [2]	36, 169	837, 070	42, 279	921, 127	21, 053	657, 174
Total	396, 025	6, 504, 733	483, 623	8, 131, 761	422, 853	6, 875, 483

[1] Included with "Other States."
[2] Includes State indicated by footnote 1 and California, Mississippi, Nevada, and Utah.

Imports of fuller's earth in 1952 totaled 157 short tons, all from the United Kingdom. Exports are not given separately in official foreign trade statistics. Reports from the producers to the Bureau of Mines, however, indicated exports of approximately 26,000 short tons in 1952, compared with 35,000 short tons in 1951 and 16,400 in 1950. Destinations reported included North America, Central and South America, West Indies, several European countries, and the Philippines.

The Attapulgus Clay Co., with mines at Attapulgus, Ga., was purchased in 1952 by the Minerals Separation North American Corp. The name was changed to the Attapulgus Minerals & Chemical Co. This company is the largest producer of fuller's earth in the United States.[8]

MISCELLANEOUS CLAYS

This section presents statistics for the large-tonnage clays and shales, other than those discussed in the preceding pages, that are used in the

[8] Pit and Quarry, vol. 45, No. 8, February 1953, p. 59.

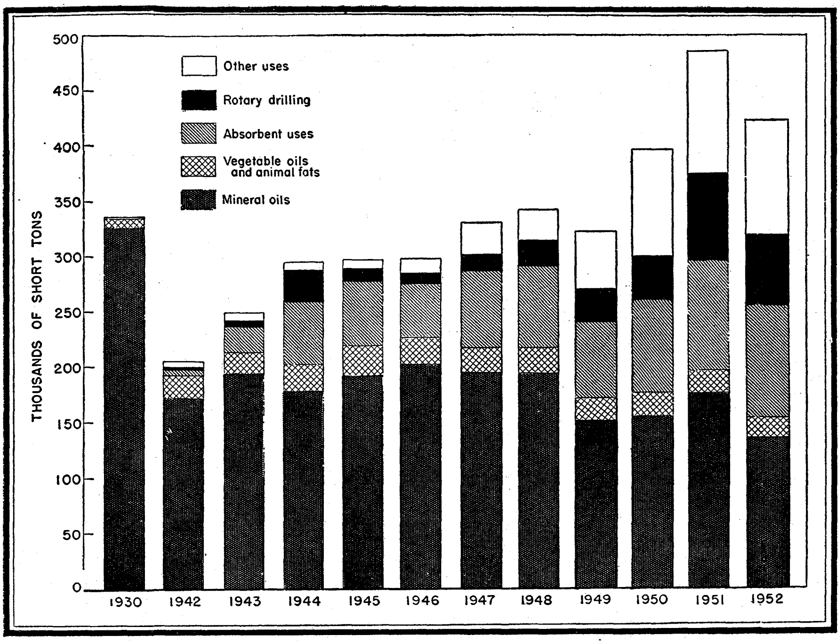

FIGURE 3.—Fuller's earth sold or used by producers for specified uses, 1930 and 1942–52.

manufacture of heavy clay products and portland cement. With these clays are grouped small tonnages of slip clay, oil-well drilling mud, pottery clay, and clays that cannot clearly be identified with one of the types discussed separately in this chapter.

Miscellaneous clays sold or used by producers decreased 2 percent in 1952, compared with 1951. The tonnage of clay used in the production of cement in 1952 increased 9 percent over 1951, owing to a heavy demand for cement, the production of which in 1952 reached a new high. Miscellaneous clays consumed in the manufacture of heavy clay products decreased 8 percent in 1952, compared with 1951. The quantity and value of shipments of clay construction products produced showed a similar decrease in 1952. In 1952, 65 percent of the total miscellaneous clays were used in manufacturing heavy clay products and 31 percent in cement. Captive tonnage, clay produced by the mine operators for their own use in manufacturing brick, tile, cement, and other end products and marketed for the first time as such, amounted to 96 percent, the same as for the past 6 years, of all miscellaneous clays and shales. The average value of miscellaneous clays sold as crude or prepared clay in 1952 was $1.91, compared with $2.05 in 1951. Some special types of clay included under the miscellaneous clay classification, however, sold for much higher prices. The value of the captive tonnage was computed from individual estimates that average about $1 per ton.

TABLE 9.—Miscellaneous clays, including shale and slip clay sold by or used by producers in the United States, 1951–52, by States

State	Sold by producers [1]		Used by producers [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1951						
Arkansas			171,518	$184,532	171,518	$184,532
California	117,142	$644,775	1,927,134	1,947,648	2,044,276	2,592,423
Colorado	(3)	(3)	(3)	(3)	323,808	340,558
Connecticut			275,900	252,725	275,900	252,725
Georgia			1,083,952	978,727	1,083,952	978,727
Illinois	(3)	(3)	(3)	(3)	2,097,013	2,249,324
Indiana	87,250	95,321	937,758	997,464	1,025,008	1,092,785
Iowa	3,302	57,963	877,752	955,550	881,054	1,013,513
Kansas			708,910	680,821	708,910	680,821
Kentucky			185,734	202,484	185,734	202,484
Louisiana	(3)	(3)	(3)	(3)	306,542	306,542
Maine			21,885	21,885	21,885	21,885
Maryland	(3)	(3)	(3)	(3)	558,083	558,083
Massachusetts			143,023	143,023	143,023	143,023
Michigan	(3)	(3)	(3)	(3)	1,509,712	1,579,065
Minnesota	(3)	(3)	(3)	(3)	111,984	127,206
Missouri	(3)	(3)	(3)	(3)	782,335	859,720
Montana			34,431	34,431	34,431	34,431
Nebraska	(3)	(3)	(3)	(3)	114,845	114,845
New Hampshire			(3)	(3)	28,501	28,501
New Jersey			253,159	277,368	253,159	277,368
New Mexico	(3)	(3)	(3)	(3)	56,780	89,918
New York	(3)	(3)	(3)	(3)	1,559,472	1,632,878
North Carolina	875	1,312	1,432,505	1,564,717	1,433,380	1,566,029
Ohio	115,351	127,944	2,417,327	2,495,129	2,532,678	2,623,073
Oklahoma	(3)	(3)	(3)	(3)	551,200	561,841
Oregon			143,479	148,479	143,479	148,479
Pennsylvania	21,466	31,738	1,927,892	2,096,033	1,949,358	2,127,771
South Carolina			619,272	620,022	619,272	620,022
Texas	28,554	326,200	1,687,563	1,689,563	1,716,117	2,015,763
Utah			203,809	567,869	203,809	567,869
Washington	(3)	(3)	(3)	(3)	220,887	224,475
West Virginia			371,154	371,154	371,154	371,154
Wisconsin	(3)	(3)	(3)	(3)	141,746	141,746
Wyoming			17,796	17,796	17,796	17,796
Undistributed [4]	615,799	740,659	11,217,799	11,419,498	3,470,690	3,345,455
Total	989,739	2,025,912	26,659,752	27,666,918	27,649,491	29,692,830
1952						
Arkansas			166,465	176,392	166,465	176,392
California	125,828	117,515	1,917,723	1,828,177	2,043,551	1,945,692
Colorado	(3)	(3)	(3)	(3)	267,856	298,540
Connecticut			157,500	157,500	157,500	157,500
Georgia			1,050,792	1,020,132	1,050,792	1,020,132
Illinois	(3)	(3)	(3)	(3)	1,886,299	2,324,583
Indiana	73,234	70,676	860,728	897,508	933,962	968,184
Iowa	62,943	658,751	772,177	1,984,104	835,120	2,642,855
Kansas			642,250	738,481	642,250	738,481
Kentucky			247,425	278,525	247,425	278,525
Louisiana	(3)	(3)	(3)	(3)	380,218	384,218
Maine			26,050	26,050	26,050	26,050
Maryland	(3)	(3)	(3)	(3)	578,051	651,622
Massachusetts	73	1,453	140,075	158,918	140,148	160,371
Michigan	(3)	(3)	(3)	(3)	1,775,784	1,809,087
Minnesota	(3)	(3)	(3)	(3)	96,203	104,297
Missouri	(3)	(3)	(3)	(3)	1,140,217	1,638,833
Montana			44,205	41,205	44,205	41,205
New Hampshire			30,135	30,135	30,135	30,135
New Jersey	1,910	3,820	315,707	339,925	317,617	343,745
New Mexico	(3)	(3)	(3)	(3)	38,048	71,615
New York	(3)	(3)	(3)	(3)	1,218,850	1,291,736
North Carolina			1,332,051	1,546,949	1,332,051	1,546,949
Ohio	281,338	293,644	2,345,035	2,411,024	2,626,373	2,704,668
Oklahoma	(3)	(3)	(3)	(3)	516,705	527,245
Oregon	(3)	(3)	(3)	(3)	256,692	548,934
Pennsylvania	47,059	56,126	1,691,972	1,857,653	1,739,031	1,913,779

For footnotes, see end of table.

TABLE 9.—Miscellaneous clays, including shale and slip clay sold or used by producers in the United States, 1951-52, by States—Continued

State	Sold by producers [1]		Used by producers [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
South Carolina			616,953	$577,899	616,953	$577,894
Texas	16,000	$288,000	1,557,603	1,503,234	1,573,603	1,791,234
Utah			84,943	171,369	84,943	171,369
Virginia			937,156	947,359	937,156	947,359
Washington	(3)	(3)	(3)	(3)	211,163	196,921
West Virginia			360,034	348,981	360,034	348,981
Wisconsin	48,632	48,672	85,821	85,821	134,453	134,493
Wyoming			13,895	7,799	13,895	7,799
Undistributed [4]	1,077,161	1,770,514	9,892,087	10,735,891	2,603,162	2,658,774
Total	1,734,178	3,309,171	25,288,782	27,871,031	27,022,960	31,180,202

[1] Includes slip clay as follows: Indiana, Michigan (1951 only), and New York; figures cannot be shown separately. Purchases by portland cement companies of common clay and shale: 1951—658,450 tons, estimated at $660,936; 1952—801,854 tons, estimated at $809,657.
[2] Includes the following: Common clay and shale used by portland cement companies: 1951—7,060,473 tons, estimated at $7,205,289; 1952—7,098,154 tons, estimated at $7,129,669.
[3] Included under "Undistributed."
[4] Figures include Alabama, Arizona, Delaware, District of Columbia, Florida, Idaho, Mississippi, Nebraska (1952 only), Nevada, North Dakota, South Dakota, Tennessee, and States indicated by footnote 3.

Miscellaneous clays, including shales and the so-called common or surface clays, are of widespread occurrence, and production was reported from all States except Vermont and Rhode Island. Two States, California and Ohio, reported tonnage exceeding 2 million short tons each. Other States reporting over 1 million tons sold or used by producers were, in order of output: Illinois, Michigan, Pennsylvania, Texas, North Carolina, New York, Missouri, and Georgia. Of the States for which data are shown in table 9, 12 reported increases and 22 decreases in output in 1952 compared with 1951.

As has been the case for the past several years, continued interest was shown in the development of expanded lightweight aggregates from clays and shales. Characteristics of different materials present individual problems. Proper methods allow the use of almost all types of clay to produce lightweight aggregate. The need for proper preparation of the raw materials and for the proper control of the sintering operation were discussed.[9]

Sintered aggregate from clay was produced in a highly mechanized plant. This operation, in Kansas City, Kans., produced 600 cubic yards of aggregate daily.[10] Hollow glass bubbles made from clay formed a new lightweight aggregate. The method of manufacture and potential applications were explained.[11] An aggregate plant designed for straight-line material flow was built near Ottawa, Kansas. The Kansas State Geological Survey cooperated to find the shale bed used as raw material.[12] Sunnyhill Aggregate Co., New Lexington, Ohio, was building a $500,000 plant to produce expanded shale lightweight aggregate.[13] Laboratory tests were made on 27 different Florida clays to determine their suitability in producing lightweight aggregate. From the tests, it appeared that most Florida clays are good bloating

[9] Bell, W. C. Proper Pelletizing Technique—Key to Efficient Sintering of Aggregate: Brick and Clay Record, vol. 120, No. 1, January 1952, pp. 46, 49, 52.
[10] Brick and Clay Record, vol. 120, No. 5, May 1952, pp. 38-39.
[11] Brick and Clay Record, vol. 121, No. 4, October 1952, pp. 46-47.
[12] Brick and Clay Record, vol. 120, No. 6, June 1952, pp. 42-45. Rock Products, vol. 55, No. 6, June 1952, pp. 101-103.
[13] Brick and Clay Record, vol. 120, No. 5, May 1952, p. 23.

materials and that the sintering-machine process may be the most satisfactory.[14] The Bureau of Mineral Research, Rutgers University, tested numerous deposits of shales and clays in New Jersey and found them suitable for lightweight aggregate.[15] In May 1952, lightweight-aggregate producers formed the Expanded Shale Institute, Washington, D. C.[16]

A completely modern brick plant was placed in operation at Cleveland, Ohio, with a daily capacity of about 140,000 brick. The only manual operation is the removal of brick from the off-bearing belt.[17]

HEAVY CLAY PRODUCTS

The high demand for structural clay products that characterized 1950 and 1951 did not carry over into 1952. Clay consumed in producing structural clay products decreased 7 percent in quantity and 8 percent in value of shipments in 1952 from 1951, according to data compiled by the Bureau of the Census, United States Department of Commerce. The largest percentage decrease occurred in unglazed structural tile, which decreased 21 percent in quantity and 20 percent in the value of shipments in 1952, compared with 1951. Other decreases in shipments were as follows: Unglazed brick (common and face), 11 percent; hollow facing tile, 17 percent; glazed and unglazed floor and wall tile, 17 percent; vitrified clay sewer pipe, less than 1 percent. Drain tile showed a 24-percent increase in shipments in 1952 compared with 1951, the only commodity in the structural clay products field to do so.

The total value of the principal structural clay products in 1952 decreased 8 percent compared with 1951.

The uninterrupted annual increase in the value of clay refractories reported for 1949 through 1951 terminated in 1952, when the value of shipments decreased 5 percent. The overall expansion in the steel and foundry industries in progress in 1951 leveled in 1952, lessening

TABLE 10.—Shipments of principal structural clay products in the United States, 1950–52 [1]

Product and unit quantity	1950		1951		1952	
	Quantity	Value (thousand dollars)	Quantity	Value (thousand dollars)	Quantity	Value (thousand dollars)
Unglazed brick (common and face) M stand. brick	6,486,332	164,470	6,306,561	170,743	5,635,249	154,566
Unglazed structural tile short tons	1,316,972	14,896	1,166,879	14,098	919,761	11,243
Vitrified clay sewer pipe do	1,567,664	53,402	1,554,711	58,238	1,544,809	58,943
Drain tile do	627,545	10,191	655,757	11,387	815,490	14,073
Hollow facing tile, glazed and unglazed M brick equiv	432,027	22,438	467,767	25,984	389,376	22,104
Glazed and unglazed floor and wall tile and accessories, including quarry tile M square feet	127,302	61,579	141,322	71,277	117,544	60,962

[1] Compiled from information furnished by the Bureau of the Census, U. S. Department of Commerce.

[14] Greaves-Walker, A. F., Bugg, S. L., and Hagerman, R. S., Development of Lightweight Aggregate From Florida Clays: Vol. 35, No. 3, March 1952, p. 39.
[15] Rock Products, vol. 55, No. 7, July 1952, p. 47.
[16] Brick and Clay Record, vol. 120, No. 6, June 1952, p. 27.
[17] Brick and Clay Record, vol. 121, No. 1, July 1952, pp. 39–45.

the demand for clay refractories. The value of fire-clay brick shipments (except superduty) represented 44 percent of the total value of fire-clay shipments in 1952; superduty fire-clay brick, 10 percent; ladle brick, 8 percent; and insulating firebrick, 7 percent. A number of classifications accounted for the remaining 31 percent, as shown in table 11.

The W. S. Dickey Clay Manufacturing Co., in conjunction with the city of Meridan, Miss., broke ground for a large clay-sewer-pipe plant. The factory was to be municipally owned but operated by the company.[18]

A snug, rootproof joint for clay sewer pipe was developed by National Clay Pipe Manufacturers, Inc. The sewer pipe is ground on the interior annular surface of the bell end and the exterior annular surface of the spigot end with a diamond drill. The two ground surfaces forming the joint are sealed with a thin rubber gasket.[19] The Robinson Clay Product Co., Akron, Ohio, announced a new plastic screw joint for clay pipe which combines a plastic material with vitrified clay to form a leak-proof, infiltration-proof joint.[20]

Roasted clay heated to about 1,500° F. was found to be superior to brick grog, which is ordinarily used in the manufacture of refractories.[21] Manufacturing activities of the refractories industry were discussed.[22] The General Refractories Co. opened a new basic refractories plant in Los Angeles, Calif., in 1952; wherever possible operations were mechanized.[23] Stowe-Fuller Refractories Co., with plants in Strawsburg, Ohio, and Alexandria, Pa., was purchased by the Robinson Clay Product Co., Akron, Ohio, December 31, 1952.[24]

TECHNOLOGY

Recent years have witnessed growing recognition of the value and importance of research in the ceramic industry. One issue of Ceramic Industry dealt solely with research and discussed the following aspects: What research is and how much is necessary; how to get the most out of a research program; projects conducted by industry associations; private facilities available for research; the use of universities in a research program; and what the plant research department can accomplish.[25]

Strength, absorption, and saturation-coefficient relations were determined on several thousand building brick by the National Bureau of Standards, Washington, D. C. These brick included examples of all commercial types of forming and represented a wide range of raw materials.[26] Methods of testing plasticity, drying and firing behavior, and other properties of clay materials for structural clay products were described. Improvement of the finished ware was said to result

[18] Brick and Clay Record, vol. 121, No. 3, September 1952, p. 66.
[19] Brick and Clay Record, vol. 120, No. 3, March 1952, pp. 60–61.
[20] Brick and Clay Record, vol. 120, No. 3, March 1952, pp. 62–63.
[21] West, H. F. and Veale, J. H., Use of Roasted Clay in the Manufacture of Firebrick: Am. Ceram. Soc. Bull., vol. 31, No. 6, 1952, p. 209.
[22] Brick and Clay Record, vol. 122, No. 1, January 1953, pp. 67–70.
[23] Brick and Clay Record, vol. 121, No. 6, December 1952, pp. 53–55.
[24] Pit and Quarry, vol. 45, No. 7, January 1953, p. 78.
[25] Ceramic Industry, vol. 59, No. 2, August 1952, pp. 31–117.
[26] McBurney, J. W., Richmond, J. C., and Copeland, M. A., Relations Among Certain Specification Properties of Building Brick and Effects of Differences in Raw Materials and Methods of Forming: Jour. Am. Ceram. Soc., vol. 35, No. 12, Dec. 1, 1952, pp. 309–318.

TABLE 11.—Production and shipments of refractories in the United States, by kind, 1951–52

[Bureau of the Census]

Product	Unit of quantity	1951			1952		
		Production (quantity)	Shipments		Production (quantity)	Shipments	
			Quantity	Value (thousand dollars)		Quantity	Value (thousand dollars)
Clay refractories:							
Fire-clay brick, standard and special shapes except superduty.	1,000 9-in. equiv.	725, 659	710, 289	78, 562	628, 262	610, 254	70, 849
Superduty fire-clay brick, standard and special shapes.	---do------	94, 916	92, 783	16, 158	96, 495	93, 428	16, 951
High-alumina brick, standard and special shapes (50 percent Al_2O_3 and over, except fused alumina and mullite).	---do------	23, 643	23, 414	6, 825	22, 251	21, 655	6, 655
Insulating firebrick, standard and special shapes.	---do------	56, 052	56, 605	11, 076	60, 343	60, 127	11, 510
Ladle brick	---do------	229, 694	226, 918	14, 652	209, 511	199, 913	13, 490
Hot-top refractories	---do------	56, 047	54, 944	5, 517	49, 148	48, 892	5, 042
Sleeves, nozzles, runner brick, and tuyeres.	---do------	65, 809	65, 581	8, 879	55, 085	54, 231	7, 789
Glass-house pots, tank blocks, upper structure, and floaters.	Short tons	25, 601	25, 763	3, 819	20, 513	19, 404	3, 373
High-temperature bonding mortars	---do------	83, 027	82, 745	6, 877	71, 402	72, 427	6, 272
Plastic refractories (including wet and dry ramming mixtures).	---do------	100, 089	99, 577	5, 529	101, 856	101, 893	5, 624
Cast and castables (hydraulic setting).	---do------	69, 534	69, 138	5, 628	83, 111	82, 387	6, 807
Ground crude fire-clay and high-alumina material.	---do------	446, 426	444, 970	4, 877	397, 144	397, 860	4, 892
Other clay refractories	---do------	--------	--------	2, 687	--------	--------	2, 680
Total clay refractories	------------	--------	--------	171, 086	--------	--------	161, 934
Nonclay refractories:							
Silica brick, standard and special shapes.	1,000 9-in. equiv.	368, 653	374, 237	51, 686	336, 579	327, 997	46, 797
Magnesite and magnesite-chrome (magnesite predominating) brick, standard and special shapes.	---do------	39, 846	39, 132	21, 800	38, 420	38, 150	21, 949
Chrome and chrome-magnesite (chrome predominating) brick, standard and special shapes.	---do------	57, 133	55, 949	27, 343	48, 708	48, 187	23, 658
Graphite and other carbon crucibles and retorts.	Short tons	13, 737	13, 343	7, 425	9, 810	9, 844	5, 573
Other graphite and carbon refractories.	---do------	1, 543	1, 527	677	1, 358	1, 329	593
Silicon carbide	------------	--------	--------	10, 940	--------	--------	7, 761
Mullite and kyanite	------------	--------	--------	4, 461	--------	--------	3, 766
Sillimanite	------------	--------	--------	379	--------	--------	268
Fused alumina and bauxite	------------	--------	--------	3, 538	--------	--------	2, 560
Zirconia, forsterite, fused magnesia, pyrophyllite, and other nonclay shapes.	------------	--------	--------	5, 995	--------	--------	4, 618
High-temperature bonding mortars	Short tons	47, 136	46, 787	5, 644	45, 802	44, 990	5, 283
Plastic refractories (including wet and dry ramming mixtures).	---do------	133, 608	133, 292	10, 522	141, 779	141, 836	11, 245
Other nonclay refractory materials, sold in lump or ground forms (including ground silica and nonclay cast and castables).	------------	--------	--------	5, 346	--------	--------	4, 572
Total nonclay refractories [1]	------------	--------	--------	155, 756	--------	--------	138, 643
Grand total refractories [1]	------------	--------	--------	326, 842	--------	--------	300, 577

[1] Data for dead-burned magnesia or magnesite excluded to avoid duplication in other refractory products covered in this table (such as magnesite brick and shapes). Quantity and value of shipment of dead-burned magnesia or magnesite totaled 372,000 tons valued at $16,620,000 in 1951, and 331,000 tons valued at $15,752,000 in 1952.

from application of the data to methods of manufacture.[27] The effect of variations in raw material properties on the firing schedules of tunnel kilns of small cross section was discussed. Large reductions in firing time were said to be attained for slow-firing materials by controlling the particle-size distribution of the grog or by adding other clays or shales to the mix.[28]

The principles underlying the various processes used in the ceramic field were described with visual aids to make their application clear.[29] An article described the clay-preparation methods used at a Pennsylvania fire-clay mine.[30] Clay mining by power shovel, dragline, shale planer, scraper, and other mechanical loaders was described and the advantages of each method were discussed.[31]

The trend toward plant modernization and improved methods of manufacture evident in 1951 continued in 1952 in the structural clay products industry.[32]

The record of a symposium on clay dealing with certain problems of clay and laterite genesis was published in a book during 1952.[33]

A book was published to provide studio potters and others with an elementary background of the technology of clays and clay-working processes.[34]

WORLD REVIEW

Australia.—Australia was said to have clays for every type of ceramic product. Almost every geological age contributed to Australia's ceramic raw materials.[35]

Canada.—The clay resources of Saskatchewan Province have been the subject of numerous reports and investigations during the last several decades. A report published in 1952 discussed the potentialities of ball clay and kaolin found in this Province.[36]

France.—A comparison of the firing and shrinkage tests, X-ray examinations, and microscopic, chemical, and thermal analyses of clays from the bauxite district of southern France with the properties of Missouri flint clays showed that they were similar, although the geologic age was different.[37]

Hungary.—Bentonite mining was begun in Hungary in the 1930's. In 1949 a bentonite-research committee was established to find ways to expand production during the 5-year economic development period that began in 1950. In 1952, plans were announced for a new factory to process bentonite on a large scale. It was said that a surplus of the processed material was available for export.[38]

---

[27] Cook, R. L., Properties and Testing of Clay Materials: Brick and Clay Record, vol. 121, No. 3, September 1952, pp. 68–70, 72.
[28] Robinson, G. C., Limitations Imposed by Raw Materials on Firing Schedules: Jour. Am. Ceram. Soc., vol. 35, No. 1, January 1952, pp. 1–5.
[29] Norton, F. H., Elements of Ceramics: Addison-Wesley Press, Inc., Cambridge, Mass., 1952, 246 pp.
[30] Brick and Clay Record, Careful Clay Preparation Improves the Quality: Vol. 120, No. 2, February 1952, pp. 46–49.
[31] Brick and Clay Record, vol. 121, No. 4, October 1952, pp. 44–45.
[32] Brick and Clay Record, vol. 120, No. 2, February 1952, pp. 41–49, 50–51; No. 3, March 1952, pp. 45–48 No. 4, April 1952, pp. 57–60, 62–63; No. 5, May 1952, pp. 34–36; No. 6, June 1952, pp. 46–49; vol. 121, No. 2, August 1952, pp. 45–48, 61–63; No. 3, September 1952, pp. 42–43, 52–55, 56–59; No. 4, October 1952, pp. 56–57, 60–63; No. 5, November 1952, pp. 54–56, 70–77.
[33] American Institute of Mining and Metallurgical Engineers, Problems of Clay and Laterite Genesis: New York, N. Y., 1952, 244 pp.
[34] Home, R. M., Ceramics for the Potter: Chas. A. Bennett Co., Inc., Peoria, Ill., 1952, 229 pp.
[35] Hosking, J. S., Clay Deposits in Australia: Ceram. Age, vol. 60, No. 2, August 1952, pp. 37–38, 48–49.
[36] Crawford, G. S., Whiteware Raw Materials From Saskatchewan: Resources Utilization Laboratory, Dept. of Natural Resources, Regina, Saskatchewan, Canada, September 1952, 7 pp.
[37] Hahm, Louise, Comparative Study of American and French Clays: Bull. Am. Ceram. Soc., vol. 31, No. 3, March 1952, pp. 79–84.
[38] Chemical Age (London), vol. 67, No. 1735, Oct. 11, 1952, p. 500.

Puerto Rico.—The Federal Geological Survey, in cooperation with the Puerto Rican Economic Development Administration, conducted a preliminary investigation in 1952 of an occurrence of bentonite in Puerto Rico. The deposit is on the western end of the island, 1½ miles southeast of Aguada, Barrio Malpaso.

The report was available on open file, and copies could be inspected at the Geological Survey Library, General Services Bldg., Washington, D. C., and at the Industrial Laboratories of the Puerto Rican Economic Development Administration, Hato Rey, Puerto Rico.[39]

[39] Oil, Paint, and Drug Reporter, vol. 163, No. 10, Mar. 9, 1953, p. 46.

Cobalt

By Hubert W. Davis[1] and Charlotte R. Buck[2]

CHIEFLY as a result of a substantial increase in world production and much larger use of scrap, the cobalt supply position was greatly improved in 1952. World production was 1,700 metric tons larger than in 1951. Consumption of purchased scrap in the United States was 474,000 pounds greater. The improved supply position made it unnecessary for the International Materials Conference to recommend adoption of distribution plans for cobalt for the first quarter of 1953. However, the supply position did not improve enough to permit using cobalt in many less essential products in the United States.

During 1952 the I. M. C. allocated 6,334 metric tons of cobalt (65 percent of the free-world total) to the United States.

Financial assistance by the Defense Minerals Exploration Administration under the Defense Production Act was provided Northfield Mines and Montana Coal & Iron Co. to explore for cobalt at the Stevenson property and Black Pine mine, respectively, in Lemhi County, Idaho, during 1952.

In 1952 consumption of cobalt in the United States exceeded 10 million pounds for the first time and was 9 percent more than in 1951. Consumption of cobalt in high-temperature alloys, low-cobalt alloy steels, cemented carbides, and pigments was substantially higher than in 1951. These gains, however, were partly offset by losses in consumption of cobalt in high-speed steel, magnet alloys, alloy hard-facing rods, and ground-coat frit for porcelain enamel.

Cobalt-metal production in the United States in 1952 was 4 percent more than in 1951; but imports, which established a new record, were 47 percent greater. Sales of cobalt metal to consumers gained only 5 percent, but deliveries to the National Stockpile were 117 percent larger.

Production of cobalt oxide in the United States in 1952 exceeded that in 1951 by 18 percent, but imports declined 9 percent; sales gained 4 percent. Production of hydrate, salts, and driers was smaller than in 1951.

Prices of cobalt metal and oxide were unchanged throughout 1952.

A comprehensive report on cobalt,[3] prepared by the Bureau of Mines with the cooperation of the Geological Survey, was made available in 1952.

[1] Commodity-industry analyst.
[2] Statistical clerk.
[3] Bureau of Mines, Cobalt: Materials Survey, prepared for National Security Resources Board, 1952, 197 pp.

DOMESTIC PRODUCTION

Mine Production.—Despite the fact that the United States is the largest consumer of cobalt in the world, only a small part of its requirements has been furnished by domestic ore. (Table 1 shows domestic production and shipments through 1952.) However, there was a prospect of decreased dependence on foreign sources when full production is attained by Calera Mining Co. in Idaho and Cobalt-Nickel Reduction Co. in Missouri.

Production and shipments of cobalt ore in the United States in 1952 were 51 and 11 percent, respectively, greater than in 1951.

TABLE 1.—Cobalt ore produced and shipped in the United States through 1952

Year	Produced		Shipped from mines	
	Gross weight (short tons)	Cobalt content (pounds)	Gross weight (short tons)	Cobalt content (pounds)
Previous to 1921 (partly estimated)	(1)	730,000	(1)	730,000
1921-32 (partly estimated)	93	9,300	41	5,000
1933	20	1,160		
1934	31	2,009		
1935	23	1,995		
1936	6	526		
1937	24	3,023		
1938	16	1,075		
1939	27	1,705		
1940	5,048	133,800	4,500	127,000
1941	19,127	505,377	20,031	521,627
1942	26,241	735,335	23,741	661,657
1943	27,103	732,098	28,541	763,772
1944	18,407	828,515	17,539	556,687
1945	19,770	1,099,654	17,528	1,281,681
1946	15,620	518,378	15,542	506,884
1947	22,348	645,295	23,442	676,612
1948	25,721	687,464	22,173	580,703
1949	19,599	521,656	25,175	673,773
1950	28,660	809,328	23,662	660,025
1951	28,485	902,629	26,564	755,631
1952	21,159	1,363,251	24,551	836,372
Total	(1)	10,233,573	(1)	9,337,424

[1] Data not available.

The Calera Mining Co., a wholly owned subsidiary of Howe Sound Co., displaced the Bethlehem Steel Co. as the chief producer of commercial cobalt ore in the United States in 1952. The company operates the Blackbird mine at Cobalt, Idaho, and the ore carries about 0.6 to 0.8 percent cobalt, about twice as much copper, and a little nickel and gold. The concentrate produced averaged 16.21 percent cobalt in 1952. The concentrate will be feed for the company refinery at Garfield, Utah, which will begin commercial production of metal in early 1953. The metal will be marketed in the form of granules, which, initially at least, will contain 95 parts cobalt and 5 parts nickel. Planned production is 1,650 short tons annually. According to the Howe Sound Co.:[4]

Operations at this mine [Blackbird] continued on a standby basis, pending full utilization of its products by the cobalt refinery at Garfield. No large develop-

[4] Howe Sound Co., Annual Report, 1952, pp. 5–7.

ment program was undertaken and underground work was confined to that necessary to prepare stopes for full tonnage production whenever required. The enlargement of the concentrator was completed and the milling process was further tested and improved. During the last six months of the year the concentrator was operated at about 40 percent of capacity. Resulting copper concentrates were sold as produced and cobalt concentrates, except for amounts required for the work at the refinery, were stored. At the year's end there was a substantial inventory of such concentrate.

Apartments, dormitories, and a community building, representing the last construction of the project, were completed. To provide additional housing, a contract was made with the Defense Housing Authority of the United States Government for the construction of seventy-five dwelling units, without cost to the Company except for the installation of water and sewerage lines, the grading of necessary streets, and the extension of power lines into the area. The Company's portion of the work was completed before the end of the year and preliminary work by the contractor employed by the government agency was started. The administration of this sub-division, including rental or sales of the dwellings, will be handled by an agent of the Government.

* * * * *

Construction of the refinery, which was designed and built for the Company on a contract basis by Chemical Construction Corporation, a subsidiary of American Cyanamid Company, was not substantially completed until August. The chemical process used is owned by Chemical Construction Corporation.

The refining process is completely new. A great deal of the equipment required had never before been constructed for commercial use under the peculiar corroding and eroding conditions incident to the high temperatures, pressures, and acid conditions of the process. The specification for mechanical design required the incorporation in the plant of the contractor's knowledge of the technology of this particular process and their experience in the metals recovery field and in chemical plant practice.

Since the substantial completion of the plant it has been operated on an intermittent basis. Delays were originally caused by the malfunctioning of equipment used in connection with one of the preliminary stages of the actual chemical process. Subsequently, other mechanical difficulties and the failure of parts and equipment, including among other things, packing, valves, pipe lines, etc., to withstand the corrosive and abrasive conditions to which they were subject, have made continuous operation impossible. Experimentation and research have been required and many material combinations have been tested. At the present writing (March 12, 1953) a great number of the original troubles have been rectified. There are, however, some trouble spots remaining and every effort is being made to solve these problems and the most competent advice which is available is being used to obtain an early and satisfactory solution. Because of these frequent delays the quantity of refined cobalt produced has been small relative to the designed capacity of the plant.

The officers of the Company have been deeply concerned over the delay caused by the difficulties outlined above in bringing the plant to a commercial production stage. The chemistry of the process has, however, proved to be sound. Such chemical difficulties as have developed have been minor and once the remaining mechanical troubles have been eliminated it is our belief that the process will prove satisfactory.

Bethlehem Steel Co. produced 39 percent less cobalt in 1952 than in 1951. The cobalt-bearing material (averaging 1.31 percent in 1952) is obtained as a flotation sulfide concentrate from the magnetite mined at Cornwall, Pa. The concentrate is shipped to the Pyrites Co., Wilmington, Del., where it is processed into metal and other cobalt products.

The Sullivan Mining Co., Kellogg, Idaho, continued to recover cobalt at its electrolytic zinc plant in 1952 but, as in previous years, made no shipments. In 1952 it recovered 97 short tons of residues containing 7,114 pounds of cobalt.

The St. Louis Smelting & Refining Division of National Lead Co. continued to produce an iron concentrate carrying cobalt, nickel, and copper at its property near Fredericktown, Madison County, Mo. The cobalt content of the reject concentrate produced averages 3 to 4 percent. Construction of a 50-ton plant (head feed) to process the reject concentrate was begun in early 1952; completion is scheduled for late 1953. The plant will be operated by Cobalt-Nickel Reduction Co., a newly formed subsidiary of National Lead Co., and is expected to produce cobalt, nickel, and copper at an annual rate of 1,386,000, 1,852,000, and 1,418,000 pounds, respectively.

Refinery Production.—Although the United States is a small producer of cobalt ore, the country is an important producer of cobalt products, as is evident from table 2. Production of metal and oxide was 4 and 18 percent, respectively, greater than in 1951. The metal and oxide are produced chiefly from white alloy from Belgian Congo and concentrates from Pennsylvania. Consumption of cobalt contained in white alloy and ore by refiners exceeded that in 1951 by 5 percent. Production of salts and driers was 2 and 11 percent, respectively, smaller than in 1951. The salts and driers are made chiefly from cobalt fines, rondelles, hydrate, and scrap. Consumption of these products in the manufacture of salts and driers was 8 percent less than in 1951.

TABLE 2.—Cobalt products produced and shipped in the United States, 1951–52, in pounds

Product	Production		Shipments	
	Gross weight	Cobalt content	Gross weight	Cobalt content
1951				
Metal	1,989,952	1,955,145	2,022,560	1,987,023
Oxide	637,456	457,618	638,896	458,455
Hydrate	242,264	98,444	244,216	97,477
Salts:				
Acetate	87,324	20,611	105,875	24,762
Carbonate	153,308	68,922	160,170	71,924
Sulfate	675,025	144,084	713,541	151,684
Other	122,869	28,174	124,976	28,891
Driers	8,739,612	541,541	8,801,734	532,141
1952				
Metal	2,065,447	2,028,964	1,932,608	1,898,871
Oxide	745,934	539,467	708,674	512,581
Hydrate	244,656	96,326	244,914	98,046
Salts:				
Acetate	109,541	25,612	104,913	24,572
Carbonate	127,844	58,694	111,408	51,103
Sulfate	609,274	128,000	574,038	118,120
Other	197,443	43,917	179,893	39,997
Driers	7,924,714	480,616	7,409,610	449,269

TABLE 3.—Cobalt consumed by refiners or processors in the United States, 1948–52, in pounds of contained cobalt

Cobalt material [1]	1948	1949	1950	1951	1952
Alloy and ore	2,715,605	2,607,281	2,526,755	2,857,328	3,002,087
Fines	393,725	422,493	856,042	647,016	581,187
Rondelles	107,520	95,759	137,822	70,620	61,921
Hydrate	150,826	129,444	80,497	81,710	79,733
Carbonate	4,608	2,664	13,944	6,841	292
Other	----------	17,565	48,261	48,549	53,081

[1] Total consumption is not shown, since the fines, rondelles, hydrate, and carbonate originated from alloy and ore; combining alloy and ore with these materials would result in duplication.

TABLE 4.—Refiners or processors of cobalt in the United States in 1952

Refiner or processor	Location of plant	Cobalt product [1] made	Cobalt raw material [1] used
Advance Solvents & Chemical Corp	Jersey City, N. J	E	A, C
African Metals Corp	Niagara Falls, N. Y	A, B	F
Allied Chemical & Dye Corp., General Chemical Division.	Marcus Hook, Pa	D	A
Baker Chemical Co., J. T	Phillipsburg, N. J	D	A
Calera Mining Co	Garfield, Utah	A	F
Ceramic Color & Chemical Manufacturing Co	New Brighton, Pa	C, D	A
Chase Chemical Corp	Pittsburgh, Pa	E	C
Cobalt-Nickel Reduction Co	Fredericktown, Mo.[2]	A	F
Ferro Chemical Corp	Bedford, Ohio	D, E	A, C
Hall Chemical Co	Wickliffe, Ohio	B	G
Hanson-Van Winkle-Munning Co	Matawan, N. J	D	A
Harshaw Chemical Co	Cleveland, Ohio	C, D, E	A
Kennametal, Inc	Latrobe, Pa	A	F
Mallinckrodt Chemical Works	St. Louis, Mo	D	A
McGean Chemical Co	Cleveland, Ohio	D, E	A
Mooney Chemicals, Inc	do	E	A
Nuodex Products Co., Inc	Elizabeth, N. J	D	A, C
	Long Beach, Calif	D	A
Pyrites Company, The	Wilmington, Del	A, B, C, D	F
Shepherd Chemical Co	Cincinnati, Ohio	D, E	A, G
Standard Oil Co. of California	Richmond, Calif	E	A
Stresen-Reuter, Inc., Frederick A	Bensenville, Ill	C, D, E	A, C
	Chicago, Ill	C, D, E	A, C
Witco Chemical Co	do	E	A

[1] Abbreviations: A, metal; B, oxide; C, hydrate; D, salts; E, driers; F, ore or white alloy; G, cobalt scrap.
[2] Refinery under construction.

CONSUMPTION

Consumption of cobalt by industrial consumers increased for the third successive year to establish a new record of 10,818,493 pounds in 1952, a 9-percent gain over 1951, the previous record year. As in 1951, the largest single use for cobalt in 1952 was for cobalt-chromium-tungsten-molybdenum alloys, which represented 59 percent of the total quantity consumed and utilized 31 percent more than in 1951.

The second-largest use for cobalt was for magnet alloys, which consumed 16 percent of the total in 1952; however, 20 percent less was consumed for this purpose than in 1951.

Less cobalt was also used in high-speed steel, alloy hard-facing rods, and ground-coat frit for porcelain enamel, but more was used in low-cobalt alloy steels, cemented carbides, and pigments. Usage of cobalt in cemented carbides doubled that in 1951. Cobalt salts and driers were utilized at a rate about 14 percent less than in 1951.

TABLE 5.—Cobalt consumed in the United States, 1948–52, by use, in pounds of contained cobalt

Use	1948	1949	1950	1951	1952
Metallic:					
High-speed steel	289,391	283,496	235,227	316,064	223,203
Other steel	132,803	162,638	252,885	79,885	115,761
Permanent-magnet alloys	} 1,352,371	1,194,920	2,834,040	2,052,042	1,664,842
Soft-magnetic alloys		42,965	37,552	58,652	18,727
Cobalt-chromium-tungsten-molybdenum alloys	1,196,608	1,238,083	2,226,199	4,899,591	6,408,537
Alloy hard-facing rods and materials	116,313	82,965	260,371	575,268	505,367
Cemented carbides	85,314	118,522	136,935	297,751	610,750
Other metallic	115,255	116,344	208,574	276,222	132,917
Total metallic	3,288,055	3,239,933	6,191,783	8,555,475	9,680,104
Nonmetallic (exclusive of salts and driers):					
Ground-coat frit	613,745	424,051	683,358	448,983	309,167
Pigments	232,725	188,606	262,441	50,073	85,262
Other nonmetallic	66,699	84,336	43,826	60,462	42,960
Total nonmetallic	913,169	696,993	989,625	559,518	437,389
Salts and driers: Lacquers, varnishes, paints, inks, pigments, enamels, glazes, feed, electroplating, etc. (estimate)	818,000	765,000	1,102,000	818,000	701,000
Grand total	5,019,224	4,701,926	8,283,408	9,932,993	10,818,493

TABLE 6.—Cobalt consumed in the United States, 1948–52, by form in which used, in pounds of contained cobalt

Form	1948	1949	1950	1951	1952
Metal	3,321,516	3,311,229	6,087,048	7,534,864	8,328,552
Oxide	850,255	606,510	964,055	680,452	418,211
Cobalt-nickel compound	9,413	4,315	3,434	1,786	----------
Ore and alloy	----------	----------	436	3,438	2,736
Purchased scrap	20,040	14,872	126,435	894,453	1,367,994
Salts and driers	818,000	765,000	1,102,000	818,000	701,000
Total	5,019,224	4,701,926	8,283,408	9,932,993	10,818,493

PRICES

Prices of cobalt metal and cobalt oxide remained unchanged throughout 1952. Metal (97–99 percent, in 500–600-pound kegs) was $2.40 a pound f. o. b. Niagara Falls or New York, N. Y., and ceramic-grade oxide (72½–73½ percent, in 350-pound containers) was $1.82 a pound (gross weight) east of the Mississippi River. The price for metal has been in effect since October 1, 1951, and that for ceramic-grade oxide since November 8, 1951.

FOREIGN TRADE [5]

Imports.—For the third successive year, imports of cobalt into the United States increased to establish a new high of 15,031,000 pounds (cobalt content) in 1952 and were 45 percent larger than in 1951, itself a record year. Belgian Congo continued to be the chief source;

[5] Figures on imports and exports (unless otherwise indicated) compiled by Mae B. Price and Elsie D. Page of the Bureau of Mines, from records of the U. S. Department of Commerce.

in 1952 it supplied 72 percent of the total imports. Belgium supplied 25 percent of the total imports in 1952; however, 89 percent of the metal and oxide was produced from Belgian Congo alloy.

TABLE 7.—Cobalt imported for consumption in the United States, 1943–47 (average), and 1948–52, by class

[U. S. Department of Commerce]

Year	Alloy [1] (pounds)		Ore		
			Pounds		Value
	Gross weight	Cobalt content	Gross weight	Cobalt content	
1943–47 (average)	6,481,717	2,813,725	2,659,747	318,127	$376,928
1948	4,879,413	2,179,473	8,167,545	870,519	647,000
1949	3,691,051	1,657,788	109,009	11,965	9,344
1950	3,979,088	1,792,348	164,188	18,838	16,003
1951	4,083,541	1,904,429	[2] 537,309	40,303	[2] 54,015
1952	6,113,102	2,841,210	215,572	17,384	2,281

Year	Metal		Oxide		Salts and other compounds	
	Pounds	Value	Pounds (gross weight)	Value	Pounds (gross weight)	Value
1943–47 (average)	1,851,394	$2,560,523	446,398	$583,107	255	$770
1948	[3] 5,266,521	7,743,679	790,300	828,667	1,374	4,514
1949	5,588,327	9,025,595	360,318	384,879	359	1,167
1950	[3] 6,706,875	[3] 11,210,872	[3] 904,650	[3] 1,009,431	4,649	5,927
1951	[3] 8,119,326	16,302,356	436,517	603,855	3,157	4,048
1952	[3] 12,014,920	[3] 27,291,006	386,935	620,955	12,759	11,328

[1] Reported by importer to Bureau of Mines; not separately classified by U. S. Department of Commerce. Value not available.
[2] Includes 146 pounds of zaffer, valued at $215.
[3] Adjusted by Bureau of Mines.

TABLE 8.—Cobalt alloy, ore, metal, and oxide imported for consumption in the United States, 1951–52, by countries, in pounds

[U. S. Department of Commerce]

Country	White alloy (crude) and ore				Metal		Oxide (gross weight)	
	1951		1952		1951	1952	1951	1952
	Gross weight	Cobalt content	Gross weight	Cobalt content				
Belgian Congo	[1] 4,083,541	[1] 1,904,429	[1] 6,113,102	[1] 2,841,210	[2] 4,929,512	8,120,195	--------	--------
Belgium	--------	--------	--------	--------	[2] 3,000,500	3,539,210	431,767	385,220
Canada	344,872	36,478	--------	--------	182,700	[2] 354,325	4,750	100
France	--------	--------	--------	--------	6,613	--------	--------	827
Germany, West	--------	--------	--------	--------	--------	--------	--------	500
Mexico	192,291	3,825	214,402	17,284	--------	--------	--------	185
Morocco, French	--------	--------	1,170	100	--------	--------	--------	--------
Netherlands	--------	--------	--------	--------	--------	--------	--------	100
Switzerland	--------	--------	--------	--------	--------	1,190	--------	--------
United Kingdom	--------	--------	--------	--------	1	--------	--------	3
	4,620,704	1,944,732	6,328,674	2,858,594	[2] 8,119,326	[2] 12,014,920	436,517	386,935

[1] Reported by importer to Bureau of Mines.
[2] Adjusted by Bureau of Mines.

Historical table 9 shows imports of cobalt for 1923–52, by classes. Corresponding figures for earlier years are not available.

During the 30 years 1923–52, receipts of metal comprised 54 percent of the cobalt imports, most of which were supplied by Belgium and Belgian Congo. Smaller quantities of metal have been received from Austria, Canada, Finland, France, Germany, Japan, Sweden, and United Kingdom. Imports of alloy represented the second largest quantity (34 percent); virtually all were from Belgian Congo. About 9 percent of the imports of cobalt have been in the form of oxide, chiefly from Belgium. Substantial quantities of oxide have also been received from Germany and Canada, and smaller quantities from Australia, Finland, and France. Cobalt ore has been about 3 percent of total imports; Canada has been the largest source, and most of the remainder comes from Australia and French Morocco.

TABLE 9.—Cobalt imported for consumption in the United States, 1923–52, in pounds

Year	Gross weight					Total	
	Alloy	Ore	Metal	Oxide	Sulfate and other compounds	Gross weight	Cobalt content (estimated)
1923		58,719	225,639	258,574	45,644	588,576	426,000
1924		28,786	118,952	226,703	797	375,238	283,000
1925		34,782	198,669	287,265	13,256	533,972	408,000
1926		154,468	387,076	333,132	37,342	912,018	642,000
1927		60,382	407,198	369,747	55,127	892,454	680,000
1928		107,498	535,817	364,154	68,281	1,075,750	819,000
1929		434,443	806,640	475,928	64,782	1,781,793	1,212,000
1930		199,642	460,251	425,881	55,303	1,141,077	794,000
1931		83,895	164,967	321,891	46,317	617,070	410,000
1932		27,193	123,112	225,896	92,098	468,299	303,000
1933		556,119	281,713	568,057	99,231	1,505,120	769,000
1934	439,476	748,513	506,119	328,730	43,787	2,066,625	1,000,000
1935	378,848	419,110	563,866	557,083	80,554	1,999,461	1,167,000
1936		1,039,760	883,377	813,642	46,658	2,783,437	1,580,000
1937		587,499	1,073,129	842,847	56,585	2,560,060	1,734,000
1938		449,984	938,476	373,215	41,867	1,803,542	1,249,000
1939		611,083	2,130,296	680,644	76,664	3,498,687	2,665,000
1940	7,843,828	2,653,891	130,321	756,759	11,468	11,396,267	4,200,000
1941 [1]	9,970,589	2,443,725	554,030	38,002	4,980	[1] 13,011,326	[1] 4,328,000
1942	10,313,867	834,797	148,304		200	11,297,168	4,280,000
1943	10,110,879	10,556,042	266,670	58,928	56	20,992,575	5,626,000
1944	8,500,516	473,529	73,088	225,609	115	9,272,857	3,798,000
1945	8,397,145	859,940	946,475	120,672	224	10,324,456	4,615,000
1946	1,648,595	657,787	1,935,582	1,074,630	350	5,316,944	3,451,000
1947	3,751,452	751,438	6,035,153	752,150	530	11,290,723	8,206,000
1948	4,879,413	8,167,545	5,266,521	790,300	1,374	19,105,153	8,821,000
1949	3,691,051	109,009	5,588,327	360,318	359	9,749,064	7,458,000
1950	3,979,088	164,188	6,706,875	904,650	4,649	11,759,450	9,095,000
1951	4,083,541	[2] 537,309	8,119,326	436,517	3,157	13,179,850	10,338,000
1952	6,113,102	215,572	12,014,920	386,935	12,759	18,743,288	15,031,000

[1] In addition to classes shown, 4,796,000 pounds of Burmese speiss containing 335,721 pounds of cobalt were imported.
[2] Includes 146 pounds of zaffer.

Exports.—Exports of cobalt from the United States are small; 61,288 pounds of metal, alloys, and cobalt-bearing scrap valued at $208,838 was exported in 1952. Some oxide, salts, and driers are also exported, but the figures are not separately recorded by the United States Department of Commerce.

Tariff.—Since June 7, 1951, the duty on cobalt oxide has been 5 cents a pound, sulfate 2½ cents a pound, and linoleate 5 cents a pound. The duty on salts and compounds continued at 30 percent ad valorem. Cobalt metal and ore enter the United States duty-free.

TECHNOLOGY

The Bureau of Mines conducted important research on cobalt in 1952. Tests were made on copper converter slag produced at the Boleo smelter, Santa Rosalia, Baja California, Mexico, using aluminum-silicon alloy as a reducing agent for recovering the cobalt. The converter slag assayed 1.05 percent cobalt, 6.35 percent Cu, 39.8 percent Fe, 0.15 percent Pb, 1.3 percent Zn, 3 percent Al_2O_3, 5 percent MgO, 3.1 percent CaO, and 17.9 percent SiO_2. These tests were made in a gas-fired, pot furnace at 1,450° C., with additions of 1, 3, and 5 percent aluminum-silicon alloy assaying 50.8 percent Al, 12.8 percent Fe, and 32 percent Si. The various tests gave similar results. Over 90 percent of the cobalt was recovered in an alloy assaying 3.3 to 4 percent Co, 20.3 percent Cu, 68.6 percent Fe, and 0.15 percent Al. The final slags assayed about 0.3 percent Co and 2.5 percent Cu. Further testing is planned, using other reductants to improve the cobalt recovery. Selective oxidation of the iron and fluxing with silica also will be investigated to produce a higher grade alloy.

The Bureau of Mines made ore-dressing tests on cobalt ore from San Bernardo, Sonora; Mexico; the ore contained 3.45 percent Co, 14 percent Fe, 23.5 percent As, 0.04 percent Cu, $<$0.05 percent Ni, and 0.57 and $<$0.1 ounce Au and Ag per ton. Elimination of gangue constituents by flotation of the cobalt and gold minerals resulted in concentrates of 7.2 and 7.8 percent cobalt, with 1.3 ounces of gold per ton. Recovery was 86 and 89 percent of the cobalt and about 91 percent of the gold.

Methods of recovering cobalt and nickel from two southeastern Missouri sources were developed at the Mississippi Valley Experiment Station (Rolla, Mo.) of the Bureau of Mines.[6] According to the report:

> Methods of recovery of cobalt and nickel from two southeastern Missouri sources have been developed at the Bureau of Mines Mississippi Valley Experiment Station. One source under investigation was pyrite and copper concentrates from the National Lead Co. mill at Fredericktown, Mo.; the other, copper-lead matte produced by the St. Joseph Lead Co. at Herculaneum, Mo.
>
> It has been estimated that the present annual lead and copper sulfide ore production in southeastern Missouri contains approximately 2,000,000 pounds of cobalt and 2,700,000 pounds of nickel.
>
> Methods to treat the pyrite and copper concentrates include both hydro- and pyrometallurgy. Hydrometallurgical studies involved gaseous chlorination, oxidation of iron chloride, and water leaching of cobalt, nickel, and copper chlorides, which resulted in the extraction of over 90 percent of the cobalt, nickel, and copper. Separation of these metals and their purification in aqueous solution and studies on the production of high-purity cobalt by electrolysis are described. Pyrometallurgical investigations involved roasting to oxidize sulfides and selective molten reduction to produce a cobalt-nickel-copper regulus and an iron slag.

[6] Kenworthy, H., and Kershner, K. K., Metallurgical Investigations of Southeastern Missouri Cobalt-Nickel Resources: Bureau of Mines Rept. of Investigations 4999, 1953, 37 pp.

This treatment also gave approximately 90 percent recovery of cobalt, nickel, and copper, in the form of a regulus. Methods for treatment of the matte were limited to pyrometallurgy. Blowing of the molten matte was used to fume off lead and zinc and slag the iron, which resulted in the formation of a high-metal pseudo-matte deficient in sulfur. This material remelted with sulfur and allowed to cool slowly produced a coarsely crystallized mass of sulfides. When remelted with metal oxide and allowed to cool slowly, a mixture of copper sulfide and iron-cobalt-nickel metallics was produced. The sulfide mass was subjected to flotation for separation, and the mixture, to magnetic methods. Overall recoveries in either treatment were about 75 percent for the cobalt and 90 percent for the nickel and copper. Increased recoveries should be attained by return of the converter slag to the lead blast furnace for resulfidization. These hydro- and pyrometallurgical investigations are being continued.

A method for recovering cobalt, nickel, and copper from the drosses and residues resulting from the production of Alnico permanent magnets has been described.[7] The cleaned, dried, and crushed waste material is magnetically sorted, then reblended to correct proportions. Aluminum is added as a deoxidizer. Silica and sodium silicate are added to produce a marketable slag. The mix is melted. Just before pouring, iron oxide is added to remove excess carbon and silicon.

New ways of extracting cobalt, nickel, copper, and other metals from ores by chemical rather than by the usual smelting and refining methods have been announced by the Chemical Construction Corp. Some details of the process, which is described as basically new and revolutionary, have been published.[8] According to this article:

> Refiners using the new process will prepare ore concentrates by standard flotation methods, introduce the concentrate as a slurry into an autoclave along with water and an acid or ammonia. From the resulting leach solution, recovery of individual metals is made by use of suitable reducing agents. By varying conditions during treatment, different metals in the ore are produced separately as pure powders, which may be pressed into forms ready to market, or in the case of copper, extruded as rods or pipe. The reagents are generally recovered. By manipulating the variables during reduction, selective separation of nickel, and/or cobalt, and/or copper can be made simultaneously. The separation is a continuous process.

First commercial use of the process was by the Calera Mining Co. at its refinery at Garfield, Utah. The process will also be used by Cobalt-Nickel Reduction Co. at its refinery under construction at Fredericktown, Mo., and by Sherritt Gordon Mines, Ltd., at its refinery under construction at Fort Saskatchewan, Alberta.

Because of the shortage of strategic materials, more attention has been turned toward alloys which could use high-temperature scrap. Haynes Alloy 99 is one development. Approximate composition is 11–13 percent cobalt, 20–22 percent chromium, 2–3 percent tungsten, 17–19 percent nickel, 3–4 percent molybdenum, 0.03–0.08 percent boron, and about 1 percent each silicon and manganese and the remainder iron.[9] This alloy is looked upon by metallurgists as a modified N–155, which contains 20 percent each cobalt, chromium, and nickel, 3 percent molybdenum, 2 percent tungsten, 1 percent columbium, 0.32 percent iron, and 0.3 percent carbon. Alloy 99 was used

[7] Sherman, A. H., and Pesses, Marvin, Alnico Recovery Process Salvages Valuable Nickel, Cobalt: Iron Age, vol. 170, No. 1, July 3, 1952, pp. 115–119.
[8] New Chemical Method Recovers Nickel, Cobalt, and Copper Metals: Mining Eng., vol. 4, No. 6, June 1952, pp. 565–567.
[9] Steel, vol. 132, No. 1, Jan. 5, 1953, p. 282.

in substantial quantity as an alternate for more strategic alloys in 1952.

Methods of producing cobalt from pyrites were reviewed in a trade journal article.[10]

Recent advances in the electrolytic extraction of cobalt have been reviewed.[11]

WORLD REVIEW

Virtually all cobalt occurs in combination with other metals, such as copper, nickel, iron, arsenic, lead, zinc, manganese, silver, and gold. Belgian Congo and Northern Rhodesia, where cobalt is associated with copper, and French Morocco, where cobalt occurs with nickel, gold, and silver, have been the chief producing countries in recent years, followed by Canada and the United States. These 5 countries supplied about 95 percent of the world output of cobalt in the 3 years 1950–52. Some cobalt production is derived from pyrites residues, but a complete record of such output is lacking.

TABLE 10.—World mine production of cobalt, by countries, 1943–47 (average) and 1948–52, in metric tons of contained cobalt

[Compiled by Berenice B. Mitchell]

Country	1943–47 (average)	1948	1949	1950	1951	1952
Australia (recoverable cobalt)	10	10	9	10	8	(1)
Belgian Congo (recoverable cobalt)	[2] 2,519	[2] 4,323	[2] 4,403	5,148	[2] 5,715	6,831
Canada [3]	88	701	281	265	[2] 432	592
Chile	2	-	-	-	-	-
Finland (recoverable cobalt)	90	(1)	(1)	(1)	(1)	(1)
Italy (content of ore)	8	1	(4)	-	-	(1)
Japan (content of concentrates)	8	(4)	-	-	-	(1)
Mexico (content of ore)	-	-	-	-	[5] 2	[5] 8
Morocco, French (content of concentrates)	191	221	209	420	680	1,000
Northern Rhodesia [6] (content of white alloy)	753	367	402	670	678	585
Sweden	2	-	-	-	-	-
United States (shipments) (content of concentrates)	343	263	306	299	343	379
Total (estimate)	4,300	6,100	5,900	[2] 7,200	[2] 8,300	10,000

[1] Data not available. Estimate by author of chapter included in total.
[2] Revised figure.
[3] Figures comprise Canadian ore processed in Canada and exported (irrespective of year when mined), plus cobalt content of concentrates made at Port Colborne from copper-nickel ore; however, figures exclude the cobalt recovered at Clydach, Wales, from Canadian nickel-copper ores, for which estimate by author of chapter has been included in world total.
[4] Less than 0.5 ton.
[5] Imports into United States.
[6] Year ended June 30 of year stated.

Belgian Congo.—Belgian Congo continues to be the leading source of cobalt, and the Union Minière du Haut-Katanga is the sole producer there. For 6 successive years output has established new records; in 1952 it was 6,831 metric tons, a gain of 20 percent over 1951. A further increase is anticipated in 1953 as a result of putting into service a second 3-phase furnace of 2,160 kv.-a. and enlarging the cobalt refinery at Jadotville.

[10] Chemical Age (London), Cobalt Production From Roast Pyrites: Vol. 66, No. 1695, Jan. 5, 1952, pp. 23–25.

[11] Cuthbertson, J. W., Recent Advances in the Electrolytic Extraction of Manganese, Chromium and Cobalt: Chemistry and Industry (London), No. 48, Nov. 29, 1952, pp. 1165–1170.

Some of the figures on production of cobalt in Belgian Congo published previously have been in error. In order that an accurate record will be available, the Union Minière has furnished the figures for 1925–52 shown in table 11.

TABLE 11.—Cobalt produced in Belgian Congo from earliest production through 1952[1]

Year	Metric tons	Year	Metric tons
1924	273	1940	918
1925	126	1941	1,191
1926	328	1942	1,916
1927	435	1943	2,099
1928	444	1944	1,943
1929	704	1945	2,805
1930	755	1946	2,156
1931	295	1947	3,590
1932	201	1948	4,323
1933	315	1949	4,403
1934	181	1950	5,148
1935	177	1951	5,715
1936	318	1952	6,831
1937	978		
1938	1,131	Total	50,912
1939	1,213		

[1] Figures for 1924–25 represent content of white alloy, those for 1926–44 represent salable production, and those for 1945–52 represent production of recoverable cobalt.

The operations of Union Minière in Belgian Congo have been described[12] in much detail by its chairman. Much information is also given in the chapter of this series for 1951.

Canada.—According to the Dominion Bureau of Statistics, production of cobalt (content) was 1,305,400 pounds in 1952 compared with 951,607 pounds (revised figure) in 1951. These figures, however, do not include the cobalt recovered by Mond Nickel Co. at its Clydach (Wales) nickel refinery from the nickel-copper ores of the Sudbury district.

As a result of increased demand, there was greater activity in cobalt in Northern Ontario in 1952. The new cobalt concentrator (daily capacity, 150 tons) of Silver Miller Mines, Ltd., started operating in September 1952 on ore from the La Rose mine. The company entered into a contract with the United States Government to furnish concentrates containing 5 million pounds of cobalt. A major consolidation, involving the merger of Penn-Cobalt, Cobalt Lode, Hellens Mining & Reduction, Gilgreer Mines, and unspecified assets of Silanco Mining & Refining, was reported[13] being negotiated between a Toronto group and Quebec Metallurgical Industries, Ltd., a subsidiary of Ventures, Ltd., and Frobisher, Ltd. It was also reported that Quebec Metallurgical Industries, Ltd., had completed negotiations for constructing a smelting and refining plant to produce cobalt, nickel, and silver at Cobalt, Ontario.

The smelting, refining, and metallurgical works of Deloro Smelting & Refining Co., Ltd., at Deloro, were being expanded and modernized. The company, which operates no mines, treats ores from Northern

[12] Sengier, E. B., Katanga's Mineral Empire Based on Many Metals: Eng. and Min. Jour., vol. 152, No. 11, November 1951, pp. 86–89; No. 12, December 1951, pp. 92–96.
[13] American Metal Market, vol. 59, No. 224, Nov. 21, 1952, p. 8.

Ontario, Northwest Territory, and French Morocco, acts as the sole purchaser of cobalt for the Canadian Government stockpile, and refines ore to metal for the United States Government.

The International Nickel Co. of Canada, Ltd., continued to produce cobalt concentrate at its Port Colborne refinery. The cobalt is contained in the Sudbury nickel-copper ores. According to the company, recovery of cobalt concentrate has been substantially increased as a result of process improvements at the refinery.

Falconbridge Nickel Mines, Ltd., began commercial recovery of cobalt from the nickel-copper ores of the Sudbury district in July 1952.

A paper on recent developments in Northern Ontario was presented.[14]

It is reported [15] that an occurrence of cobalt in the Mount Wright area, New Quebec, was being explored by surface work and diamond drilling. Hand-picked specimens of the ore were said to assay as high as 11 percent cobalt, with low values in nickel.

The Eldorado Mining & Refining (1944), Ltd., continued to produce cobalt-nickel speiss at its Port Hope refinery from pitchblende mined at Port Radium, Northwest Territory. The speiss averages about 14 percent cobalt.

Construction was begun in May 1952 on the refinery of Sherritt Gordon Mines, Ltd., at Fort Saskatchewan, Alberta; completion was scheduled December 1953. Annual production planned from concentrates from company mines at Lynn Lake, Manitoba, is 150 tons of cobalt, 8,500 tons of nickel, and 4,000 tons of copper.

Finland.—The cupriferous pyrite of the Outukumpu mine in eastern Finland contains 0.1 to 0.2 percent cobalt, 4 to 4.45 percent copper, 27 percent iron, 1 percent zinc, and 26 percent sulfur.[16] The sulfur contained in the pyrite concentrate produced is extracted by roasting in Finland. After the roasting process the remaining pyrite sinter, which contains 0.4 to 0.5 percent cobalt, is shipped to Duisburg, Germany, for recovery of the cobalt, iron, zinc, and copper. Production of cobalt derived from roast pyrites in West Germany was 80 to 90 metric tons in 1948 [17] and reached nearly 300 tons in 1950.[18]

French Morocco.—Production of cobalt concentrate in French Morocco was 9,136 metric tons containing 1,000 tons of cobalt in 1952 compared with 6,255 tons containing 680 tons of cobalt in 1951. La Société Minière de Bou-Azzer et du Graara, Casablanca, is the sole producer. The cobalt concentrate contains 10 to 12 percent cobalt. During 1952 a substantial quantity of French Morocco concentrate was refined to metal by Deloro Smelting & Refining Co. at Deloro, Ontario, Canada, for the United States Government.

Northern Rhodesia.—The Rhokana Corp., the sole producer in Northern Rhodesia, has been producing cobalt since 1933. The output of alloy was 1,698 short tons containing 645 tons of cobalt in the year ended June 30, 1952, compared with 1,978 tons containing 747 tons in 1951. The grade of ore treated was 0.156 percent cobalt in 1952 compared with 0.155 percent in 1951. Concentrates produced

[14] Hellens, A. D., Recent Developments in the Cobalt Area: Canadian Min. Jour., vol. 73, No. 6, June 1952, pp. 73–78.
[15] Canadian Mining Journal, vol. 73, No. 8, August 1952, p. 64.
[16] Young, R. S., Cobalt: Reinhold Publishing Corp., New York, 1948, p. 19.
[17] Mining World, vol. 11, No. 11, October 1949, p. 42.
[18] Chemical Age (London), Cobalt Production from Roast Pyrites: Vol. 66, No. 1695, Jan. 5, 1952, p. 23.

contained 1.59 percent cobalt in 1952 compared with 1.56 percent in 1951. The company completed its electrolytic cobalt refinery in January 1952, but because of the difficulties usually encountered in a new process production of metal did not begin until August 1952. Initial shipments of granules were made in September. A plant to produce cobalt carbonate was under construction.

Norway.—Falconbridge Nickel Mines, Ltd., began producing electrolytic cobalt at its new refinery at Kristiansand in July 1952. The cobalt is recovered from the matte produced at Falconbridge, Ontario, from nickel-copper ores.

Uganda.—In its initial exploration of one region of the Ruwenzori Range, Kilembe Mines, Ltd., has located a large tonnage of ore which probably will average 1.95 percent copper and 0.2 percent cobalt.[19] The deposits probably will be in production in 4 years and will produce 2,000 to 3,500 tons of ore daily. The mine and concentrator will get power from the Namwamba River hydroelectric plant, and concentrates will be shipped by the 160-mile railway to Kampala. Both the railway and the power plant are expected to be completed at about the time the mine is ready for production.

[19] Engineering and Mining Journal, vol. 153, No. 1, January 1952, p. 142.

Columbium and Tantalum

By Robert F. Griffith [1]

COLUMBIUM and tantalum were among the rare metals most vital in 1952 to the United States defense program. Columbium is one of the key alloying materials used to impart high-temperature strength and stability in alloys suitable for operating temperatures up to 1,500° F. and above. Heretofore, tantalum has been used principally as a metal in the field of electronics and in chemical equipment and as tantalum carbide in the production of wire-drawing dies and sintered cutting tools. Recently, the largest use of tantalum has been in the manufacture of ferrotantalum-columbium, because tantalum was found to be usable in conjunction with, and as a substitute for, columbium in making high-temperature alloys.

During the past decade the United States has depended on foreign sources for over 99 percent of its supply of columbium-tantalum; Nigeria and Belgian Congo supplied over 90 percent.

The principal mineralogical source of columbium and tantalum is a completely isomorphous mineral series containing columbium, tantalum, iron, and manganese oxides. The mineral is called columbite if the columbium pentoxide content exceeds that of tantalum pentoxide and, conversely, tantalite if the tantalum pentoxide content is in excess. Columbite-tantalite is recovered principally from placer deposits in conjunction with tin (cassiterite). Smaller quantities are recovered as a byproduct of pegmatite mining.

To encourage increased production of columbium-tantalum concentrates of both domestic and foreign origin, the Defense Materials Procurement Agency on May 29, 1952, announced a Government-guaranteed purchase program, which included an incentive bonus to producers. Fansteel Metallurgical Corp., North Chicago, Ill., was designated as purchasing agent. Revision 1 of the announcement, dated July 28, 1952, designated the Wah Chang Corp., New York, and the Emergency Procurement Service, General Services Administration, as additional purchasing agents. Amendment 1 to revision 1, dated October 24, 1952, provided for the purchase of small lots of columbium-tantalum ores from domestic producers. On May 2, 1952, the National Production Authority issued Schedule 5 to Order M–80 modifying controls that had limited the use of columbium and tantalum.

DOMESTIC PRODUCTION

Mine Production.—Columbite recovered as a byproduct of spodumene mining by the Foote Mineral Co., Kings Mountain, N. C., was largely responsible for increased domestic production in 1952. Mine shipments were also reported from Colorado and South Dakota.

[1] Commodity-industry analyst.

342070—55——22

Domestic production, however, still accounted for less than 1 percent of the total United States supply. Columbium and tantalum have been recovered in the United States principally as byproducts of pegmatite mining in the form of columbite-tantalite and microlite (a calcium tantalate). The possibility of recovering Cb-Ta in the United States as a byproduct of large-scale placer mining had been overlooked until recently. Extensive deposits of columbium-bearing gravels have been discovered in Valley County, Idaho, and plans are underway to exploit these deposits by dredging. The columbium occurs in columbite and in the following columbates of uranium and the rare earths: Euxenite, samarskite, and fergusonite. A columbite placer deposit was also investigated in Elmore County, Idaho. Recently, monazite placer deposits in the Southeastern States have been found to contain interesting quantities of columbium associated with ilmenorutile.

TABLE 1.—Columbium and tantalum concentrates shipped from mines in the United States, 1943–52

Year	Columbium concentrates		Tantalum concentrates	
	Pounds	Value	Pounds	Value
1943	5,771	$1,465	[1] 9,411	$27,621
1944	3,208	917	[1] 7,204	23,317
1945	1,149	287	5,500	13,366
1946	------	------	3,475	8,793
1947	------	------	3,259	8,677
1948	100	(2)	500	(2)
1949	(3)	(3)	[4] 1,020	1,785
1950	(3)	(3)	[4] 1,000	2,150
1951	(3)	(3)	[4] 925	1,528
1952	5,385	16,723	------	------

[1] Principally microlite.
[2] Bureau of Mines not at liberty to publish.
[3] Columbite and tantalite production not differentiated and given under tantalum concentrates.
[4] Tantalite-columbite.

The presence of columbium associated with titanium minerals in the Magnet Cove area and in bauxite in Pulaski and Saline Counties, Ark., has been known for some time. Fractionation of black sand from Arkansas bauxite shows the columbium to be concentrated chiefly in an ilmenite fraction containing as much as 0.86 percent Cb.[2] The Bureau of Mines is investigating the recovery of columbium from this large potential source under a memorandum agreement with DMPA, dated Oct. 6, 1952.

Refinery Production.—The Electro Metallurgical Division, Union Carbide & Carbon Co., produced ferrocolumbium and ferrotantalum-columbium in 1952 at its plant in Niagara Falls, N. Y. Fansteel Metallurgical Corp., North Chicago, Ill., produced tantalum and columbium sheet, rod, wire, powder, fabricated products, and miscellaneous alloys and compounds. A contract to expand production of columbium and tantalum was negotiated by DMPA with the Fansteel company. Kennametal, Inc., Latrobe, Pa., consumed columbium-tantalum ores to produce various alloys, carbides, and miscellaneous products.

[2] Fleischer, Michael, Murata, K. J., Fletcher, Janet D., and Narten, Perry F., Geochemical Association of Niobium (Columbium) and Titanium and its Geological and Economic Significance: Geol. Survey Circ. 225, 1952, 13 pp.

CONSUMPTION AND USES

Domestic consumption of columbium-tantalum minerals, in terms of contained metal, was estimated at 300 to 400 tons in 1952. Columbium is used almost exclusively in ferrous and nonferrous alloys. The largest use is in the form of ferrocolumbium and ferrotantalum-columbium in the manufacture of stabilized austenitic (chromium-nickel) stainless steels. The carbon in the alloy combines preferentially with the columbium rather than with the chromium. Crystal boundaries thus retain their chromium content, and intergranular and intercrystalline corrosion is inhibited. The weldability and creep and impact strength are also increased. American Iron and Steel Institute (AISI) type 347 stainless steel, which contains 18 percent Cr, 11 percent Ni, and Cb equal to 10 times the carbon content, is one of the more important types. The use of columbium in specialized, nonferrous alloys and in cemented carbides is increasing. Kentanium, a titanium-columbium carbide, with or without tantalum, is used in turbine blades and nozzle vanes for jet engines. The ingredients are mixed and ground to very fine particle size in a ball mill, pressed as near to the desired shape as possible, given further shaping as required with or without presintering, and then sintered out of contact with air.[3] Columbium has limited applications in electronic tubes, low-voltage rectifiers, electrodes for welding stainless steels, manufacture of special magnet alloys, and in ceramics, as the oxide. The estimated distribution of columbium in 1952 was as follows, by use: As ferrocolumbium and ferrotantalum-columbium in steel, 60 percent; specialized nonferrous alloys, 30 percent; cemented carbides, 5 percent; welding rods and miscellaneous, 5 percent.

In many respects tantalum is analogous to the noble metals, gold, silver, and the platinum group. Unlike the noble metals, however, tantalum is not found in elemental form in ore deposits. Because of its inert properties, ductility, malleability, and toughness, tantalum was used before 1952 largely in the chemical industry as a material of construction and in electronic applications. With the increased use of high-temperature metals, the demand for columbium exceeded its availability. To alleviate this shortage, Electro Metallurgical Co. developed a ferrotantalum-columbium alloy containing approximately 20 percent Ta and 40 percent Cb; columbium ores usually contain substantial quantities of tantalum. From the standpoint of high-temperature strength, Cb and Ta can be used interchangeably or in combination; however, on a weight basis Ta has the disadvantage of an atomic weight double that of Cb. As a result of ferrotantalum-columbium being substituted for ferrocolumbium, the largest use of Ta in 1952 was in the steel and alloy industry. Tantalum in metal form continued to have important uses in electronic tubes, electrolytic capacitors,[4] chemical equipment, and surgical and dental supplies;[5] in the form of the carbide, in dies and cutting tools; and, as K_2TaF_7, as an activator in the synthetic rubber industry. This latter use has been temporarily discontinued. As a material of construction for corrosive

[3] Redmond, John C., and Graham, John W., Field of Cemented Carbides Expanded by Titanium Compositions: Metal Prog., vol. 61, No. 4, April 1952, pp. 67–70.
[4] Technical Information Pilot, Library of Congress, July 24, 1952, p. 3926; Sept. 23, 1952, p. 4085; Nov. 6, 1952, p. 4234.
[5] Science News Letter, vol. 62, No. 17, Oct. 25, 1952, p. 258.

chemicals, tantalum, because of its high thermal conductivity and ability to be rolled in extremely thin foil, is used principally in heat exchangers of the shell-and-tube, coil, and bayonet type.[6] The estimated distribution of tantalum in 1952 was as follows by use: As ferrotantalum-columbium in steel, 28 percent; electronic uses, 25 percent (electronic tubes, 18 percent; electrolytic capacitors, 7 percent) chemical equipment, 20 percent; as tantalum carbide, 16 percent; in the synthetic rubber industry, 6 percent; and for surgical, dental, and other purposes, 5 percent.

STOCKS

Columbium-tantalum ores and concentrates containing not less than 35 percent combined Cb_2O_5 and Ta_2O_5 are purchased for the National Stockpile. Ores of lower grade are considered for purchase if the seller bears the cost of upgrading to the minimum specifications. Quantitative data on industry or Government stocks of columbium-tantalum at the end of 1952 were not available for publication.

PRICES

The columbium-tantalum purchase program announced by DMPA on May 29, 1952, governed largely the market quotations for these ores for the remainder of the year. Specifications and prices were quoted in schedule (a) as follows: For columbium ores and concentrates containing not less than 35 percent combined Cb_2O_5 and Ta_2O_5 and having a Cb_2O_5–Ta_2O_5 ratio of not less than 1 to 1, c. i. f. Atlantic ports or f. o. b. depot of purchasing agent, $1.40 per pound of combined contained pentoxides, plus $0.02 per pound for each additional percent above 35 percent, plus a 100-percent incentive bonus to the producer. Impurities not to exceed the following maximum limits: TiO_2, 8 percent; SnO_2, 8 percent; FeO, 25 percent; MnO, 13 percent. Where the seller is not the actual producer, he receives only the base purchase price; and the bonus is paid to the producer. The above schedule, including bonus, is equivalent to the following prices per pound of ore: 35 percent, $0.98; 50 percent, $1.70; and 65 percent, $2.60. Special provisions were made for high-grade tantalum ores; however, the price on the basis of combined pentoxides was comparable to that quoted in schedule (a). Minimum lot acceptable under the original program was 2,000 pounds. Revision 1, amendment 1, dated October 24, 1952, provided for the purchase of small lots from domestic producers. Quantities less than 2,000 pounds are accepted at purchase depots in Custer, S. Dak., Spruce Pine, N. C., and Franklin, N. H., on the basis of visual inspection. Lots accepted are presumed to contain 50 percent combined pentoxides and are purchased at a flat rate of $3.40 per pound of contained pentoxide or $1.70 per pound of concentrate. The seller may request a chemical analysis at his expense. Before the Government purchase program, columbite was quoted in the Metal Bulletin (London) at 256s. (about $35.84) per unit contained pentoxides, c. i. f. Atlantic ports, 50–55 percent combined oxides. This quotation is equivalent to $0.90 per pound for 50-percent ore compared to the $1.70 per pound Government price.

[6] Chemical Engineering, Tantalum Goes Chemical: Vol. 59, No. 9, September 1952, pp. 252–254.

Ferrocolumbium, 50-55 percent Cb, remained steady at $4.90 per pound of contained Cb. Ferrotantalum-columbium was quoted at $3.75 per pound of contained Cb plus Ta. Columbium metal was quoted in American Metal Market as follows: Powder, $62.75 per pound; rod, $280 per kilogram; and sheet, $250 per kilogram. Tantalum metal was quoted in E&MJ Metal and Mineral Markets as follows: Powder, $33.50 per pound; rod, $160.60 per kilogram; and sheet, $143 per kilogram. A leading producer offered tantalum compounds at the following prices, subject to discount: Tantalum carbide (TaC), $31.50 per pound; tantalum oxide (Ta_2O_5), $19.85 per pound; and potassium tantalum fluoride (K_2TaF_7), $9.00 per pound.

In addition to the principal consumers and Government purchasing agents, other buyers of Cb-Ta ores and concentrates include: Ayrton Metal Co., New York, N. Y.; Beryl Ores Co., Arvada, Colo.; Derby & Co., Inc., New York, N. Y.; DeRewal International Rare Metals Co., Philadelphia, Pa.; Foote Mineral Co., Philadelphia, Pa.; Frankel Co., Inc., Detroit, Mich.; Mercantile Metal & Ore Corp., New York, N. Y.; Metal Hydrides, Beverly, Mass.; Metal Traders, Inc., New York, N. Y.; Miles Metal Corp., New York, N. Y.; Philipp Bros., Inc., New York, N. Y.; Transatlantic Metal & Ore Corp., New York, N. Y.; and Hyman Viener & Sons, Richmond, Va.

FOREIGN TRADE[7]

Columbite imports increased about 20 percent compared with those of 1951 but were still over 50 percent under the peak year of 1945. Nearly 80 percent of the supply was from Nigeria. Imports of tantalite, largely from Belgian Congo, also increased substantially over the 1951 figure. The weight of concentrates imported from different countries does not give a true view of relative values because of the wide variance in grade. To present more usable data, an estimate of the pentoxide content of 1952 columbite-tantalite imports, based on analyses of selected lots for a 6-month period, is given in table 4. In addition to columbite-tantalite concentrates, large quantities of Cb-Ta-bearing tin slags were imported from Belgian Congo, Portugal, and United Kingdom (Nigeria). These slags, which contained 14 to 21 percent combined columbium-tantalum pentoxides, were imported by less than three firms, and quantitative data are not available for publication. United States imports of Cb-Ta concentrates were 63 percent of the reported world production; United Kingdom and Belgium are believed to be the other principal recipients. The only United States imports of Cb-Ta in other forms were 11,200 pounds of ferrocolumbium, valued at $38,220 from United Kingdom.

No columbium ore was exported from the United States. Four pounds of columbium metal valued at $146 was exported to Canada. Exports of tantalum ore, metal, alloys, and scrap, in crude form, totaled 1,058 pounds valued at $36,230. Exports of tantalum primary forms were 1,360 pounds valued at $89,054. These exports were principally to Sweden, France, West Germany, Canada, Switzerland, United Kingdom, and Australia.

[7] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 2.—Columbite imported for consumption in the United States, 1943–52, by countries, in pounds

[U. S. Department of Commerce]

Country	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952
Argentina	2,685									
Belgian Congo		1,373			2,734	113,813	198,585	400,868	177,273	354,732
Belgium-Luxembourg [1]						27,125				
Bolivia			1,034	[2] 6,834						14,678
Brazil				7,717		6,926	8,568	10,981	6,377	5,017
British Guiana										800
India	21,600	1,470								
Japan [1]								31,835		
Malaya										20,264
Mozambique			22,046				1,200		17,082	21,205
Nigeria	2,350,329	3,658,084	4,220,691	2,411,695	2,818,900	1,822,843	1,349,126	1,280,930	[3] 1,336,041	1,450,787
Portugal								2,103		
Uganda [4]	3,111	23,603	33,381							4,622
Union of South Africa	4,325					1,821				6,030
United Kingdom [1]						1,200				
Total: Pounds	2,382,050	3,684,530	4,277,152	2,426,246	2,821,634	1,973,728	1,557,479	1,726,717	[3] 1,536,773	1,878,135
Value	$844,544	$1,196,899	$1,312,346	$742,804	$857,550	$658,950	$561,945	$752,926	[3] $1,362,393	$2,368,769

[1] Presumably country of transshipment rather than original source.
[2] Classified by U. S. Department of Commerce as from Chile, which is believed to be the country of transshipment only.
[3] Revised figure.
[4] Classified by U. S. Department of Commerce as British East Africa.

TABLE 3.—Tantalite imported for consumption in the United States, 1943–52, by countries, in pounds

[U. S. Department of Commerce]

Country	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952
Anglo-Egyptian Sudan		98								
Argentina	2,420	8,233				1,074				
Australia	10,708	9,315	21,125	500	9,468				1,467	1,590
Belgian Congo	157,073	332,312	485,986	263,097	311,526	93,939	38,086	211,433	210,402	236,701
Belgium-Luxembourg [1]					3,199			85,683	20,876	
Brazil	416,874	440,460	68,229	98,072	71,634	9,202	63,478	13,378		49,813
Canada		700								
India	1,805	2,442								
Japan [1]								10,691		
Malaya										2,087
Mozambique	3,567	4,751								
Netherlands [1]							29,500			
Nigeria	5,757	18,116	31,410		7,998	14,559	4,480	7,543	5,700	2,273
Portugal										35,428
Southern Rhodesia	40,481	12,794	9,967		14,928	8,914				233
Spain										741
Uganda [2]	3,063	7,277	11,348							
Union of South Africa	1,332	632	2,027	1,884			1,120			
Total: Pounds	643,080	837,130	630,092	363,553	418,753	127,688	136,664	328,728	238,445	328,866
Value	$724,066	$699,473	$453,141	$302,397	$386,934	$82,799	$237,292	$244,205	$190,383	$398,849

[1] Presumably country of transshipment rather than original source.
[2] Classified by U. S. Department of Commerce as British East Africa.

TABLE 4.—Estimated grade of columbite and tantalite concentrates imported for consumption in the United States, 1952, by countries

Country	Columbite [1]					Tantalite [2]				
	Cb_2O_5 [3]		Ta_2O_5 [3]		Value	Ta_2O_5		Cb_2O_5		Value
	Percent	Pounds	Percent	Pounds		Percent	Pounds	Percent	Pounds	
Australia						47.1	749	10.5	167	$3,487
Belgian Congo	40.3	142,957	30.7	108,903	$515,810	39.5	93,497	31.6	74,798	259,812
Bolivia	59.6	8,748	11.2	1,644	19,406					
Brazil	48.7	2,443	25.8	1,294	7,768	60.1	29,938	29.1	14,496	93,091
British Guiana	56.0	448	16.0	128	700					
Malaya	53.6	10,862	12.7	2,574	34,146	39.9	833	35.2	735	4,059
Mozambique	39.7	8,418	32.5	6,892	28,026					
Nigeria	58.8	853,063	8.3	120,415	1,749,010	54.0	1,227	19.0	432	4,262
Portugal						40.3	14,277	30.5	10,806	33,119
Southern Rhodesia						40.0	93	29.2	68	563
Spain						40.0	296	35.0	259	456
Uganda	31.8	1,470	16.6	767	4,863					
Union of South Africa	37.6	2,267	34.7	2,092	9,040					
Total		1,030,676		244,709	2,368,769		140,910		101,761	398,849

[1] Average grade of columbite imports is 67.9 percent combined pentoxides.
[2] Average grade of tantalite imports is 73.8 percent combined pentoxides.
[3] To obtain metallic content, multiply Cb_2O_5 by 0.699 and Ta_2O_5 by 0.819.

No tariff restrictions apply to columbite-tantalite concentrates imported into the United States. Import duties on refined products range from 12.5 percent ad valorem on ferrocolumbium to 40 percent on special alloys. Columbium-tantalum ore, metal, alloys, scrap, and primary forms remained on the positive list of products requiring export licenses to foreign destinations (excepting Canada).

Dealers and producers of Cb-Ta products in foreign countries include: H. F. Pollock & Co., Ltd., Montreal, Canada; Murex Co., Rainham, Essex, England; Hoboken Works of the Union Minière du Haut-Katanga near Antwerp, Belgium; and Societa per Aziona Silta, Milan, Italy.

TECHNOLOGY

Columbium was named by its discoverer, C. Hatchett, an English chemist, who discovered it in 1801 while analyzing a mineral from New London, Conn. The following year Ekeberg, a Swedish chemist, discovered and named tantalum. In 1846 H. Rose thought he had found a new element in tantalite and called it niobium; however, it was found later that columbium and niobium were one and the same. Both names have been used interchangeably for many years. Columbium is favored by United States and British mining and metallurgical engineers.

The density of Cb-Ta minerals enables them to be concentrated with other heavy minerals by gravity methods; sluices, jigs, spirals, and tables are commonly used in conjunction with screen sizing. Columbite-tantalite is separated from other heavy minerals by a combination of high-tension electrostatic and high-intensity electromagnetic means. Concentrates from Nigerian placer deposits, which are worked primarily for cassiterite, are dried and treated by magnetic separators to remove the magnetic constituents: Magnetite, ilmenite, columbite, monazite, and magnetic cassiterite. The magnetic fraction is retreated to separate minerals of different permeabilities. Columbite, monazite, and magnetic cassiterite are weakly magnetic. Columbite and magnetic cassiterite are separated on air flotation tables, whereas columbite and monazite are separated electrostatically.[8]

Concentrates from the open pit pegmatite tin-mining operation of *Compagnie Gèologique et Minière des Ingènieurs et Industriels Belges* (Geomines), Manono, Belgian Congo, are dried and treated magnetically to remove tantalite-columbite. About 65 to 75 percent of the tantalite-columbite is recovered in a concentrate containing 65 to 75 percent combined pentoxides. The remaining Cb-Ta reports in the final slag from tin smelting and is shipped to the United States for further refining.[9] The recovery of Cb-Ta from tin slags was investigated successfully by industy and by the Bureau of Mines. As a result, the metallic content, Cb plus Ta, of tin slags imported for consumption in the United States from Belgian Congo and other sources during 1952 was comparable to the metallic content of columbite-tantalite concentrates, previously the only source of supply.

Fusion, leaching, digesting, and electrolytic methods are usually

[8] Cothay, Frank H., Columbium—Rarest Jet Metal: Mining World, vol. 14, No. 10, September 1952, pp. 44–47.

[9] Mining World, How GEOMINES Will Treat 24,000 Tons of "Hard" Tin Ores per Day: Vol. 14, No. 12, November 1952, pp. 32-37.

employed to extract columbium and tantalum from their ores. The two metals are extracted together, freed from other metals, and then separated from each other. An estimated 90 percent of the columbium and 80 percent of the tantalum are recovered by current metallurgical procedures. Studies involving extraction and separation of columbium and tantalum by chlorine metallurgy and liquid-liquid separation were conducted by the Bureau of Mines in 1952.

An investigation aimed toward the better understanding of strain hardening phenomena in metals was conducted in 1952 by studying the behavior of large crystals of columbium, tantalum, and other metals.[10] The crystal structure of $TaCr_2$ and $CbCr_2$ was studied and described.[11] A patent for a method of resistance welding tantalum was issued in 1952.[12]

No suitable all-round substitute has been developed for columbium or tantalum as a stabilizer of carbon in stainless steels, although titanium is acceptable in certain applications of 18–8 steels (18 percent nickel—8 percent chromium). Lowering the carbon content and therefore the columbium needed to stabilize certain steels is another means of conserving this metal. The most important substitute for metallic tantalum is probably zirconium, although this metal has not been available to industry in quantities.

One of the more troublesome factors in columbium-tantalum metallurgical investigations has been the lack of a rapid, accurate, analytical procedure. Wet analyses require several time-consuming fractional precipitation steps. Techniques developed by the Bureau of Mines in 1952 employing the X-ray spectrograph make possible the accurate determination of Cb-Ta in a fraction of the time required for wet analyses. Reports are in the process of publication. A radioactivation method for assaying Cb-Ta ores was described.[13]

RESERVES

Domestic potential reserves of columbium-tantalum were increased materially with the discovery of columbium-tantalum minerals in placer deposits of Idaho and the Southeastern States. Known placer deposits in Idaho, amenable to dredging operations, are estimated to contain 10 million pounds of Cb-Ta metal. However, concentration, separation, and metallurgical extraction processes must be perfected before these deposits can be exploited. Reserves of columbite in South Dakota, North Carolina, Arizona, and Colorado have been estimated at about 250,000 pounds. This estimate does not include the columbium content of the bauxites of Pulaski and Saline Counties, Ark., or the columbium-bearing titanium minerals in the Magnet Cove, Ark., area. Tantalite reserves have been estimated at 130,000 pounds and microlite at 600,000 pounds.

---

[10] Maddin, Robert and Chen, N. K., Study Metals Behavior with Large Metal Crystals: Iron Age, vol. 170, No. 17, October 1952, pp. 108–111.

[11] Duwez, Pol, and Martens, Howard, Crystal Structure of $TaCr_2$ and $CbCr_2$: Jour. Metals, vol. 4, No. 1, January 1952, pp. 72–74.

[12] Otto, George (assigned to Fansteel Metallurgical Corp.), Method for Resistance Welding Tantanlum: U. S. Patent 2,620,424, Dec. 2, 1952.

[13] Eichholz, G. G., Activation Assaying for Tantalum Ores: Nucleonics, vol. 10, No. 12, December 1952, pp. 58–61.

Foreign columbite reserves, chiefly in Nigeria, are estimated to be about 30 million pounds. The Belgian Congo has large reserves of low-grade columbite-tantalite ore; estimates in the order of 50 million pounds have been reported. Reserves of high-grade tantalite have been estimated at 5 million pounds, of which 4 million pounds is in Brazil. Not enough data are available relative to koppite deposits in Germany and Norway, pyrochlore deposits in Nigeria and Northern Rhodesia, and ellsworthite deposits in Ontario, Canada, to include these deposits in world reserves.

WORLD REVIEW

Australia.—An area near Bynoe Harbour, 70 miles east of Darwin, was worked for tapiolite, a tantalum ore ($FeTa_2O_6$).[14] Economic aspects of the principal tantalum-bearing deposits of the Pilbara Goldfield, Northwest Division, were described.[15]

Belgian Congo.—Columbite and tantalite are accessory minerals within the tin-producing areas of the Congo and Ruandi-Urundi. Geomines, at Manono, is the principal producer. Thoreaulite, a tantalite of tin, occurs in Maniema and at Manono.

Bolivia.—Columbite production was reported from the northern part of the Province of Nuflo de Charez.

British Guiana.—Columbite placer deposits in the Mazaruni River area, which includes the Morabisi and the Rumong-Rumong River basins, were investigated. Production was reported by Kennametal, Inc., and Morabisi Mining Co., Ltd.

Canada.—Investigation of a large columbium-tantalum-uranium-bearing deposit at Lake Nipissing, near North Bay, Ontario, was initiated by the Inspiration Mining and Development Co.

French Guiana.—Preliminary steps were taken toward the exploration of a tantalite deposit in the Sinnamary River area; no production was reported.

Germany.—Koppite-bearing limestone was mined in Kaiserstuhl, near Freiburg, and shipped to France for processing by Fabriques de Produits Chimiques at Thann, Haut-Rhin. Columbic acid, in white powder form, is extracted. Koppite is a rare-earth columbate similar to pyrochlore.

India.—Export controls do not apply to columbium-tantalum concentrates provided that they are certified by the Indian Atomic Energy Commission to be free from associated uranium compounds.[16]

Malaya.—Columbite production was 47 long tons compared with 25 tons in 1951. Sample lots of tin slag from Penang and Singapore were shipped to the United States for assaying and metallurgical tests. Columbite production was largely from alluvial deposits at Semiling in the northern part of the State of Kedah. The deposits in the State of Johore were not worked because of the low grade of the deposit and because the area was too disturbed from a security point of view.[17]

---

[14] Mining World, vol. 14, No. 4, April 1952, p. 57.
[15] Economic Geology, vol. 47, No. 2, March–April 1952, p. 236.
[16] State Department Dispatch 1311, American Embassy, New Delhi, India, Dec. 2, 1952.
[17] State Department Dispatch 11, Singapore, July 3, 1952, 8 pp.

TABLE 5.—World production of columbite concentrates[1], 1943–52, in pounds

[Compiled by Berenice B. Mitchell and Lee S. Petersen]

Country [1]	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952
Argentina [2]	1,800	200	1,000	(3)	(3)	(3)	[4] 1,080	(3)	(3)	(3)
Belgian Congo	332,955	648,270	436,590	370,440	[5] 348,390	[5] 319,725	[5] 255,780	[5] 297,675	[5] 209,437	[5] 231,042
Bolivia (exports)			1,034	6,834					1,043	
Brazil	[4] 37,500	[4] 116,871		[4] 15,435		[4] 10,494	[4] 33,942	[4] 26,709	[4] 11,000	[6] 5,017
French Equatorial Africa			10,584	2,200		3,461	12,984	3,655		3,527
India	7,981	1,019			(3)	(3)	(3)	(3)	(3)	(3)
Madagascar			22						8,598	5,732
Malaya, Federation of	[7] 3,000	[7] 3,000	[7] 3,000					17,920	56,000	105,280
Mozambique	11,023	9,965	3,314	440			550	7,700	[8] 11,133	40,518
Nigeria	1,796,480	4,603,536	3,519,040	3,472,000	2,880,640	2,455,040	1,989,120	1,935,360	2,419,200	2,896,320
Portugal (exports)								3,009	4,526	
Uganda	(9)	[10] 20,552	[10] 13,194	[10] 4,883	[10] 2,800	[10] 2,285	[4] [11] 5,571	[4] [11] 11,413	[4] [11] 42,560	[4] [11] 5,914
United States (mine shipments)	5,771	3,208	1,149			100	(12)	(12)	(12)	[13] 5,385
Total (estimate)	2,250,000	5,450,000	4,050,000	3.900,000	3,300,000	2,950,000	2,500,000	2,450,000	2,850,000	3,400,000

[1] Concentrate produced in Argentina, Belgian Congo, French Equatorial Africa, Mozambique, and Portugal are frequently termed "columbite-tantalite," this designation being applied because, in general, their composition ($Cb_2O_5+Ta_2O_5$) lies in an intermediate range, neither Cb_2O_5 nor Ta_2O_5 being strongly predominant. In tabulating production of columbite and tantalite, all output designated "columbite-tantalite" has arbitrarily been placed in the columbite table.

[2] Estimated average Cb_2O_5 content of concentrates.

[3] Data not available; estimate by author of chapter included in total.

[4] Exports.

[5] In addition, tin-columbite-tantalite concentrates were produced as follows: 1947, 597,555 pounds, columbite-tantalite content unspecified; 1948, 1,148,050 pounds; 1949, 1,944,457 pounds; 1950, 2,431,674 pounds; 1951, 2,597,019 pounds; 1952, 2,813,070 pounds; columbite-tantalite content averaging about 10 percent.

[6] United States imports.

[7] Estimate.

[8] In addition to figure shown, 204,036 pounds of samarskite were produced.

[9] Tin-columbite-tantalite concentrates, columbite-tantalite content unspecified, produced as follows: 1943, 15,700 pounds; 1947, 329 pounds; 1948, 210 pounds.

[10] Contained in 28,334 pounds mixed concentrates in 1944; in 17,687 pounds in 1945; in 7,706 pounds in 1946; in 3,651 pounds in 1947; and in 3,203 pounds in 1948.

[11] Columbite-tantalite concentrates.

[12] Columbite and tantalite production in the United States not always differentiated; therefore, see tantalite table.

[13] A small amount of tantalite is included in the columbite concentrates.

TABLE 6.—World production of tantalite concentrates [1] 1943–52, in pounds

[Compiled by Berenice B. Mitchell and Lee S. Petersen]

Country [1]	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952
Australia	27,418	24,192	1,053	806	1,411	12,023	3,502	16,536	5,125	15,720
Brazil	[2] 399,033	[2] 443,125	[2] 66,138	[2] 98,035	[2] 71,650	[2] 9,202	[2] 91,237	[2] 18,700	[2] 8,818	[3] 49,813
Nigeria	4,500	27,082	29,792	2,890	8,310	8,243	4,980	2,240	6,720	2,240
Southern Rhodesia	13,820	12,640	14,740	16,900	27,300	16,120	10,840	1,700	----	10,360
South-West Africa	[4] 2	----	----	----	493	17	5,364	12,570	3,974	4,400
Uganda	(5)	[2,5,6] 9,518	[2,5,6] 3,636	(5)	(5)	(5)	(5)	(5)	(5)	(5)
Union of South Africa	2,440	6,312	776	4,000	----	----	----	4,000	6,000	8,000
United States (mine shipments)	[7] 9,411	[7] 7,204	[7] 5,500	[7] 3,475	[7] 3,259	500	[8] 1,020	[8] 1,000	[8] 925	(9)
Total (estimate)	485,000	575,000	127,000	132,000	118,000	51,500	123,000	62,500	37,500	95,000

[1] See columbite world production table, footnote 1. Tantalite production of Belgian Congo is included in columbite production figure. United States imports show 98 pounds tantalite received from Anglo Egyptian Sudan in 1944; 700 pounds from Canada in 1944; 1,805 pounds and 2,442 pounds from India, respectively in 1943 and 1944, and 35,428 pounds from Portugal in 1952.

[2] Exports.

[3] United States imports.

[4] In addition, tin-tantalite-columbite concentrates, unspecified tantalite-columbite content, produced as follows: 1943, 560 pounds, and 1944, 2,000 pounds.

[5] See columbite production table.

[6] Includes 6,720 pounds bismutotantalite in 1944 and 670 pounds of bismutotantalite in 1945.

[7] Principally microlite.

[8] Tantalite-columbite.

[9] A small quantity of tantalite is included in the columbite concentrates (*see* columbite table).

Nigeria.—Pyrochlore-bearing granites of the Kaffo Valley, Northern Nigeria, were reported to be a potentially large source of columbium and uranium provided that economical extraction methods were developed.[18] Columbite production increased 140 short tons over 1951. The principal producers were Amalgamated Tin Mines, Ltd., Jantar Co., Ltd., Bisichi Tin Co., Ltd., Naraguta Tin Mines, Ltd., Gold Coast Consolidated Lands, Ltd., and Gold & Base Metal Mines, Ltd.

Northern Rhodesia.—A columbite deposit was reportedly discovered in Lusaka State.[19]

Norway.—A satisfactory method for processing columbium ore discovered at Sove, in Telemark, was reported.[20] The ore mineral is koppite, which occurs in limestone. Mutual Security Agency has provided part of the capital for development work and a mill and has agreed to purchase 80 percent of the columbium production for a 5-year period.

Portugal.—Over 35,000 pounds of tantalite concentrates, the first recorded shipments, were imported from Portugal in 1952. The Portuguese-American Tin Mining Co. recovered tantalite-columbite in dredging for cassiterite. The Fontainhas mine of the Cia. Portuguesa de Minas has important reserves of columbite-tantalite ore. Mine development and a 50-ton mill are being financed through MSA assistance.

Southern Rhodesia.—The production of tantalite was resumed in 1952. The occurrence of tantalum-columbium deposits was described.[21]

South-West Africa.—Columbite-tantalite was found to occur in the pegmatite tin-bearing deposits of the Uis Tin Mining Co. The deposits are reportedly the largest so far discovered. Successful pilot-plant tests were made to recover these minerals.[22]

United Kingdom.—Imports of columbite-tantalite concentrates by United Kingdom for the first 9 months of 1952 totaled about 560 long tons; consumption for the same period was 320 long tons.

---

18 Mining Journal (London), vol. 238, No. 6094, June 6, 1952, p. 583; vol. 238, No. 6096, June 20, 1952, p. 648.
19 Metal Bulletin, (London) No. 3750, Dec. 9, 1952, p. 25.
20 Mining World, vol. 14, No. 13, December 1952, pp. 61–63.
21 Southern Rhodesia Geological Survey, Tantalum and Niobium: Mineral Resources Ser. 4, 1952, 4 pp.
22 Mining Journal (London), vol. 239, No. 6122, Dec. 19, 1952, p. 701.

Copper

By Helena M. Meyer[1] and Gertrude N. Greenspoon[2]

THE SUPPLY of copper for defense and total civilian requirements in the United States continued inadequate in 1952. Despite Government and civilian efforts to stimulate the flow of metal, actually, slightly less copper was available in 1952 than in 1951. In May, when exports of copper from Chile to the United States were embargoed, the President of the United States authorized the release of 22,000 tons of copper from the National Stockpile to meet the temporary emergency. Following Office of Price Stabilization permission to raise prices for foreign copper and to pass on to consumers most of the increased costs, the situation improved enough so that late in August the Defense Production Administration moved copper from the list of most critical materials to the list of those in approximate balance. Larger imports in July–December had eased the situation, but supplies of copper continued to be inadequate for all needs.

Probably the outstanding feature of the year, and the most controversial, was the multiple prices for copper. Domestic prices continued to be controlled by the General Ceiling Price Regulation, in force since January 26, 1951. There was no specific ceiling for domestic copper; the General Ceiling Price Regulation established prices for individual producers at levels prevailing in the base period (December 19, 1950, to January 25, 1951, inclusive). By midyear foreign copper, which had been selling at 27.5 cents, began to be sold at 36.5 cents a pound.

Mine production in 1952 fell short by a slight margin of the record for 1951. Receipts of copper from abroad in crude form—ores, concentrates, regulus, and blister—were 9 percent above 1951, while imports of refined copper increased 45 percent.

Production of refined copper from scrap declined 7 percent, and total production of alloyed and unalloyed copper from old scrap (of which the refined production from scrap is a part) dropped 10 percent.

Producers' stocks of refined copper at the end of 1952 decreased 26 percent from the end of 1951 and were the same as at the end of 1950, or the smallest since 1906.

Exports of refined copper, under Government control, gained 31 percent over 1951. Foreign material treated in the United States on toll made up most of this tonnage.

Supplies of copper in the second half of 1952 exceeded those in the first 6 months, largely because efforts to increase imports were successful. About 60 percent of total imports came into the United States in the latter half of 1952, and refined copper from scrap increased 1 percent, but domestic mine production declined 2 percent.

[1] Assistant chief, Base Metals Branch.
[2] Statistical assistant.

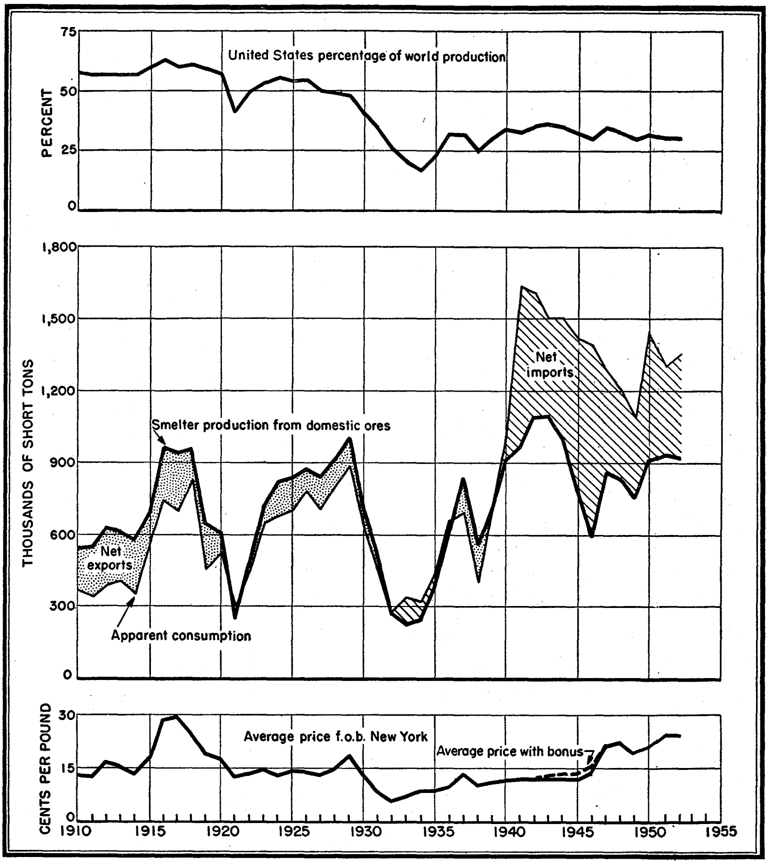

FIGURE 1.—Production, consumption, and price of copper in the United States, 1910–52

Government efforts to expand domestic production through loans, through purchase contracts at specified prices and with escalation provisions, and through permits granting accelerated amortization of capital outlay brought little fruit in 1952, as was expected. A little new production resulted from these stimuli, and some threatened production losses were prevented by granting over-the-ceiling contracts to marginal producers, but major increases must await the end of 1953 and even later. Government efforts to maintain production at marginal mines and to bring in new production are given in this summary under Defense Production Act Stimulation. Apart from Government-assisted projects, the Greater Butte project in the Summit Valley (Butte) district, Montana, began to produce in the first half of 1952; but despite all gains and the fact that mining operations were almost entirely free of the labor strikes that had impeded production in the past several years, total production was lower in 1952 than in 1951; this drop was largely due to the decreased grade of ore treated at some large properties. Some production was lost because of a

2-month strike at properties of the Calumet & Hecla, Inc., Michigan, ending November 10 and a strike that lasted about 1 week in August at the Ray mine (Kennecott Copper Corp.), Mineral Creek (Ray) district, Arizona.

During the early months of the year domestic prices, under Office of Price Stabilization controls, were largely 24.5 cents a pound for electrolytic copper delivered Connecticut Valley, but a few producers had higher ceilings because their base period prices were higher. Foreign copper was sold at 27.5 cents a pound. In May Chile abrogated its agreement with the United States Government, which provided, among other things, that Chile withhold for Government disposition in world markets not over 20 percent of the outputs of American mines operating in that country. Chilean dissatisfaction with the 27.5-cent price caused the break. Exports to the United States were embargoed for a short time; but, after the Office of Defense Mobilization, on May 21, authorized importers to pay higher prices for imported copper and to pass on to consumers 80 percent of costs above 27.5 cents, shipments to the United States were resumed. Later the provision was changed to "increased costs above 24.5." The Chilean price went immediately to 35.5 cents a pound f. a. s. Chilean ports or about 36.5 cents in the United States. On June 24 the OPS exempted from price control refined copper imported and copper refined from imported copper-bearing materials and imported scrap and later issued amendments to orders for wire mills and brass mills, effective July 1, to reflect increases permitted by the ODM directive. The ceilings were to be revised from time to time, based in part on the proportion of foreign to domestic copper available.

The price situation caused considerable confusion, and in some instances much dissatisfaction, in domestic mining circles, in the Government, and elsewhere. The situation described was confused further by the fact that a few domestic high-cost producers had higher ceiling prices than the large majority of producers and that some others had over-the-ceiling Defense Materials Procurement Agency subsidies. In September OPS established a 27.5-cent ceiling price for Calumet & Hecla, Inc., based on costs of production.

The National Production Administration, in order to make as equitable a distribution as possible of the different-price supplies, decided to allocate copper to all consumers on the basis of estimated supply—60 percent domestic and 40 percent foreign. Prices of products were based on this assumed distribution to the end of the year.

Despite the confusion and dissatisfaction with prices, supplies improved because more foreign copper began to flow to the United States. Fifty-eight percent more copper entered the United States from abroad in the second half than in the first 6 months of 1952. Part of the increase, however, could not be credited to the advanced prices for foreign copper in the United States, because the greater imports from Canada resulted in large part from the diversion to United States refineries of copper from a labor-struck refinery in Quebec.

The price for copper in foreign markets in the latter part of 1952 was under that in the United States, in contrast with the situation that had prevailed for many earlier months, when foreign prices sharply exceeded those in the United States.

342070—55——23

TABLE 1.—Salient statistics of the copper industry in the United States, 1943–47 (average) and 1948–52, in short tons

	1943–47 (average)	1948	1949	1950	1951	1952
New (primary) copper produced—						
From domestic ores, as reported by—						
Mines	858,512	834,813	752,750	909,343	928,330	925,377
Ore produced:						
Copper ore [1]	83,350,721	84,729,043	76,032,531	94,585,792	95,494,214	99,947,492
Average yield of copper, percent	.96	.92	.91	.89	.90	.85
Smelters	863,314	842,477	757,931	911,352	930,774	927,365
Percent of world total	34	[2] 33	29	31	30	30
Refineries	863,862	860,022	695,015	920,748	951,559	923,192
From foreign ores, matte, etc., refinery reports	285,674	247,424	232,912	319,086	255,429	254,504
Total new refined, domestic and foreign	1,149,536	1,107,446	927,927	1,239,834	1,206,988	1,177,696
Secondary copper recovered from old scrap only	458,231	505,464	383,548	485,211	458,124	414,635
Imports (unmanufactured) [3]	633,055	507,449	552,709	690,389	[2] 489,135	618,944
Refined	346,075	249,124	275,811	317,363	[2] 238,972	346,960
Exports of metallic copper [4]	191,801	207,022	195,990	192,339	166,274	[5] 212,390
Refined (ingots and bars)	98,613	142,598	137,827	144,561	133,305	174,135
Stocks at end of year (producers)	357,100	250,000	322,000	258,000	217,000	211,000
Refined copper	87,100	67,000	61,000	26,000	35,000	26,000
Blister and materials in solution	270,000	183,000	261,000	232,000	182,000	185,000
Withdrawals (apparent) from total supply on domestic account:						
Total new copper	1,420,000	1,214,000	1,072,000	1,447,000	[2] 1,304,000	1,360,000
Total new and old copper (old scrap only)	1,878,000	1,719,000	1,456,000	1,932,000	[2] 1,762,000	1,775,000
Price average [6] cents per pound	14.1	21.7	19.7	20.8	[7] 24.2	[7] 24.2
World smelter production, new copper	2,575,000	[2] 2,580,000	[2] 2,600,000	[2] 2,915,000	[2] 3,105,000	3,120,000

[1] Includes old tailings smelted or retreated. Not comparable with mine production figure shown in that latter includes recoverable copper content of ores not classified as "copper."
[2] Revised figure.
[3] Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering country under bond. Comprises copper in ingots, plates, and bars, ores and concentrates, regulus, blister, and scrap.
[4] Total exports of copper, exclusive of ore, concentrates, composition metal, and unrefined copper. Exclusive also of "Other manufactures of copper," for which quantity figures are not recorded. (See table 28.)
[5] Due to changes in classifications 1952 data are not strictly comparable to earlier years.
[6] Exclusive of bonus payments of the Office of Metals Reserve under Premium Price Plan, which covered the period February 1, 1942, to June 30, 1947, inclusive.
[7] Exclusive of copper produced abroad and delivered in the United States.

The British Ministry of Materials official maximum price was £227 per long ton (equivalent to 28.375 cents a pound) when the year began, rose to £287 (35.875 cents) on July 7, was reduced to £285 (35.625 cents) on July 31, and thereafter remained unchanged. Selling prices on the European Continent were reported to be about this level. Selling prices in foreign markets in 1951 were considerably higher than in 1952, but an average world price is not available.

Outside of the United States, a number of strikes impeded production in 1952, in contrast with the relatively undisturbed situation at United States mines. Strikes at the Chuquicamata and Andes properties in Chile began in April and lasted about 15 days each, with the Chilean President effecting a compromise arrangement. Another strike at Andes in October lasted a few days only. Workers at the Braden mine, also in Chile, struck December 20 and were out at the year end. Miners at the four main Northern Rhodesian copper properties—Mufulira, Nchanga, Roan Antelope, and Rhokana—were out of work 3 weeks, ended November 10, because of a strike; the reported loss was 20,000 tons of copper. The Montreal East refinery of Canadian Copper Refineries, Ltd., Quebec, Canada, reopened late in November after a strike that lasted 18 weeks.

Labor disorders were given by the American Smelting & Refining Co. as the reason for advising the Bolivian Government in July that it planned to suspend operations at the Corocoro mine in 90 days. The company leased the mine to the Bolivian Government early in October for an indefinite period.

World smelter production established a new alltime peak for the second successive year—3,120,000 short tons compared with 3,105,000 in 1951. The previous record was 3,049,000 tons in 1942.

DEFENSE PRODUCTION ACT STIMULATION

Among the major Government actions in 1952 directed toward increasing supplies of copper under the Defense Production Act, were the following:

A contract was signed by DMPA with Falconbridge Nickel Mines, Ltd., in February, for the purchase of tonnages of copper as well as nickel and cobalt. Purchase was to begin immediately, and the contract was to run 10 years.

On February 25 the White Pine Copper Co. entered into a contract with the Government for the production and disposition of 275,000 short tons of refined copper. The Government was to pay 25.5 cents a pound, subject to indicated adjustments.

In July DMPA announced an over-the-ceiling contract with Calumet & Hecla, Inc., for copper from the Osceola mine, Michigan. Production was to begin in mid-1955 and to amount to 53,000 tons. A price of 25.25 cents a pound, subject to escalation, was guaranteed.

In July the Reconstruction Finance Corp. approved a loan of $94,000,000 to the San Manuel Copper Corp., wholly owned subsidiary of the Magma Copper Co., for expansion of copper and molybdenum production. Plans called for mining, milling, and smelting 10,000,000 tons of ore annually, with production to begin in 1957. Full operation was expected to yield 70,000 tons of copper and 3,000 tons of molybdenum annually. In August DMPA completed a purchase contract with the company providing for the purchase of totals of 365,000 tons of copper and 16,000 tons of molybdenum.

In October the DMPA entered into a purchase agreement with the Bagdad Copper Corp., guaranteeing a market for up to 13,500 tons of copper a year, at 24.5 cents a pound subject to escalation, and 470 tons of molybdenum. The agreement covered 8 years of production, terminating automatically June 30, 1962. Enlargement of the open pit and installation of an electrolytic refinery were called for. An eventual capacity of 17,500 tons of refined copper and 6,000 tons of recoverable copper in precipitates was envisioned. Current capacity was said to be 10,000 tons of copper.

In June General Services Administration reached agreement with Campbell Chibougamau Mines, Ltd., for the purchase of 31,600 tons of refined copper from the company property at Merrill Island, Dore Lake, Quebec, by December 31, 1956, at 24.5 cents a pound delivered Connecticut Valley or the market price, whichever is higher.

TABLE 2.—Contracts for expansion and maintenance of supply of copper under the Defense Production Act, as amended, as of Dec. 31, 1952

Type of contract, name of contractor, and location of project	Quantities involved (pounds)		Effective date of contract	Date production starts	Approximate term of contract	Commitment purchase price (per pound)
	Total	Contingent purchase commitment				
Floor price:						
American Smelting & Refining Co., Silver Bell mine, Pima County, Ariz.	197,000,000	177,000,000	Nov. 28, 1951	Nov. —, 1953	7½ years	$0.245 or market.[1]
Anaconda Copper Mining Co., Yerington, Lyon County, Nev.	384,000,000	256,000,000	Nov. 10, 1951	do	8 years	$0.255 or market.[1,2]
Calumet & Hecla Consolidated Copper Co., Osceola mine, Houghton County, Mich.	106,000,000	106,000,000	July 18, 1952	July 1, 1955	10 years	$0.2525.[1,2]
Copper Cities Mining Co., Copper Cities, Gila County, Ariz.	192,500,000	170,000,000	Sept. 24, 1951	Oct. —, 1954	7¾ years	$0.230.[1]
Phelps Dodge Corp., Bisbee East ore body, Cochise County, Ariz.	300,000,000	225,000,000	do	Sept. —, 1955	8 years	$0.220.[1]
White Pine Copper Co., White Pine mine, Ontonagon County, Mich.	550,000,000	487,500,000	Feb. 26, 1952	Feb. —, 1955	9¾ years	$0.255.[1,2]
Campbell Chibougamau Mines, Ltd., Merrill Island, Dore Lake, Quebec, Canada.	63,200,600	63,200,600	June 10, 1952	Dec. —, 1954	4½ years	$0.245.[1]
San Manuel Copper Corp., Pinal County, Ariz.	730,000,000	[3] 695,000,000	Aug. 29, 1952	Mar. —, 1957	10 years	$0.24.[1]
Bagdad Copper Corp., Yavapai County, Ariz.[4]	216,000,000	216,000,000	Oct. 16, 1952	Oct. 15, 1952	do	$0.245.[1]
Subsidy:						
Banner Mining Co., Miser's Chest mine, Hidalgo County, N. Mex.	5,400,000		Mar. 3, 1952	Dec. 1, 1951	2 years	None.[2]
Calumet & Hecla Consolidated Copper Co., 3 mines [5] in Houghton and Keweenaw Counties, Mich.	14,780,000		Jan. 8, 1952	do	12–17 months	Do.[2]
Copper Range Co., Champion No. 4 east ore body, Houghton County, Mich.	6,372,000		Mar. 13, 1952	Jan. 1, 1952	2 years	Do.[2]
Howe Sound Co., Holden mine, Chelan County, Wash.	8,834,000		June 12, 1952	Feb. 1, 1952	1 year	Do.[2]
Sam Knight Mining Lease, Inc., Christmas mine, Gila County, Ariz.	2,390,000		Mar. 14, 1952	Dec. 1, 1951	2 years	Do.[2]
Yucca Mining & Milling Co., Inc., Antler mine, Mohave County, Ariz.	5,205,000		Apr. 10, 1952	do	3 years	Do.[2]
Purchase:						
National Lead Co.,[6] Madison County, Mo.	7,087,500	7,087,500	Oct. 11, 1951	Apr. —, 1953	6½ years	$0.214.[1]
Falconbridge Nickel Mines, Ltd., McKim and Hardy mines, Ontario, Canada.[7]	37,500,000	37,500,000	Feb. 14, 1952	Jan. 1, 1952[8]	10 years	$0.19 or market.[2]
Advance—repayment: North Butte Mining Co., Granite Mountain mine, Silver Bow County, Mont.	5,250,000		Sept. 19, 1951	Dec. —, 1951	21 months	([9]).

Type of contract or assistance, name of contractor and location of project	Approximate amount involved	Effective date of contract
Loan:		
White Pine Copper Co., White Pine mine, Ontonagon County, Mich	$57,185,000	Nov. 15, 1951
San Manuel Copper Co., Pinal County, Ariz	94,000,000	July 10, 1952
Yucca Mining & Milling Co., Antler mine, Mohave County, Ariz	50,000	Oct. 30, 1952
Tax amortization: [10]		
American Smelting & Refining Co., Silver Bell mine, Pima County, Ariz	8,249,000	Jan. 4, 1952
Anaconda Copper Mining Co., Yerington mine, Lyon County, Nev	24,565,000	Oct. 15, 1951
Phelps Dodge Corp., Bisbee East ore body, Cochise County, Ariz	12,401,000	July 6, 1951
White Pine Copper Co., White Pine mine, Ontonagon County, Mich	40,912,000	Nov. 16, 1951
C. L. Maguire, Unida Copper, Yavapai County, Ariz	76,000	June 15, 1951
Kennecott Copper Corp.:		
Deep Ruth mine, White Pine County, Nev	3,988,000	Apr. 4, 1951
Utah mine, Salt Lake County, Utah	3,330,000	May 20, 1952
Do	1,374,000	July 31, 1952
Do	1,946,000	July 6, 1951
Do	670,000	Aug. 3, 1951
Sierra Copper Co., Calaveras County, Calif	670,000	Oct. 9, 1951
Allied Chemical & Dye Co., Grayson County, Va	561,000	Feb. 7, 1952
Telluride Mines, Inc., San Miguel County, Colo		Sept. 21, 1951
American Smelting & Refining Co., Contra Costa County, Calif		June 26, 1951
San Manuel Copper Co., Pinal County, Ariz	64,691,000	Dec. 19, 1951
Anaconda Copper Mining Co., Greater Butte project, Silver Bow County, Mont	3,939,000	May 21, 1952
Bagdad Copper Corp., Yavapai County, Ariz	11,134,000	July 15, 1952

[1] Includes escalator clause.
[2] Contracted at over ceiling price (ceiling price was 24½ cents a pound for most producers).
[3] Also 30,660,000 pounds out of 32,120,000 pounds of molybdenum at $0.60 per pound.
[4] Also 3,760 short tons of molybdenum.
[5] Original contract covered 4 mines, but contract was amended Aug. 11, 1952, to include only 3 mines
[6] Also 9,261,000 pounds of nickel and 6,930,000 pounds of cobalt.
[7] Also 75,000,000 pounds of nickel and 1,500,000 pounds of cobalt.
[8] Date reflects beginning of term of production.
[9] Terms of repayment of $60,000 loan were 1 cent a pound on first 300,000 pounds of contained copper and 2 cents thereafter until repaid with interest but not later than June 30, 1953.
[10] Amortization, 5 years.

Maintenance of production subsidies were granted by DMPA to the following companies in December 1951 and during 1952:

Calumet & Hecla, Inc.—certain properties.
Copper Range Co.—Champion mine.
Sam Knight Mining Lease, Inc.
Yucca Mining & Milling Co.
Banner Mining Co.
Howe Sound Co.

Table 2 was taken from a recent report [3] and brought up to date from records in the office of DMPA.

Bureau of Mines Reports.—The following Bureau of Mines reports of investigations, published recently, relate to copper in whole or in part:

4869. Investigation of the Colorado Copper Co. Properties, Mesa and Montrose Counties, Colo.
4890. Investigation of the Millett Copper Deposit, Iliamna Lake, Southwestern Alaska.
4895. Investigation of Shamrock Copper-Nickel Mine, Jackson County, Oreg.
4906. MacArthur Copper Deposit; Lyon County, Nev.
4927. Concentration Tests on Various Base-Metal Ores.
4945. Processes for Beneficiating Great Gossan Lead Ores, Carroll County, Va.
4952. Preliminary Tests of Nevada Oxidized Copper Ores.

During the year the Bureau of Mines released a comprehensive report on copper, Materials Survey—Copper. It was prepared by the Bureau of Mines, with the cooperation of the Geological Survey, on behalf of the National Security Resources Board. The primary purpose was to provide information about copper for use of Government officials, particularly those concerned with the defense program. The Bureau proposed to correct, revise, and bring the report on copper up to date every few years.

DOMESTIC PRODUCTION

Statistics on copper production may be compiled upon a mine, smelter, or refinery basis. Mine data are most accurate for showing the geographic distribution of production; smelter figures are better than mine figures for showing the actual recovery of metal and more accurate than refinery figures for showing the source of production; and refinery statistics are best for showing recovery of metal but indicate only in a general way the source of crude materials treated.

TABLE 3.—Copper produced from domestic ores, as reported by mines, smelters, and refineries, 1948–52, in short tons

Year	Mine [1]	Smelter	Refinery
1948	834,813	842,477	860,022
1949	752,750	757,931	695,015
1950	909,343	911,352	920,748
1951	928,330	930,774	951,559
1952	925,377	927,365	923,192

[1] Includes Alaska.

[3] Compilation Showing Progress and Status of the Defense Minerals Program, October 10, 1952, 82d Cong., 2d sess. (printed for the use of the Committee on Interior and Insular Affairs), 1952, opposite p. 32.

Mineral Resources of the United States, 1930, part I (pp. 701–702), discusses differences among the three sets of figures.

PRIMARY COPPER

Mine Production.—The figures for mine production are tabulated from reports supplied by all domestic mines that produce copper. These data are classified geographically, by metallurgical method, and by type of ore. Tables presenting the information in detail are to be found in the State chapters appearing in volume III.

As usual, Arizona led all other States by a wide margin in production in 1952, supplying 43 percent of the total for the United States, followed by Utah, with 31 percent. Arizona's output comes from a number of important copper-producing districts and mines, whereas Utah's is predominantly from one mine, the largest copper producer in the United States. Production from New Mexico, Montana, Nevada, and Michigan, ranking next in importance as copper producers in 1952, made up 23 percent of the total. These 6 States produced 97 percent of the United States total in 1952 as in 1951.

Classification of production by mining method shows that approximately 77 percent of the recoverable copper and 85 percent of the copper ore came from open pits in 1952. Most domestic copper ore was treated by flotation at or very near the mine of origin, and the resulting concentrates were shipped for smelting. Some copper ores were direct smelted either because of their high grade or because of their fluxing qualities.

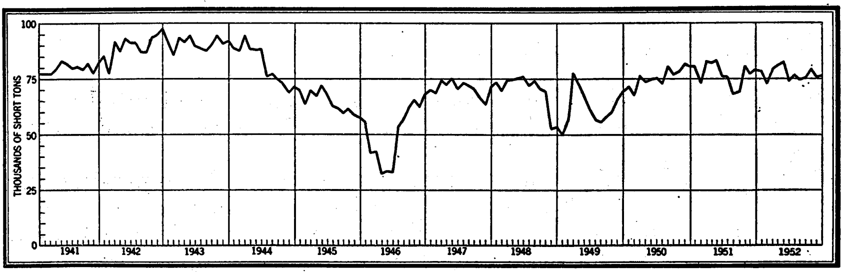

FIGURE 2.—Mine production of recoverable copper in the United States, 1941–52, by months, in short tons.

TABLE 4.—Mine production of recoverable copper in the United States in 1952, by months [1]

Month	Short tons	Month	Short tons
January	78,128	August	74,357
February	73,115	September	75,127
March	79,696	October	79,401
April	80,995	November	75,521
May	82,669	December	75,764
June	74,122		
July	76,482	Total	925,377

[1] Includes Alaska. Monthly figures adjusted to final annual mine production total.

TABLE 5.—Mine production of copper in the principal districts[1] of the United States, 1943–47 (average) and 1948–52, in terms of recoverable copper in short tons

District or region	State	1943–47 (average)	1948	1949	1950	1951	1952
West Mountain (Bingham)	Utah	240,806	225,225	196,101	277,655	270,183	282,098
Copper Mountain (Morenci)	Arizona	107,073	148,316	141,934	154,689	143,921	124,882
Globe-Miami	do	90,810	88,478	80,189	84,688	90,225	93,079
Central (including Santa Rita)	New Mexico	[2] 59,444	[3] 72,784	[3] 53,276	63,694	71,526	74,008
Ajo	Arizona	49,838	55,615	58,350	64,400	63,093	63,808
Summit Valley (Butte)	Montana	90,794	57,712	55,945	53,897	56,826	61,557
Robinson (Ely)	Nevada	52,243	44,491	37,533	52,087	56,198	57,148
Mineral Creek (Ray)	Arizona	23,969	18,753	18,595	36,442	50,580	49,274
Warren (Bisbee)	do	23,540	19,204	9,840	13,345	27,271	27,440
Lake Superior	Michigan	33,087	27,777	19,506	25,608	24,979	21,699
Pioneer (Superior)	Arizona	13,615	18,720	21,616	22,636	17,662	17,716
Eureka (Bagdad)	do	4,993	7,247	7,906	10,673	9,087	9,228
Verde (Jerome)	do	22,268	14,544	17,215	13,291	9,742	4,524
Chelan Lake	Washington	5,170	5,654	[4] 5,249	[4] 4,904	3,932	[5] 4,273
San Juan Mountains	Colorado	969	1,865	1,974	2,582	2,712	3,157
Southeastern Missouri	Missouri	2,332	2,370	3,670	2,982	2,422	2,576
Coeur d'Alene	Idaho	1,283	1,388	1,171	1,896	1,874	1,862
Cochise	Arizona	527	968	689	498	1,350	1,838
Lordsburg	New Mexico	1,793	1,708	1,934	2,061	1,521	1,475
Blackbird	Idaho		8			148	[6] 1,214
Pima (Sierritas, Papago, Twin Buttes).	Arizona	232	268	348	282	334	1,090
Burro Mountain	New Mexico	[7] 1,498	(3)	(3)		(8)	
Lebanon (Cornwall mine)[9]	Pennsylvania	(10)	(10)	(10)	(10)	(10)	(10)
Ducktown[9]	Tennessee	(10)	(10)	(10)	(10)	(10)	(10)
Orange County[9]	Vermont	(10)	(10)	(10)	(10)	(10)	(10)

[1] Districts producing 1,000 short tons or more in any year of the period 1948–52.
[2] Includes average for Burro Mountain for 1945–46 to avoid disclosing individual company operations.
[3] Burro Mountain included with Central to avoid disclosing individual company operations.
[4] Includes Peshastin Creek and Wenatchee to avoid disclosing individual company operations.
[5] Includes Ferry to avoid disclosing individual company operations.
[6] Includes Spring Mountain and Texas to avoid disclosing individual company operations.
[7] Average for 1943–44 and 1947; included with Central for 1945–46 to avoid disclosing individual company operations.
[8] Less than 0.5 ton.
[9] Not listed in order of output.
[10] Figures withheld to avoid disclosing individual company operations.

The first 5 mines in table 7 produced 65 percent of the United States total, the first 10 produced 85 percent, and the entire 25 furnished 98 percent.

Quantity and Estimated Recoverable Content of Copper-Bearing Ores.—Tables 8 through 11 list the quantity and estimated recoverable copper content of the ore produced by copper mines in the United States in 1952. Of the total copper produced from copper ores in the United States during 1952 (1951 percentages were identical), 93 percent was obtained from ores concentrated before smelting, 3 percent from direct-smelting ores, and 4 percent from ore treated by straight leaching.

Close agreement between the output as reported by smelters and the recoverable quantity as reported by mines indicates that estimated recoverable tenor is close to actual recovery. Classification of some of the complex western ores is difficult and more or less arbitrary. "Copper ores" include not only all those that contain 2.5 percent or more recoverable copper but also those that contain less than this percentage if they are valuable chiefly for copper, notably the "porphyry ores." Mines report considerable copper from ores mined primarily for other products. These include siliceous gold and silver ores, lead and zinc ores, and pyritic ores.

TABLE 6.—Mine production of recoverable copper in the United States, 1942–52, with production of maximum year, and cumulative production from earliest record to end of 1952, by States, in short tons

State	Maximum production [1]		Production by years											Total production from earliest record to end of 1952
	Year	Quantity	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	
Western States and Alaska:														
Alaska	1916	59,927	22	27	2	5	2	12	16	4	6	1	--------	685,905
Arizona	1951	415,870	393,387	403,181	358,303	287,203	289,223	366,218	375,121	359,010	403,301	415,870	395,719	13,493,331
California	1909	28,644	1,058	8,762	12,721	6,473	4,240	2,407	481	649	646	921	800	631,728
Colorado	1938	14,171	1,102	1,028	1,048	1,485	1,754	2,150	2,298	2,403	3,141	3,212	3,606	267,521
Idaho	1907	5,445	3,430	2,324	1,688	1,548	1,038	1,640	1,624	1,438	2,107	2,160	3,213	119,969
Montana	1916	176,464	141,194	134,525	118,190	88,506	58,481	57,900	58,252	56,611	54,478	57,406	61,948	6,924,948
Nevada	1942	83,663	83,663	71,068	61,232	52,595	48,616	49,603	45,242	38,058	52,569	56,474	57,537	2,082,151
New Mexico	1942	80,100	80,100	76,163	69,730	56,571	50,191	60,205	74,687	55,388	66,300	73,558	76,112	1,756,449
Oregon	1916	1,791	103	6	3	1	7	14	2	20	19	11	1	12,410
South Dakota	1918	32	1	--------	1	--------	--------	--------	--------	--------	--------	--------	--------	106
Texas	1928	224	99	81	115	55	3	6	23	24	2	1	18	1,383
Utah	1943	323,989	306,691	323,989	282,575	226,376	114,284	266,533	227,007	197,245	278,630	271,086	282,894	6,423,836
Washington	1940	9,612	8,030	7,315	6,169	5,821	4,527	2,240	5,665	5,275	5,057	4,089	4,357	105,609
Wyoming	1900	2,102	--------	--------	--------	--------	1	--------	--------	--------	--------	--------	--------	16,326
Total	--------	--------	1,018,880	1,028,469	911,777	726,639	572,367	808,928	790,418	716,125	866,256	884,789	886,205	32,521,672
West Central States: Missouri	1949	3,670	1,300	1,340	3,302	3,399	1,857	1,760	2,370	3,670	2,982	2,422	2,576	[2] 35,458
States east of the Mississippi:														
Alabama	1907	42	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	(3)
Georgia	1917	465	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	(3)
Maine	1918	383	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	(3)
Maryland	1917	146	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	(3)
Massachusetts	1906	5	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	(3)
Michigan	1916	136,846	45,679	46,764	42,421	30,401	21,663	24,184	27,777	19,506	25,608	24,979	21,699	4,963,243
New Hampshire	1908	[4] 94	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	(3)
North Carolina	1930	(5)	(6)	(6)	(6)	--------	--------	--------	--------	--------	--------	--------	--------	(3)
Pennsylvania	1942	(5)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(3)
South Carolina	(3)	(3)	(7)	(7)	--------	--------	--------	--------	--------	--------	--------	--------	--------	(3)
Tennessee	1930	(5)	[6] 14,174	[6] 13,855	[6] 12,860	[6] 12,385	[6] 12,850	[6] 12,686	[6] 14,248	[6] 13,449	[6] 14,497	[6] 16,140	[6] 14,897	(3)
Vermont	1952	(5)	--------	290	1,898	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(3)
Virginia	1944	291	28	100	291	70	--------	5	--------	--------	--------	--------	--------	(3)
Wisconsin	1914	5	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	--------	(2)
Total	--------	--------	59,881	61,009	57,470	42,856	34,513	36,875	42,025	32,955	40,105	41,119	36,596	[8] 5,618,309
Grand total	1943	1,090,818	1,080,061	1,090,818	972,549	772,894	608,737	847,563	834,813	752,750	909,343	928,330	925,377	[9] 38,175,439

[1] For Missouri and States east of the Mississippi, maximum since 1905.
[2] Small quantity for Wisconsin included with Missouri. [3] Data not available.
[4] The 1908 volume of Mineral Resources credits this figure to Massachusetts and New Hampshire; the 1909 volume credits it to New Hampshire alone.
[5] Figures withheld to avoid disclosing individual company operations.
[6] Tennessee includes other States indicated by footnote 6 to avoid disclosing individual company operations. [7] Less than 0.5 ton.
[8] For States other than Michigan, figures represent largely smelter output. Excludes small quantity, not separable, for Wisconsin shown with Missouri.
[9] Largely smelter production for States east of the Mississippi except Michigan.

TABLE 7.—Twenty-five leading copper-producing mines in the United States in 1952, in order of output

Rank	Mine	District	State	Operator	Source of copper
1	Utah Copper	West Mountain (Bingham)	Utah	Kennecott Copper Corp	Copper ore.
2	Morenci	Copper Mountain (Morenci)	Arizona	Phelps Dodge Corp	Do.
3	Chino	Central	New Mexico	Kennecott Copper Corp	Do.
4	New Cornelia	Ajo	Arizona	Phelph Dodge Corp	Do.
5	Butte Mines	Summit Valley (Butte)	Montana	Anaconda Copper Mining Co	Copper, zinc-lead ores.
6	Ray	Mineral Creek (Ray)	Arizona	Kennecott Copper Corp	Copper ore.
7	Inspiration	Globe-Miami	do	Inspiration Consolidated Copper Co	Do.
8	Ruth Pit	Robinson (Ely)	Nevada	Kennecott Copper Corp	Do.
9	Copper Queen	Warren (Bisbee)	Arizona	Phelps Dodge Corp	Copper, zinc-lead ores.
10	Castle Dome	Globe-Miami	do	Castle Dome Copper Co., Inc	Copper ore.
11	Miami	do	do	Miami Copper Co	Do.
12	Calumet & Hecla, Inc	Lake Superior	Michigan	Calumet & Hecla, Inc	Copper ore and tailings.
13	Magma	Pioneer (Superior)	Arizona	Magma Copper Co	Copper, zinc-copper ores.
14	Morris Brooks Pit	Robinson (Ely)	Nevada	Consolidated Coppermines Corp	Copper ore.
15	Bagdad	Eureka (Bagdad)	Arizona	Bagdad Copper Corp	Do.
16	Ruth Pit Extension	Robinson (Ely)	Nevada	Consolidated Coppermines Corp	Do.
17	Burra Burra, Calloway, Mary, Eureka, Boyd.	Polk County	Tennessee	Tennessee Copper Co	Copper-zinc ore.
18	United Verde	Verde (Jerome)	Arizona	Phelps Dodge Corp	Zinc-copper, copper ores.
19	Holden	Chelan Lake	Washington	Howe Sound Co	Zinc-copper ore.
20	Elizabeth	Orange County	Vermont	Vermont Copper Co., Inc	Copper ore.
21	Cornwall	Lebanon County	Pennsylvania	Bethlehem Steel Co	Magnetite-pyrite-chalcopy rite ore.
22	Quincy	Lake Superior	Michigan	Quincy Mining Co	Copper ore-tailings.
23	Treasury Tunnel-Black Bear	Upper San Miguel	Colorado	Idarado Mining Co	Copper-lead-zinc ore.
24	Republic & Mammoth	Cochise	Arizona	Coronado Copper & Zinc Co	Zinc-copper ore.
25	Bonney-Miser's Chest	Lordsburg	New Mexico	Banner Mining Co	Copper ore.

TABLE 8.—Copper ore, old tailings, etc., sold or treated in the United States in 1952, with copper, gold, and silver content in terms of recoverable metal [1]

State	Ore, old tailings, etc., sold or treated (short tons)	Recoverable metal content				Value of gold and silver per ton of ore
		Copper		Gold (fine ounces)	Silver (fine ounces)	
		Pounds	Percent			
Arizona	44,539,353	731,266,573	0.82	84,439	2,909,567	$0.13
California	1,987	99,100	2.49	312	3,180	6.95
Colorado	73	8,610	5.90	1	251	3.59
Idaho	100,800	2,470,521	1.23	729	7,816	.32
Michigan	3,870,182	43,398,000	.56			
Montana	2,154,657	109,435,315	2.54	3,745	1,541,348	.71
Nevada	6,850,328	114,099,000	.83	59,295	174,357	.33
New Mexico	8,398,600	111,890,896	.67	1,608	85,335	.02
Oregon	89	1,600	.90	83	362	36.33
Texas	111	7,068	3.18	22	206	8.61
Utah	32,038,719	544,668,513	.85	403,321	3,290,788	.53
Washington [2]	553,987	8,650,100	.78	18,924	81,748	1.33
East of the Mississippi (except Michigan) [2]	1,438,606	[3] 29,794,000		403	102,930	
Total	99,947,492	[3] 1,695,789,296	.85	572,882	8,197,888	.27

[1] Excludes copper recovered from precipitates as follows: Arizona, 43,483,108 pounds; California, 177,900 (includes small quantity, not separable from tungsten ore) pounds; Montana, 6,959,260 pounds; Nevada, 391,400 pounds; New Mexico, 38,605,236 pounds; Utah, 17,349,440 pounds.
[2] Includes ore classed as zinc-copper ore and copper, gold and silver recovered therefrom.
[3] Copper from magnetite-pyrite-chalcopyrite ore included with that from copper ores.

TABLE 9.—Copper ore, old tailings, etc., concentrated in the United States in 1952, with content in terms of recoverable copper

State	Ore, old tailings, etc., concentrated (short tons)	Recoverable copper content	
		Pounds	Percent
Arizona	[1] 40,181,312	[2] 614,334,926	0.76
California	1,000	36,000	1.80
Idaho	100,641	2,427,040	1.21
Michigan	3,870,182	43,398,000	.56
Montana	2,105,347	107,539,813	2.55
Nevada	6,762,158	112,248,100	.83
New Mexico	8,257,971	108,861,076	.66
Utah	32,036,100	544,364,650	.85
Washington [3]	553,916	8,647,500	.78
East of the Mississippi (except Michigan)[4]	1,438,606	[5] 29,794,000	
Total	95,307,233	[5] 1,571,651,105	.82

[1] In addition, 3,735,773 tons was treated by straight leaching.
[2] In addition, 65,034,878 pounds of copper was recovered by straight leaching.
[3] Zinc-copper ore.
[4] Includes copper-zinc ore.
[5] Includes copper from magnetite-pyrite-chalcopyrite ore.

TABLE 10.—Copper ore, old tailings, etc., shipped to smelters in the United States in 1952, with content in terms of recoverable copper

State	Ore, old tailings, etc., shipped to smelters		
	Short tons	Recoverable copper content	
		Pounds	Percent
Arizona	622,268	51,896,769	4.17
California	987	63,100	3.20
Colorado	73	8,610	5.90
Idaho	159	43,481	13.67
Montana	49,310	1,895,502	1.92
Nevada	88,170	1,850,900	1.05
New Mexico	140,629	3,029,820	1.08
Oregon	89	1,600	.90
Texas	111	7,068	3.18
Utah	2,619	303,863	5.80
Washington	71	2,600	1.83
Total	904,486	59,103,313	3.27

TABLE 11.—Copper ores [1] produced in the United States, 1943–47 (average) and 1948–52, and average yield in copper, gold, and silver

Year	Smelting ores		Concentrating ores		Total				
	Short tons	Yield in copper (percent)	Short tons [2]	Yield in copper (percent)	Short tons [2] [3]	Yield in copper (percent)	Yield per ton in gold (ounce)	Yield per ton in silver (ounce)	Value per ton in gold and silver
1943–47 (average)	1,276,031	3.61	78,880,371	0.92	83,350,721	0.96	0.0052	0.118	$0.27
1948	877,748	3.78	80,098,098	.89	84,729,043	.92	.0058	.094	.29
1949	645,520	3.46	72,019,010	.89	76,032,531	.91	.0057	.093	.28
1950	624,261	3.37	90,206,169	.88	94,585,792	.89	.0062	.089	.30
1951	776,558	3.63	91,021,243	.87	95,494,214	.90	.0059	.088	.29
1952	904,486	3.27	95,307,233	.82	99,947,492	.85	.0057	.082	.27

[1] Includes old tailings, smelted or retreated, etc.
[2] Includes some ore classed as zinc-copper ore.
[3] Includes copper ore leached.

Smelter Production.—The recovery of copper by smelters in the United States from ores of domestic origin totaled 927,400 short tons in 1952, virtually the same as in 1951 (930,800). Output of United States smelters from domestic ores constituted 51 percent of the world production during 1925–29 but dropped sharply in the succeeding years until 1934, when it was only 17 percent. From 1936 to 1941 it fluctuated between 25 and 33 percent; in 1942–44 it was slightly above 35 percent; and in 1945–52 it ranged from 29 to 35 percent; for 1952 alone it was 30 percent.

The figures for smelter production shown in table 12 are based upon returns from all primary smelters handling copper-bearing materials produced in the United States. Blister copper is accounted for in terms of fine-copper content. Some casting and electrolytic copper produced direct from ore or matte is included in the smelter production, as well as in the refinery output. For Michigan, furnace-refined copper is included. Metallic and cement copper recovered by leaching is included in smelter production.

TABLE 12.—Copper produced (smelter output from domestic ores) in the United States, 1943–47 (average) and 1948–52, and total, 1845–1952

Year	Short tons	Value [1] (thousands of dollars)
1943–47 (average)	868,314	242,567
1948	842,477	365,635
1949	757,931	298,625
1950	911,352	379,122
1951	930,774	450,495
1952	927,365	448,845
Total 1845–1952	38,264,012	11,892,336

[1] Excludes bonus payments of Office of Metals Reserve under Premium Price Plan in effect Feb. 1, 1942, to June 30, 1947.

The quantity and value of copper produced from domestic ores by smelters in the United States are shown by years for 1845–1930 in Mineral Resources of the United States, 1930, part I (p. 703).

Refinery Production.—The refinery output of primary copper in the United States in 1952 was made by 13 plants; 9 of these employed the electrolytic method only, 2 the furnace process on Lake Superior copper, 1 the furnace process on western ores, and 1 both electrolytic and the furnace methods.

Five large electrolytic refineries are on the Atlantic seaboard, 3 Lake refineries on the Great Lakes, and 4 electrolytic refineries west of the Great Lakes—1 at Great Falls, Mont.; 1 at Tacoma, Wash.; 1 at El Paso, Tex.; and 1 at Garfield, Utah. In 1942 fire-refined copper was produced for the first time at the Hurley, N. Mex., plant of the Kennecott Copper Corp.; virtually all of the plant output was treated by this method in 1949. A small part went as blister to electrolytic refineries in 1952. The El Paso plant of the Phelps Dodge Refining Corp. produced fire-refined copper in addition to the electrolytic grade. Of the plants specified above, the Lake refinery of the Copper Range Co., idle since October 9, 1945, was being dismantled in 1952. That of the Quincy Mining Co., idle since 1933, was reopened in the final quarter of 1948 and continued to produce through 1952.

The leaching plant of the Inspiration Consolidated Copper Co. at Inspiration, Ariz., is not, strictly speaking, a refinery, although so listed here; it produces electrolytic copper direct from leaching solutions. At one time all this copper was shipped as cathodes to other refineries, where it was melted and cast into merchant shapes. In 1946, however, over one-third went directly to consuming plants. In 1947 and 1948 the practice was continued on a considerably reduced scale, virtually ceased in 1949, but was resumed in 1950–52.

These 14 plants constitute what commonly are termed "primary refineries." The electrolytic plants, exclusive of that at Inspiration, have a rated capacity of 1,608,000 tons of refined copper a year. They produced at the rate of 74 percent of capacity in 1952.

Tables 13 and 14 show the production of refined copper at primary refining plants, classified according to source of copper, grade, and form in which cast.

TABLE 13.—Primary and secondary copper produced by primary refineries in the United States, 1943–47 (average) and 1948–52, in short tons

	1943–47 (average)	1948	1949	1950	1951	1952
Primary:						
From domestic ores, etc.: [1]						
Electrolytic	745,362	745,102	606,826	821,803	835,419	819,539
Lake	32,405	26,511	17,608	29,555	25,309	21,681
Casting	86,095	88,409	70,581	69,390	90,831	81,972
Total	863,862	860,022	695,015	920,748	951,559	923,192
From foreign ores, etc.: [1]						
Electrolytic	278,727	247,424	232,912	319,086	255,429	254,504
Casting and best select	6,947					
Total refinery production of new copper	1,149,536	1,107,446	927,927	1,239,834	1,206,988	1,177,696
Secondary:						
Electrolytic [2]	124,776	222,602	196,850	173,063	127,347	113,827
Casting	11,260	22,774	15,542	16,683	7,676	8,549
Total secondary	136,036	245,376	212,392	189,746	135,023	122,376
Grand total	1,285,572	1,352,822	1,140,319	1,429,580	1,342,011	1,300,072

[1] The separation of refined copper into metal of domestic and foreign origin is only approximate, as an accurate separation at this stage of manufacture is not possible.
[2] Includes copper reported from foreign scrap.

TABLE 14.—Copper cast in forms at primary refineries in the United States, 1950–52

Form	1950		1951		1952	
	Thousands of short tons	Percent	Thousands of short tons	Percent	Thousands of short tons	Percent
Wire bars	799	56	774	58	767	59
Ingots and ingot bars	111	8	142	11	139	11
Cathodes	189	13	146	11	138	11
Billets	172	12	141	10	137	10
Cakes	130	9	119	9	108	8
Other forms	29	2	20	1	11	1
Total	1,430	100	1,342	100	1,300	100

In addition to the primary refineries, many plants throughout the country operate on scrap exclusively, producing metallic copper and a variety of alloys. The output of these plants is not included in the statements of refined-copper production in tables 13 and 14 but is included in table 16, on secondary-copper production.

Copper Sulfate.—Production and shipments of copper sulfate in 1952 were less than in 1951. Shipments were less than production and stocks at the end of the year increased substantially over those held a year earlier. Of the total shipments of 92,500 tons (104,300 in 1951), producers' reports indicated that 26,100 tons (44,000) were for agricultural, 24,000 (27,000) for industrial, and 42,400 (33,300) for other purposes.

According to a British report, the largest quantities of copper sulfate are used in viticulture and other forms of agriculture. In France, Portugal, and the Mediterranean wine-producing countries, the vinegrowers use it in the form of Bordeaux or Burgandy mixture to spray their vines against mildew. Farmers in these and many other coun-

TABLE 15.—Production, shipments and stocks of copper sulfate in 1943–47 (average) and 1948–52, in short tons

Year	Production		Shipments (gross weight)	Stocks at end of year [1] (gross weight)
	Gross weight	Copper content		
1943–47 (average)	106,820	26,707	100,780	11,440
1948	96,700	24,186	93,100	11,800
1949	79,000	19,749	84,400	6,400
1950	87,300	21,814	91,300	2,200
1951	106,944	26,736	104,260	4,888
1952	94,536	23,634	92,472	6,884

[1] Some small quantities are purchased and used by producing companies, so that the figures given do not balance exactly.

tries spray potatoes to protect them against blight, and a list appended to the report shows many other ways of using copper sulfate on farms in preserving health of plants and animals and in increasing crops. In Greece, Turkey, and Australia it is used in spraying the bushes and vines which provide currants and sultanas. Many thousands of tons are used against leaf spot on banana plantations. In Ceylon, India, and Indonesia it is needed on the tea, coffee, and rubber plantations, and for cocoa in West Africa and coffee in East Africa. In some countries it is used in increasing quantities to counteract deficiency of copper in the soil. It plays an outstanding part in helping to stamp out disease in humans and animals in Egypt and the Sudan, among other places, where it is used to kill the snails that harbor the bilharzia and liver fluke parasites.

In the industrial field, copper sulfate is used by mining companies in many parts of the world as a flotation reagent. It is used in various copper-plating processes. The dyeing industry uses it in a number of processes, the paint industry uses it mainly in antifouling paints, and it is used in coloring glass and china. Timber and woodwork may be protected by a preservative containing copper sulfate, and it may be added to plaster to prevent the spread of dry rot or to cement to reduce too-white glare, also in the manufacture of some rayon yarns and in leather-tanning processes. It helps to preserve fishing nets, keeps reservoirs and swimming pools free from algal growths, and is used in some types of hair dyes as well as in the sachets of some permanent-wave systems.[4]

SECONDARY COPPER

Copper recovered from copper scrap, copper-alloy scrap, and other copper-bearing scrap materials as metal, as copper alloys without separation of the copper, or as copper compounds is known as secondary copper. Quantities are reported in terms of copper content.

Secondary copper is produced from new and from old scrap. "New scrap" is defined as refuse produced during manufacture of copper articles and includes defective finished or semifinished articles that must be reworked. Typical examples of new scrap are defective castings, clippings, punchings, turnings, borings, skimmings, drosses, and slag. "Old scrap" consists of metal articles that have been discarded

[4] British Sulphate of Copper Association, Ltd., Uses of Copper Sulphate: London, E. C. I., 30 pp.

after having been used. Such articles may be worn out, obsolete, or damaged. Typical examples are discarded trolley wire, fired cartridge cases, used pipe, and lithographers' plates.

Table 16 summarizes the production of secondary copper during 1943–52. Refined copper produced from scrap at primary refineries is included in the "unalloyed" class. Detailed information appears in the Secondary Metals—Nonferrous chapter of this volume.

TABLE 16.—Secondary copper produced in the United States, 1943–47 (average) and 1948–52, in short tons

	1943–47 (average)	1948	1949	1950	1951	1952
Copper recovered as unalloyed copper	158, 575	284, 026	250, 089	260, 704	186, 462	173, 904
Copper recovered in alloys [1]	803, 183	688, 762	463, 054	716, 535	745, 820	729, 293
Total secondary copper	961, 758	972, 788	713, 143	977, 239	932, 282	903, 197
From new scrap	503, 527	467, 324	329, 595	492, 028	474, 158	488, 562
From old scrap	458, 231	505, 464	383, 548	485, 211	458, 124	414, 635
Percentage equivalent of domestic mine output	112	117	95	107	100	98

[1] Includes copper in chemicals, as follows: 1943–47 (average), 16,614; 1948, 17,612; 1949, 14,840; 1950, 17,413; 1951, 22,905; 1952, 15,388.

CONSUMPTION

Apparent consumption of primary copper, which includes sporadic copper shipments to the national stockpile, increased 4 percent in 1952. As in 1951, the figures do not give an accurate guide to the quantities of new copper that would have been consumed had adequate supplies been available to fill all needs. Copper was subject to complete allocation in 1952, as in the late months of 1951. Government action in regard to prices made more foreign copper available for use in the latter part of 1952 than had been received in a similar period since World War II and promised easing of the scarce supply situation in 1953.

TABLE 17.—New refined copper withdrawn from total year's supply on domestic account, 1948–52, in short tons

	1948	1949	1950	1951	1952
Production from domestic and foreign ores, etc	1, 107, 446	927, 927	1, 239, 834	1, 206, 988	1, 177, 696
Imports [1]	249, 124	275, 811	317, 363	[2] 238, 972	346, 960
Stock at beginning of year [1]	60, 000	67, 000	61, 000	26, 000	35, 000
Total available supply	1, 416, 570	1, 270, 738	1, 618, 197	[2] 1, 471, 960	1, 559, 656
Copper exported [1]	142, 598	137, 827	144, 561	133, 305	174, 135
Stock at end of year [1]	67, 000	61, 000	26, 000	35, 000	26, 000
Total	209, 598	198, 827	170, 561	168, 305	200, 135
Apparent withdrawals on domestic account [3 4]	1, 214, 000	1, 072, 000	1, 447, 000	[2] 1,304,000	1, 360, 000

[1] May include some copper refined from scrap.
[2] Revised figure.
[3] Adjusted for Office of Metals Reserve stock changes; OMR stocks consigned to national stockpile late in 1948.
[4] Includes copper delivered by industry to the national stockpile.

Figures on apparent consumption of primary copper are available for a long period, whereas compilations on actual consumption of refined copper were begun in 1945. In estimating apparent consumption, it has been assumed that copper used in primary fabrication of copper is consumed. Although the table aims to show primary consumption only, it should be noted that exports and stocks, as well as the import component of "total supply," include some refined secondary copper that cannot be determined separately. Actual consumption of new copper would also differ from the figures shown in the table by changes in consumers' stocks. The figures on apparent consumption in 1947 and 1948 are especially distorted by the fact that during this period unusual quantities of copper were imported as scrap and reexported in refined form. Because refined exports cannot be broken down to show new and old copper, these reexports were necessarily deducted from apparent consumption, even though the scrap from which they were produced was not included in available supply.

Actual consumption of refined copper in 1952 increased 4 percent over 1951 and was the highest since before the end of World War II. Wire mills continued to absorb half of all the refined metal used, with brass mills very closely behind. The distribution in 1952 and in the last months of 1951 was determined by National Production Authority allocations. Unlike table 17, in which all but new copper is eliminated so far as possible, table 18 does not distinguish between new and old copper but covers all copper consumed in refined form.

Some copper precipitates are used directly in the manufacture of paint and other items. The figures may not be shown separately and are not covered by table 18, which relates to refined copper only.

TABLE 18.—Refined copper consumed in 1950–52, by classes of consumers, in short tons

Class of consumer	Cathodes	Wire bars	Ingots and ingot bars	Cakes and slabs	Billets	Other	Total
1950:							
Wire mills	25	695, 817	17, 453	6		53	713, 354
Brass mills	130, 254	67, 379	104, 359	212, 353	160, 754	1	675, 100
Chemical plants	17		110			2, 995	3, 122
Secondary smelters	4, 584	192	1, 155	248		30	6, 209
Foundries and miscellaneous	1, 783	537	18, 198	70	426	5, 635	26, 649
Total	136, 663	763, 925	141, 275	212, 677	161, 180	8, 714	1, 424, 434
1951:							
Wire mills	23	692, 656	17, 311	152		57	710, 199
Brass mills	131, 531	72, 415	124, 614	187, 041	135, 058	308	650, 967
Chemical plants			261			2, 962	3, 223
Secondary smelters	6, 953	375	5, 985	216	4	211	13, 744
Foundries and miscellaneous	5, 890	368	22, 570	302	764	8, 838	38, 732
Total	144, 397	765, 814	170, 741	187, 711	135, 826	12, 376	1, 416, 865
1952:							
Wire mills	11	727, 257	11, 977	209		33	739, 487
Brass mills	134, 613	57, 456	163, 190	185, 138	134, 223	453	675, 073
Chemical plants			279			3, 440	3, 719
Secondary smelters	8, 819	8	13, 203	326		562	22, 918
Foundries and miscellaneous	5, 947	130	23, 953	161	624	7, 720	38, 535
Total	149, 390	784, 851	212, 602	185, 834	134, 847	12, 208	1, 479, 732

STOCKS

Industry stocks of refined and unrefined copper turned upward in 1952 for the first time since 1949.

Year-end producers' inventories of refined copper dropped 26 percent and equaled those held by producers at the end of 1950, the smallest since 1906. Producers' stocks of unrefined copper, however, rose 2 percent over 1951. Of the total stocks at the end of 1952, only 12 percent was in the form of refined copper, the remainder being in smelter shapes at smelters and in transit to refineries and in smelter shapes and materials in process of refining at refineries. Table 19 gives domestic stocks of copper as reported by primary smelting and refining plants. Blister and anode copper in transit from smelters to refineries is included with stocks of blister copper.

TABLE 19.—Stocks of copper at primary smelting and refining plants in the United States at end of year, 1947–52, in short tons

Year	Refined copper [1]	Blister and materials in process of refining [2]	Year	Refined copper [1]	Blister and materials in process of refining [2]
1947	60,000	213,000	1950	26,000	232,000
1948	67,000	183,000	1951	35,000	182,000
1949	61,000	261,000	1952	26,000	185,000

[1] May include some copper refined from scrap.
[2] Includes copper in transit from smelters in the United States to refineries therein.

Fabricators' stocks of refined metal (including in-process copper and primary fabricated shapes), according to the United States Copper Association, were 331,500 tons at the end of 1952, an 18-percent increase over those on hand at the beginning of the year. Working stocks (see table 20) were 292,200 tons, or virtually unchanged from those at the end of 1951. After accounting for unfilled sales of metal, the deficiencies in stocks in relation to unfilled orders dropped 82,300 tons to 203,600 tons at the end of 1952. The latter figure represented the first decrease since 1949 in the deficit in stocks.

Figures compiled by the Copper Institute show that domestic stocks of refined copper decreased from 71,500 tons at the end of 1951 to 58,900 at the end of 1952. Inventory data of the Bureau of Mines and the Copper Institute always differ owing to somewhat different bases. Before 1947, a primary reason was that the Copper Institute coverage was limited to duty-free copper. The inclusion by the Copper Institute of all copper after January 1, 1947, reduced the differences chiefly to the method of handling metal in process of refining (included as refined by Copper Institute and as unrefined by the Bureau of Mines) and to other minor variations in interpretation until May 1951, when the institute's inventory data began to include tonnages delivered to United States consumers at foreign ports. Bureau of Mines figures are on the basis of metal physically held at primary smelting and refining plants in the United States. In the Bureau of Mines classification, cathodes to be used chiefly for casting into shapes are considered stocks in process and not refined stocks.

TABLE 20.—Stocks of copper in fabricators' hands at end of year, 1948–52, in short tons

[United States Copper Association]

	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)
1948	379,346	81,496	295,958	315,944	−151,060
1949	354,992	82,793	285,298	189,407	−36,920
1950	290,241	92,372	288,392	313,052	−218,831
1951	280,402	32,147	295,385	303,050	−285,886
1952	331,499	32,652	292,157	275,608	−203,614

[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) equals column (5).

PRICES

Reports to the Bureau of Mines from copper-selling agencies indicated that 945,000 tons of domestic refined copper was delivered to purchasers in 1952 at an average price (f. o. b. refinery except for that part sold by the Kennecott Sales Corp. whose sales were on the basis of copper delivered to consumers' plants) of 24.2 cents a pound. These figures are to be compared with 998,000 tons and 24.2 cents a pound in 1951 but may not be compared with data for earlier years, which included deliveries of foreign copper to United States buyers. The average price of foreign copper delivered in the United States was 33.4 cents in 1952 and 26.2 in 1951.

Throughout 1952 copper from United States mines continued to be controlled by provisions of the General Ceiling Price Regulation. This order limited prices for individual sellers to the highest prices received between December 19, 1950, and January 25, 1951, inclusive. Most producers sold copper at 24.5 cents a pound delivered Connecticut Valley during the base period, and that average thus repre-

TABLE 21.—Average weighted prices of copper deliveries, f. o. b. refinery, 1933–52 [1]

Year	Cents per pound	Year	Cents per pound
1933	6.4	1943	[2] 11.8
1934	8.0	1944	[2] 11.8
1935	8.3	1945	[2] 11.8
1936	9.2	1946	[2] 14.4
1937	12.1	1947	[2] 20.9
1938	9.8	1948	21.7
1939	10.4	1949	19.7
1940	11.3	1950	20.8
1941	[2] 11.8	1951	[3] 24.2
1942	[2] 11.8	1952	[3] 24.2

[1] Covers copper produced in the United States and delivered here and abroad and copper produced abroad and delivered in the United States; excludes copper both produced and delivered abroad whether or not handled by United States selling agencies.
[2] Excludes deliveries of foreign copper to Metals Reserve Company and bonus payments, applicable from February 1942 to June 30, 1947.
[3] Excludes deliveries of foreign copper to domestic consumers; average price of such deliveries was 26.2 cents per pound in 1951 and 33.4 in 1952. In 1951 and 1952 includes the copper delivered by Kennecott Copper Corp. on a delivered consumers' plant basis.

TABLE 22.—Average monthly quoted prices of electrolytic copper for domestic and export shipments, f. o. b. refineries, in the United States, 1951–52, in cents per pound

Month	1951			1952		
	Domestic f. o. b. refinery [1]	Domestic f. o. b. refinery [2]	Export f. o. b. refinery [2]	Domestic f. o. b. refinery [1]	Domestic f. o. b. refinery [2]	Export f. o. b. refinery [2]
January	24.37	24.200	24.425	24.37	24.200	27.425
February	24.37	24.200	24.425	24.37	24.200	27.425
March	24.37	24.200	24.425	24.37	24.200	27.425
April	24.37	24.200	24.425	24.37	24.200	27.425
May	24.37	24.200	25.471	24.37	24.200	27.908
June	24.37	24.200	27.374	24.37	24.200	34.586
July	24.37	24.200	27.425	24.37	24,200	34.815
August	24.37	24.200	27.425	24.37	24.200	34.904
September	24.37	24.200	27.425	24.37	24.200	34.824
October	24.37	24.200	27.425	24.37	24.200	34.751
November	24.37	24.200	27.425	24.37	24.200	34.681
December	24.37	24.200	27.425	24.37	24.200	34.780
Average for year	24.37	24.200	26.258	24.37	24.200	31.746

[1] American Metal Market.
[2] E&MJ Metal and Mineral Markets.

TABLE 23.—Average yearly quoted prices of electrolytic copper for domestic and export shipments, f. o. b. refineries, in the United States, 1943–52, in cents per pound

	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952
Domestic f. o. b. refinery [1]	11.87	11.87	11.87	13.92	21.15	22.20	19.36	21.46	24.37	24.37
Domestic f. o. b. refinery [2]	11.775	11.775	11.775	13.820	20.958	22.038	19.202	21.235	24.200	24.200
Export f. o. b. refinery [2]	11.700	11.700	11.700	14.791	21.624	22.348	19.421	21.549	26,258	31.746

[1] American Metal Market.
[2] E&MJ Metal and Mineral Markets.

sented the ceiling for most of the domestic copper sold in 1952. Some smaller producers, however, had ceiling prices that were substantially higher than the 24.5-cent level.

The price for Chilean copper, under the agreement between the United States and Chilean Governments, was 27.5 cents a pound delivered Connecticut Valley when the year began, and this was also the price for foreign copper refined in the United States. The Chilean Government and not the large American producing companies operating in Chile received the 3-cent advantage over the price for domestic copper. In the early part of 1952 prices for copper sold in foreign markets were substantially above those in the United States; under the agreement, Chile could withhold for sale in such markets not more than 20 percent of the total produced by the large American companies. Dissatisfaction with the 27.5-cent price caused Chile to abrogate the United States-Chile agreement in May and to embargo exports to the United States; following price action by the United States Government the embargo was lifted before the end of May. In February 1952 a law was passed granting the State (Chile) the right to sell the electrolytic, fire-refined, and blister copper produced by American companies. The Banco Central de Chile was empowered to represent the State as exclusive selling agent, but the bank's practice was to operate through Anaconda and Kennecott sales agencies.

The Office of Defense Mobilization on May 21 authorized importers to pay higher prices for imported metal and to pass on to domestic users 80 percent of increased costs over 27.5 cents, which was revised early in June to the increase over 24.5 cents. Almost immediately the price for Chilean copper advanced to 35.5 cents a pound f. a. s. Chilean ports, or to roughly 36.5 cents in the United States. On June 24 OPS exempted from price control, in Amendment 21 to GOR 9, refined copper imported and copper refined from imported copper-bearing materials and imported scrap purchased after June 16, and Amendment 23 extended the exemption to such copper imported between May 8 and June 16. From late May beyond the end of the year, the Chilean price remained unchanged. Much foreign copper from other countries sold in the United States at below that level.

Meanwhile, to prevent loss of production from high-cost domestic mines, the DMPA granted over-the-ceiling subsidies to producers of copper from such mines. These mines are listed in the section on Defense Production Act Stimulation. In September the Office of Price Stabilization established a 27.5-cent ceiling for Calumet & Hecla, Inc., based on costs of production.

The confusion and dissatisfaction caused by the multiprice situation were great, and most elements in the industry were outspoken in favor of the scrapping of copper price controls. The extreme spread in prices was equivalent to 50 percent of the domestic selling price.

The NPA, in an effort to make the most equitable possible distribution of multipriced supplies, began with the July allocation to allocate domestic and foreign copper to all users on a 60/40 division. Domestic fabricators, whose domestic producing affiliates supplied their needs, through this plan were called upon to fill 40 percent of their needs with foreign copper, and the producing affiliate had to dispose of low-priced domestic copper to a competitive fabricator. Domestic fabricating affiliates of American mining companies producing in Chile, on the other hand, since May 1951 had been absorbing the 3-cent differential in costs between 24.5 and 27.5 cents but during this time were not receiving the higher prices permitted for their Chilean-produced metal. They continued to receive only 24.5 cents for their production but after early June could pass on to consumers 80 percent of increased costs over 24.5 cents.

On February 27 the Office of Price Stabilization issued Order CPR 127, establishing ceiling prices on brass and bronze ingots, effective March 3. The regulation set forth specific ceiling prices for carlots of all the listed alloys of brass and bronze ingot normally produced and made provision for transportation costs and shipping in less than carlots. The regulation obviated the diversity of selling prices that prevailed for these products under the General Ceiling Price Regulation.

In Amendment 2 to Order CPR 46, effective March 12, ceilings were established on dealer-to-dealer sales. The ceilings were identical with those previously provided for other persons. In addition, the action permitted payment of a maximum premium of 1.75 cents per pound on sales between dealers.

On June 30 the OPS issued, effective July 1, Amendments 1 to Ceiling Price Regulations 68 and 110 on brass mill products and wire mill products, respectively, establishing higher prices for these products based on the passing through to the consumer of 80 percent of increases in costs of imported copper over 24.5 cents a pound. The increases usually amounted to 3.84 cents a pound of copper in brass-mill products and, allowing for scrap loss, to 4.25 cents for bare wire and, allowing for scrap loss and insulation, to 3.25 cents for weatherproof wire.

On August 14, Amendment 7 to CPR 60 permitted copper and copper-alloy castings producers to pass on increased costs from use of foreign copper.

SR 125 to GCPR, effective November 24, permitted producers of products in which primary copper was used, and whose ceiling prices were established under GCPR, to adjust their ceiling prices for these products to reflect the increased cost of foreign copper.

The quoted price for export copper, f. o. b. refinery, was 3.225 cents a pound above the domestic quotation from the latter part of May 1951 to late in May 1952. In June the differential was 10.386 cents; it rose to 10.704 in August and was 10.580 in December, averaging 7.546 cents for the year as a whole. E&MJ Metal and Mineral Markets gives the following description of the foregoing prices:

> Our export quotation for copper reflects prices obtaining in the open market and is based on sales in the foreign market reduced to the f.o.b. refinery equivalent, Atlantic seaboard. On f.a.s. transactions we deduct 0.075 cent for lighterage, etc., to arrive at the f.o.b. refinery quotation.

London Price.—The British Ministry of Materials official maximum price was £227 per long ton (equivalent to 28.375 cents a pound) when the year began; it was raised to £231 (28.875 cents), effective April 1, and to £281 (35.125 cents) June 16. In May the British Government announced that it had decided again to base its selling price of metals and other raw materials on New York market prices plus a differential for freight, etc. On June 20 the British Government announced agreement with producers to purchase copper at 33 cents a pound. The British Ministry of Materials price was raised to £287 (35.875 cents) on July 7, reduced to £285 (35.625 cents) on July 31, thereafter remaining unchanged. British purchases from producers were at 33.5 cents a pound f. a. s. New York beginning August 1. Selling prices on the European Continent were reported to be at about this level. Selling prices in foreign markets in 1951 were considerably over those in 1952, but an average world price is not available.

FOREIGN TRADE [5]

Imports of copper advanced 27 percent in 1952; receipts in the second half of the year exceeded those in the first half by 58 percent. The larger quantities made available from abroad, chiefly from Chile, were effective in improving the relationship of United States supplies

[5] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

to requirements in the late months of the year. Most of the larger receipts were in the form of refined copper, with noteworthy quantities coming from infrequent sources of United States supply. The United States continued to be a net importer by a substantial margin, and there were no signs that this situation would change in the foreseeable future.

Much of the foreign copper that entered the country was for refining and exportation or for refining, primary or later fabrication, and exportation. Much of the copper exported could not be measured quantitatively, being in such items as electric motors, automobiles, and equipment of various types.

The excess capacities of domestic smelting and refining facilities for years were used to treat foreign materials, largely for reexport as refined copper in fabricated shapes and in end products. United States smelters and refineries continue to treat foreign crude materials, both purchased and toll copper.

Exports of copper continued subject to export control in 1952; exports of refined copper rose 31 percent, nonetheless, as compared with 1951.

TARIFF

The suspension of the 2-cent excise tax on copper was extended from February 15, 1953, to June 30, 1954, by a bill signed by President Eisenhower on February 14.

IMPORTS

Imports of copper in all unmanufactured forms rose 27 percent above 1951. United States Government action permitting the passing on of most of the increased costs of foreign copper to consumers (see Price section) was chiefly responsible for the greater tonnage that entered the United States. The increase is explained in part also by the diversion of Canadian copper from a labor-struck refinery to an American plant for treatment (see section on Canada). Refined copper increased its dominant position among the import classes, furnishing 56 percent of the total receipts and increasing 45 percent over 1951. Most of the expansion came from Chile, but noteworthy advances were made also in receipts from Yugoslavia, Mexico, and Peru; and there was a substantial quantity from West Germany, which had sent none in 1951 and other recent years. The increase of 14 percent in imports of unrefined copper resulted largely because sharp expansion in entries from Canada, smaller gains from Chile and Yugoslavia, and

TABLE 24.—Copper (unmanufactured) imported into the United States, 1943–47 (average) and 1948–52 [1]

[U. S. Department of Commerce]

Year	Short tons of contained copper	Year	Short tons of contained copper
1943–47 (average)	633,055	1950	690,389
1948	507,449	1951	[2] 489,135
1949	552,709	1952	618,944

[1] Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering country under bond.
[2] Revised figure.

new entries from Turkey more than offset the noteworthy drop in imports from Northern Rhodesia. Imports of concentrates rose slightly with larger quantities from the Philippines, Peru, and the Union of South Africa, more than counterbalancing declines from Cuba, Bolivia, and elsewhere. The small-ore class increased 56 percent in 1952.

Chile supplied 59 percent of the total quantity imported; Canada and Mexico sent 13 and 8 percent, respectively.

TABLE 25.—Copper (unmanufactured) imported into the United States, 1948–52, in short tons, in terms of copper content [1]

[U. S. Department of Commerce]

	Ore	Concentrates	Regulus, black or coarse copper, and cement copper	Unrefined, black, blister, and converter copper in pigs or converter bars	Refined in ingots, plates, or bars	Old and scrap copper, fit only for remanufacture; and scale and clippings	Total
1948	8,197	81,301	3,657	155,836	249,124	9,334	507,449
1949	6,823	108,814	2,084	152,376	275,811	6,801	552,709
1950	2,600	104,168	3,233	224,222	317,363	38,803	690,389
1951							
Australia	4	[2] 713	-	-	-	426	[2] 1,143
Bolivia	219	4,230	-	-	-	-	4,449
Canada	15	24,728	658	135	28,354	664	54,554
Chile	862	11,235	-	47,178	[2] 208,444	633	[2] 268,352
Cuba	58	21,837	-	-	-	407	22,302
Japan	-	-	-	[2] 300	[2] 852	756	[2] 1,908
Malta, Gozo, and Cyprus	-	5,556	-	-	-	-	5,556
Mexico	47	6,378	1,946	38,656	[2] 757	94	[2] 47,878
Northern Rhodesia	-	-	-	[2] 43,717	-	-	[2] 43,717
Peru	818	6,533	440	1,885	377	1	10,054
Philippines	(3)	[3] 12,608	-	-	-	-	12,608
Union of South Africa	-	3,626	-	[2] 3,719	-	8	[2] 7,353
Yugoslavia	-	-	-	6,223	(4)	-	6,223
Other countries	12	147	7	109	188	2,575	3,038
Total	2,035	[2] 97,591	3,051	[2] 141,922	[2] 238,972	5,564	[2] 489,135
1952							
Australia	6	678	-	-	-	-	684
Bolivia	444	2,647	6	-	-	-	3,097
Canada	41	25,577	811	26,463	28,326	762	81,980
Chile	1,592	10,261	481	55,544	294,425	-	362,303
Cuba	233	18,688	-	-	-	1,013	19,934
France	-	-	-	-	-	1,806	1,806
Germany, West	-	-	-	-	8,932	-	8,932
Malta, Gozo, and Cyprus	-	5,441	-	-	-	-	5,441
Mexico	115	6,355	1,804	36,832	5,839	52	50,997
Northern Rhodesia	-	-	-	28,224	1	-	28,225
Peru	557	8,302	794	2	1,662	-	11,317
Philippines	(3)	[3] 14,787	-	-	-	-	14,787
Turkey	-	-	-	3,779	-	-	3,779
Union of South Africa	-	5,251	-	3,326	-	11	8,588
Yugoslavia	-	-	-	8,023	6,810	-	14,833
Other countries	195	204	4	-	965	873	2,241
Total	3,183	98,191	3,900	162,193	346,960	4,517	618,944

[1] Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering the country under bond.
[2] Revised figure.
[3] Some copper in "Ore" and "Other" from Republic of the Philippines is not separately classified and is included with "Concentrates."
[4] Less than 1 ton.

EXPORTS

Most of the copper exported from the United States is in advanced forms of manufacture, in which the copper content in not calculable, and in the form of refined copper. Refined-copper exports increased 31 percent in 1952 and were the largest since 1943. The increase was

TABLE 26.—Copper (unmanufactured) imported into the United States, 1948–52, by countries, in short tons, in terms of copper content [1]

[U. S. Department of Commerce]

Country	1948	1949	1950	1951	1952
Australia	1,570	941	1,307	[2] 1,143	684
Belgium-Luxembourg	59	273	386		646
Bolivia	6,729	4,671	5,220	4,449	3,097
Brazil	1,137	67			
Canada	43,569	82,821	82,365	54,554	81,980
Newfoundland and Labrador	3,698				
Chile	320,703	285,386	292,215	[2] 268,352	362,303
Cuba	16,270	15,849	22,891	22,302	19,934
Ecuador	482	812	640		
France			3,801	1,587	1,806
Germany			44		[3] 8,932
Japan		1,167	54,400	[2] 1,908	223
Malta, Gozo, and Cyprus	2,689	6,888	6,530	5,556	5,441
Mexico	57,593	64,706	62,748	[2] 47,878	50,997
Netherlands	791	234	352	47	41
Northern Rhodesia	[4] 19,061	[4] 27,244	[4] 87,300	[2] 43,717	28,225
Norway			4,098		1
Peru	19,318	22,316	28,502	10,054	11,317
Philippines	2,252	7,969	10,129	12,608	14,787
Turkey		4,572	3,266		3,779
Union of South Africa	5,926	8,919	9,859	[2] 7,353	8,588
United Kingdom	995	1,925	940	6	37
Yugoslavia	2,298	14,727	10,998	6,223	14,833
Other countries	2,309	1,222	2,398	1,398	1,293
Total	507,449	552,709	690,389	[2] 489,135	618,944

[1] Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering the country under bond.
[2] Revised figure.
[3] West Germany.
[4] Tonnages credited to Southern Rhodesia by the U. S. Department of Commerce have been added to Northern Rhodesia, inasmuch as copper of the grades reported does not originate currently in Southern Rhodesia.

due in part to the return to Canada of copper refined in the United States because a Canadian refinery was closed for 18 weeks by a strike. Otherwise large gains in exports to France, Germany, Italy, India, and Switzerland were about double the combined sharp drop in shipments to the United Kingdom and smaller declines for Netherlands and others.

Exports of rods virtually quadrupled, but continued very small in relation to most recent years before 1951.

TABLE 27.—Copper exported from the United States, 1943–47 (average) and 1948–52

[U. S. Department of Commerce]

Year	Ore, concentrates, composition metal, and unrefined copper (copper content)	Refined copper and semimanufactures [1]	Total (except "Other copper manufactures")		Other copper manufactures [1] [2]	Grand total [1]
	Short tons			Value		
1943–47 (average)	282	191,801	192,083	$80,134,117	$1,406,859	$81,540,976
1948	2,473	207,022	209,495	111,313,040	2,249,857	113,562,897
1949	200	195,990	196,190	95,342,124	1,655,349	96,997,473
1950	616	192,339	192,955	86,934,184	1,502,917	88,437,101
1951	234	166,274	166,508	99,011,054	1,982,042	100,993,096
1952	648	212,390	[3] 213,100	[3] 155,690,015	211,201	155,901,216

[1] Due to changes in classifications 1952 data not strictly comparable to earlier years.
[2] Weight not recorded.
[3] Includes 62 tons of copper and copper base alloy powders valued at $73,969; not separately classified before Jan. 1, 1952.

TABLE 28.—Copper exported from the United States, 1948–52, in short tons

[U. S. Department of Commerce]

	Ore, concentrates, composition metal, and unrefined copper (copper content)	Refined in bars, ingots, or other forms	Rods	Old and scrap	Pipes and tubes	Plates and sheets	Wire and cable bare [1]	Wire and cable insulated	Other copper manufactures [1]
1948	2, 473	142, 598	8, 101	2, 266	5, 246	2, 853	10, 694	35, 264	(2)
1949	200	137, 827	12, 678	8, 284	3, 344	1, 088	7, 881	24, 888	(2)
1950	616	144, 561	10, 073	9, 445	1, 988	581	7, 009	18, 682	(2)
1951	234	133, 305	521	7, 701	2, 160	572	7, 983	14, 032	(2)
1952									
Argentina	----------	----------	(3)	----------	85	1	5	240	
Australia	----------	166	----------	----------	8	(3)	29	148	
Austria	----------	1, 356	17	884	1	4	----------	11	
Brazil	----------	5, 496	1	----------	91	17	272	503	
Canada	1	12, 884	127	1, 314	497	70	1, 428	1, 788	
Canal Zone	----------	----------	(3)	----------	17	2	58	719	
Chile	----------	(3)	8	----------	4	12	44	638	
Colombia	----------	6	3	----------	94	88	148	834	
Cuba	----------	2	8	----------	439	28	185	885	
Denmark	----------	1, 447	560	----------	6	----------	200	84	
France	----------	35, 573	1	50	(3)	(3)	6	419	
Germany, West	----------	20, 447	----------	3, 827	(3)	----------	----------	2	
Greece	----------	9	----------	----------	9	(3)	282	360	
India	----------	6, 243	3	222	40	1	188	130	
Indochina	----------	----------	----------	----------	3	----------	1	562	
Indonesia	----------	174	(3)	----------	13	10	255	186	
Israel	----------	42	5	----------	33	74	80	284	
Italy	----------	17, 040	----------	2, 398	7	----------	693	193	
Japan	----------	365	----------	1	9	(3)	225	150	
Mexico	646	51	62	(3)	400	125	227	594	(2)
Netherlands	----------	5, 994	1, 092	----------	209	(3)	----------	201	
Netherlands Antilles	----------	12	1	----------	16	1	3	92	
Norway	----------	1, 674	----------	----------	18	----------	111	216	
Pakistan	----------	959	2	31	26	2	172	7	
Peru	----------	1	2	----------	81	21	158	484	
Philippines	----------	5	3	----------	81	14	251	1, 551	
Portugal	----------	771	----------	----------	5	2	2	95	
Saudi Arabia	----------	----------	1	----------	21	6	25	380	
Spain	----------	2, 352	----------	164	5	----------	54	8	

Sweden		2,242	28		6		(3)	25	
Switzerland		9,562			3	(3)		3	
Taiwan			1		3	2	52	163	
Turkey		(3)			5		24	704	
Union of South Africa					14	1	1,071	304	
United Kingdom	1	48,116			(3)	(3)	(3)	26	
Uruguay		95			16	2	22	62	
Venezuela		3	3		182	17	200	2,479	
Other countries		1,048	9	50	144	53	692	1,540	
Total: Short tons	648	174,135	1,937	8,941	2,591	553	7,163	17,070	(2)
Value	$494,930	$119,651,433	$1,257,908	$3,937,467	$3,120,143	$605,498	$4,756,608	$21,792,059	[4] $285,170

[1] Due to changes in classifications 1952 data not strictly comparable to earlier years.
[2] Weight not recorded.
[3] Less than 1 ton.
[4] Includes copper and copper base alloy powders valued at $73,969 (62 tons); not separately classified before Jan. 1, 1952.

TABLE 29.—Unfabricated brass (ingots, bars, rods, shapes, plates, and sheets) exported from the United States, 1947–52

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1947	12,622	$7,640,678	1950	2,334	$1,694,488
1948	6,395	4,499,160	1951	[1] 3,820	2,951,881
1949	4,287	3,080,509	1952 [2]	5,514	5,424,662

[1] Revised figure.
[2] Due to changes in classifications data not strictly comparable to earlier years.

TABLE 30.—Brass and bronze exported from the United States, 1951–52, by classes

[U. S. Department of Commerce]

Class	1951		1952	
	Short tons	Value	Short tons	Value
Ingots [1]	2,077	$1,299,044	2,377	$1,944,895
Scrap and old [1]	4,857	2,090,573	6,261	2,359,726
Bars, rods, and shapes [1]	914	865,660	2,212	2,370,947
Plates and sheets [1]	[2] 829	787,177	925	1,108,820
Pipes and tubes	1,458	1,679,240	1,400	1,817,425
Pipe fittings	707	1,571,038	726	1,665,206
Plumbers' brass goods	2,242	5,770,986	(3)	5,247,885
Wire of brass or bronze [1]	1,446	1,959,620	1,532	2,337,592
Hardware of brass or bronze [1]	(4)	924,366	(4)	2,165,787
Other brass or bronze manufactures [1]	(4)	5,792,815	(4)	1,034,570
Total	(4)	22,740,519	(4)	22,052,853

[1] Due to changes in classifications 1952 data not strictly comparable to earlier years.
[2] Revised figure.
[3] Weight not recorded January through June; July through December 1,138 tons valued at $2,841,383.
[4] Weight not recorded.

TABLE 31.—Copper sulfate (blue vitriol) exported from the United States, 1947–52

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1947	34,021	$4,099,551	1950	30,149	$4,151,265
1948	42,135	6,514,960	1951	43,129	8,753,641
1949	31,717	4,320,726	1952	43,421	8,482,870

TECHNOLOGY

A progress report on experimental work on geochemical prospecting for copper in semiarid regions was recently published.[6] Results showed a marked increase of copper in plants and soil over the ore body as compared with samples taken from areas beyond the limits of mineralization. On the other hand, the copper content of trees growing in the stream bed below the ore body was lower than expected.

[6] Clarke, Otis M., Jr., Geochemical Prospecting for Copper at Ray, Ariz.: Econ. Geol., vol. 48, No. 1, January–February 1953, pp. 39–45.

An article on the Holden mine, Washington, was abstracted by the authors as follows:[7]

The Holden mine produces copper, gold, and zinc from a shear zone-replacement deposit in which the control of mineralization was primarily structural. Selective replacement of a sheared siliceous amphibole schist host rock was a contributing factor. Two stages of mineralization are recognized. The ore body has been severely intruded by post-ore plutonics of a dioritic nature. No serious displacements of the economic portion of the mineralized zone have occurred.

Recent experiments in Tennessee[8] indicated that there was a place in the blast-hole drilling program for the 2⅛-inch carbide insert bit where the diamond-bit penetration was 75 feet or less per use, where excessive length of hole was not required, and where a 2-man crew was necessary because the working place was remote from other crews. The findings were reported to indicate also that it was safer to operate a deep-hole percussion drill than a high-speed diamond drill.

According to a recent report,[9] a new versatile mobile drill unit developed and tested at the Utah Copper pit, Utah, resulted in an improvement of 233 percent in drill performance.

Another article[10] stated that a mechanized method of placing concrete for underground supports had been introduced in Africa.

A recent article[11] gave the output from the open-pit operations of the Bagdad Copper Corp., Ariz., as 3,700 tons of ore a day. It described the Bagdad operation.

Open-pit operations at Ray, Ariz., until recently operated by under ground mining methods only were the subject of an article.[12]

At the mine of the Miami Copper Co. two new developments were adapted to the block-caving method in use.[13] One was an integrated system of slusher and conveyor levels to replace the full-gravity system of raises that transferred ore from caving blocks to haulage levels. The other was the use of circular and conventional steel sets for the support of level openings subject to the moving ground pressures developed beneath active blocks.

The program of the International Nickel Co. of Canada, Ltd., according to the 1952 Annual Report to Stockholders, calls for eventual production and treatment of 13,000,000 tons of ore from underground mines. A low-cost adaptation of block caving at the Creighton mine, by which great masses of ore are induced to disintegrate by their own weight, is one factor making the program possible. At the Frood section of the Frood-Stobie mine, another low-cost bulk-mining technique called the "blast-hole" method became the principal method of mining. This method differs from "induced caving" only insofar as explosives are used to break the ore.

The underground methods at International were reviewed.[14]

---

[7] Youngberg, Elton A. and Wilson, Thomas L., The Geology of the Holden Mine: Econ. Geol., vol. 47, No. 1, January–February 1952, 12 pp.

[8] Flournoy, Ezell, Blast-Hole Drilling at the Tennessee Copper Co.: Min. Cong. Jour., vol. 39, No. 4, April 1953, pp. 78–80, 111.

[9] Pett, L. F., and Snow, L. E., The Mobile Drill Unit in Use at the Utah Copper Pit: Min. Eng., vol. 4, No. 8, August 1952, pp. 799–803.

[10] Mining Journal, (London), Pneumatic Concrete Placing at Nchanga Consolidated Copper Mines: Vol. 240, No. 6134, March 13, 1953, p. 304.

[11] Hondrum, Olaf, Mining Copper at Bagdad, Arizona: Explosives Eng., vol. 30, No. 5, September-October 1952, pp. 143–145, 160.

[12] Mining World, Copper's Newest Big Open Pit: Vol. 15, No. 1, January 1953, pp. 26–30.

[13] Mining World, Miami Block Caving Developments: Vol. 14, No. 11, October 1952, pp. 26–30.

[14] Mutz, H. J., Brock, A. F., and Taylor, W. J., Underground Mining Methods at International Co.: Min. Eng., vol. 5, No. 1, January 1953, pp. 57–82.

Improvements at the mills of the Utah Copper Division, Kennecott Copper Corp., were recently described.[15] The new flotation system, under construction when the article was written, comprised new and larger flotation machines, as well as flowsheet revisions resulting from several years of research aimed at increased recovery.

The hydrometallurgy of copper was described in a recent book,[16] which covered process and plant descriptions and gave operating data, facts on equipment and materials of construction, and other information. The book describes the chemistry of leaching and includes a study of the history, cost, and future of the leaching process. It states that the future probably will see even greater dependence on leaching techniques than at present. It states further:

All one can be sure of in discussing the future of leaching is that new techniques are going to be worked out over the next few years that would have been dismissed as fantastic by the metallurgists of yesterday. Here are some examples of present trends:

It seems likely that sulfide copper ores can be leached with ammonia, as native copper ores are now. H. A. Tobelmann, consulting metallurgist, has done considerable work on this problem and feels that it may be solved one day. Prof. F. A. Forward, of the University of British Columbia, has worked out a process for dissolution of chalcocite with ammonia-leach solutions, and attempts are being made to apply the process commercially. It has been found possible to leach cobalt ores with ammonia and at the time this was being written, a full-scale project using this process was under development. There are problems, such as the requirement that the pulp be digested in an autoclave at high pressure and temperature, but the prospect of finding a solution using this technique is an inviting one. * * * (re other metals).

The flowsheet of the new plant of Nchanga Consolidated Coppermines, Ltd., was discussed.[17] The flotation section yields a sulfide concentrate which goes to the smelter and an oxide concentrate containing 15 to 20 percent copper, of which 3 to 4 percent is in the form of sulfides. The leaching process extracts virtually all of the copper contained in the oxides, but the sulfide sludge must be treated by secondary flotation.

In July 1949 the Cyprus Mines Corp., Cyprus, decided to investigate the possibilities of acid-leaching pyritic Mavrovouni ore to recover basic copper sulfates, insoluble in water, which were not recoverable in the existing flotation plant.[18] Following investigations, construction of a plant was begun June 1, 1950. The process consists of leaching 2,000 long tons per 24 hours of minus-½-inch raw Mavrovouni ore with 4-percent sulfuric acid containing 2 grams per liter of ferric iron, separating the leached material into sand and slime portions, and washing the sand portion in 4 countercurrent classifiers and the slime in 4 countercurrent thickeners. The combined washed sand and slime go to the existing grinding and flotation plant and the pregnant solution to iron cementation for recovery of the dissolved copper. The process is claimed to have been responsible for a noteworthy increase in recovery of copper.

[15] Corfield, R. J., and Johnson, A. G., Electrical and Metallurgical Improvements at Kennecott's Utah Copper Division Mills: Min. Eng., vol. 5, No. 3, March 1953, pp. 274–276.

[16] Van Arsdale, Geo. D., Hydrometallurgy of Base Metals: McGraw-Hill Book Co., Inc., New York, Toronto, London, 1953, 370 pp.

[17] Engineering and Mining Journal, Nchanga's New Copper Leach Plant: Vol. 153, No. 8, August 1952, p. 93.

[18] Schlechten, A. W., and Bruce, J. L., New Acid-Leaching Section Raises Cyprus Copper Recovery by 10 percent: Eng. and Min. Jour., vol. 153, No. 12, December 1952, pp. 88–91

A new process was developed and proposed for treating ores from the mine of the Kilembe Mines, Ltd.[19] Some of the ore was to be concentrated and some mixed with the flotation concentrate to make a feed of 650 tons per day for the Dorrco fluosolid roasters. The soluble copper and cobalt oxides were then to be leached from the roasted material, and electrolytic copper to be deposited from the solution.

Waste-dump leaching at the Chino Mines Division, Kennecott Copper Corp., was the subject of an article recently published.[20]

Investigation of the treatment of Greater Butte project (Kelley), Montana, ore showed the desirability of using sponge iron as a precipitant for the copper in solution resulting from desliming of the ore in a dilute sulfuric acid solution. Production of sponge iron at Anaconda was the subject of a recent report.[21]

An article [22] on new FluoSolids experience discussed sulfatizing of the base metals, among other things. It stated:

> FluoSolids may be described as a radically new metallurgical process by which reactions between gases and solids can be more readily accomplished at elevated temperatures and at accelerated rates previously not possible. The process is finding application in many fields, but a typical operation is the roasting of sulphide ores or concentrates to produce strong SO_2 gas and, at the same time, a calcine containing less than one percent sulphide sulphur and less than two percent total sulphur. The technique requires that the solids, to be reacted, be fluidized or partially suspended by an upward moving gas stream. When so fluidized, they are in a state of violent agitation and evenly distributed throughout the fluid bed. Fluidized solids in this state obey many of the laws of hydraulics and are efficient heat transfer systems. Close regulation of feed gas rate and temperature is possible.

Production at the Garfield smelter of the American Smelting & Refining Co., Utah, was described.[23]

Oxygen flash smelting of copper concentrates, in which all smelting heat requirements are met by reacting the concentrates with oxygen, was carried out on a commercial basis at Copper Cliff, Canada.[24] Several problems encountered in this new method of smelting are under continuing study. Large-scale production of liquid sulfur dioxide, obtained as a byproduct of the oxygen flash smelting of concentrates, was initiated in 1952. Notes on the process were recently published.[25]

Experiments in connection with treatment of copper-roaster reverberatory flue dust were the subject of a paper read at a local meeting of the American Institute of Mining and Metallurgical Engineers in Spokane, Wash., and later published.[26] The results were summarized as follows:

> Leaching tests were conducted in order to effect an extraction of copper and lead from flue dust and recover the two metals. A sulfatizing roast followed by an acid leach extracted the copper but the lead was unaffected. Chloridized roasting followed by acid-brine leach gave excellent extraction of both copper and lead.

[19] Mining World, Production at Kilembe Copper-Cobalt Mine Scheduled to Start in 1955: Vol. 14, No. 12, November 1952, p. 60.
[20] Goodrich, W. H., Waste-Dump Leaching at the Chino Mines Division, Kennecott Copper Corporation, Santa Rita, N. Mex.: Mines Mag., vol. 42, No. 3, March 1952, pp. 65–67.
[21] Frick, Frederick F., Sponge Iron at Anaconda: Min. Eng. vol. 5, No. 1, January 1953, pp. 83–84.
[22] Copeland, G. G., New FluoSolids Experience: Min. Cong. Jour., vol. 38, No. 3, March 1952, pp. 42–44, 54.
[23] Thompson, R., Production at Garfield World's Largest Copper Smelter: Jour. Metals, vol. 4, No. 5, May 1952, pp. 456-459.
[24] International Nickel Co. of Canada, Ltd., Annual Report to Stockholders, 1952.
[25] Mining Magazine, Sulphur Recovery at Copper Cliff: Vol. 86, No. 5, May 1952, pp. 315–316.
[26] Kroha, A. J., and Finley, J. A., Treatment of Copper Roaster Reverberatory Flue Dust: Mines Mag., vol. 42, No. 7, July 1952, pp. 40–42.

Flotation tests showed high reagent consumption for cement copper and sulfide copper and necessitated an additional circuit for recovery of oxidized copper and lead. This work was not completed and does not permit any generalized conclusions. Summary tables are included at the end of this report.

Operations at the White Pine mine, Michigan, being brought to the production stage with Government aid (see Defense Production Act Stimulation) were to consist of mining, milling, and smelting, with the final product fire-refined copper. The entire operation was the subject of a report published in January 1953.[27]

The general flowsheet at the El Paso, Tex., refinery and descriptions of the plant layout, operations involved, and equipment used, were included in an article published in 1952.[28]

A new chemical method of refining consists, according to a recent article,[29] of pressure leaching of unroasted sulfide ore concentrates, an almost simultaneous oxidation step, and then direct reduction from aqueous solution of copper or other metal as pure metallic powders. When the article was published three plants using the process were under construction, that is, the nickel refinery of Sherritt Gordon Mines, Ltd., near Edmonton, Alberta, Canada; the plant of the National Lead Co. at Fredericktown, Mo.; and the cobalt refinery of the Howe Sound Mining Co. near Salt Lake City, Utah.

A new copper alloy that may partly replace copper-beryllium alloys was recently described.[30] The alloy contains 10 percent nickel, 1.5 percent silicon, and 4 percent aluminum. It was said to be particularly effective for electrical contact springs in large accounting and billing machines. Properties included good electrical conductivity, corrosion resistance, and springiness.

The use of beryllium-copper for large machine parts was the subject of an article published during the year.[31]

Small percentages of copper increase strength and hardness and reduce ductility of ductile iron in the "as cast" condition, according to a recent report.[32] It was said to be a disadvantage in castings which must meet minimum elongation or optimum machining requirements. It helped where strength and wear resistance were needed.

The Electrical World of July 14 contained several articles on the use of aluminum as a substitute for copper.[33] Other articles on the same general subject were also published in 1952.[34]

---

[27] Ramsey, R. H., White Pine Copper: Eng. and Min. Jour., vol. 154, No. 1, January 1953, pp. 72–87.

[28] Kunkle, B. B., El Paso Refinery of Phelps Dodge Refinery Corp.: Mines Mag., vol. 42, No. 7, July 1952, pp. 25–29, 59.

[29] Chemical Engineering, Chemical Refining of Metals: Vol. 59, No. 6, June 1952, pp. 164–168, 368, 370, 372–374, 376.

[30] Abs. in American Metal Market, New Copper Alloy with 10 Percent Nickel, 4 Percent Aluminum for Contact Springs: Vol. 60, No. 57, Mar. 27, 1953, pp. 1, 7.

[31] Richards, John T., Beryllium-Copper Useful for Large Machine Parts: Materials & Methods, vol. 35, No. 6, June 1952, pp. 97–99.

[32] Neemes, J. C., Ductile Iron-Watch Copper Buildup: Iron Age, vol. 171, No. 6, February 5, 1953, pp. 162–164.

[33] Hickernell, L. F., and Carter, L. L., Let's Use Aluminum, Not Abuse It! Elec. World, vol. 138, No. 2, July 14, 1952, pp. 123–126.
All-Aluminum Use Climbs Cautiously: Pp. 127–128.
Rogoff, J., and Matthysse, I., Making Connections in Underground Aluminum Cable: Pp. 129–132.
Avila, C. F., Boston Edison Installs First 15-Kv. Aluminum Underground Cable: Pp. 133–136.
Hayward, J. P., Wanted: Information on Aluminum Connections: Pp. 137–138.
Bergan, M. D., The What, Why, and How of Connections for Aluminum: Pp. 139–142.

[34] Holmes, J. R., The Aluminum Auto Radiator: Modern Metals, vol. 9, No. 5, June 1952, pp. 33–34.
Everhart, John L., Copper-Clad Aluminum Can Conserve Copper in Many Uses: Materials & Methods, vol. 35, No. 2, February 1952, pp. 82–85.

WORLD REVIEW

World mine production in 1952 virtually coincided with the record high rate established in 1943 and was 4 percent higher than in 1951. Northern Rhodesia and Belgian Congo contributed to the attainment of the new high tonnages, both countries having reached new tops for the third successive year. Otherwise, production in Canada, Chile, and the United States, other leading copper-producing countries, fell below records established in earlier years; the record for Chile was in 1944, for Canada in 1940, and for the United States in 1943. Available data indicate that the U. S. S. R. produced more copper than ever before in 1952.

Angola.—The only copper producer is the Mavoio deposit in the northwestern part of the Territory. Ore production in 1952 was 11,700 metric tons (10,100 in 1951), and blister production was 1,000 tons (1,100) and copper matte 200 (100) tons. Exports go to Portugal, presumably for the manufacture of insecticides. The Empresa do Cobre de Angola has the concession to search for copper and most other minerals in an area of approximately 59,000 square kilometers, bounded on the north by Belgian Congo and reported believed to be a favorable area for finding copper. The company has contracted with a Canadian company to make an aerial and ground survey as a beginning to systematic exploitation of the concession.[35]

Australia.—Smelter output rose from 13,000 tons in 1951 to 17,000 in 1952. Better supplies of coke at the Mount Lyell, Tasmania, mine, made possible higher production there. The Mount Morgan, Queensland, mine also expanded production, and further expansions at both properties were anticipated. The new copper-concentrating mill and smelter at Mount Isa Mines, Ltd., Queensland, were completed during the year and had begun operation before the year end. Reserves thus far were said to be 3,000,000 tons of ore averaging 4 percent copper. The new operation was expected to add 18,000 tons to production in Australia, to be offset in part by closing in the latter part of the year of the New Occidental Gold Mines, most important producer in New South Wales.[36]

Belgian Congo.—Production continued the uptrend in progress since 1949 and established a new high record for the third successive year. The Union Minière du Haut Katanga produced the following quantities of ores and metals (comparison with 1951 in parentheses): 205,700 (192,000) metric tons of copper, 6,800 (5,700) tons of cobalt, 189,400 (154,000) tons of zinc concentrates, 20,500 (24,300) kilograms of cadmium, and an undetermined quantity of uranium–radium ores. In the course of the treatment of its copper and other products by the Société Générale Métallurgique de Hoboken, Belgium, 147,000 (118,000) kilograms of silver, 54 (14.7) kilograms of gold, and small quantities of palladium and platinum were recovered.

A comprehensive report on the concentrating operations of the Union Minière du Haut Katanga, but having to do chiefly with concentration of oxide ores by flotation, was prepared during the year. There are large concentrating mills at Panda (Jadotville), Kipushi, and Kolwezi. From the beginning of mining, washers have been

[35] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 2, August 1953, p. 9.
[36] Mining Journal (London), Australia: Ann. Rev. No., 1953 ed., May 1953, p. 149.

TABLE 32.—World mine production of copper, 1947–52, in metric tons [1]

[Compiled by Pauline Roberts]

Country	1947	1948	1949	1950	1951	1952
North America:						
Canada	208,750	222,513	239,003	239,685	244,912	233,787
Cuba	13,729	16,300	17,400	20,400	19,700	17,900
Mexico	64,811	59,076	57,246	61,699	67,351	58,463
United States	768,892	757,326	682,880	824,938	842,162	839,484
Total North America	1,056,182	1,055,215	996,529	1,146,722	1,174,125	1,149,634
South America:						
Bolivia [2]	6,241	6,616	5,074	4,704	4,846	4,703
Chile	426,671	444,967	371,095	362,757	379,726	404,742
Ecuador	166	474	704	526	2	----------
Peru	22,492	18,068	27,959	30,275	32,304	31,179
Total South America	455,570	470,125	404,832	398,262	416,878	440,624
Europe:						
Austria	259	982	1,296	1,635	1,838	2,643
Finland	15,409	18,384	18,741	15,600	18,400	22,000
France	386	458	524	(3)	(3)	(3)
Germany:						
East	[4] 17,500 (East and West)	(3)	(3)	(3)	(3)	(3)
West		[5] 364	864	1,360	1,669	2,352
Hungary	[4] 300	(3)	(3)	[4] 400	(3)	(3)
Italy	133	30	14	49	144	144
Norway	14,707	15,112	14,875	15,621	14,003	14,600
Spain [6] [7]	6,454	5,503	6,702	6,171	7,560	8,977
Sweden	13,144	14,835	16,273	16,100	14,447	15,876
U. S. S. R. [4] [8] [9]	165,000	180,000	200,000	218,000	254,000	295,000
Yugoslavia [9]	32,350	36,870	34,384	40,080	32,011	32,819
Total Europe [4] [8]	266,000	287,000	308,000	330,000	360,000	410,000
Asia						
China [9]	915	472	1,874	[4] 4,000	[4] 6,000	[4] 6,000
Cyprus [2]	12,681	15,735	23,936	23,301	22,811	26,820
India	5,462	6,316	6,305	7,000	7,388	6,523
Japan	21,468	25,752	32,880	39,432	42,756	53,184
Korea, Republic of	389	66	28	27	6	500
Philippines	2,502	3,350	7,007	10,384	12,712	13,241
Saudi Arabia	253	67	49	41	(3)	(3)
Taiwan (Formosa)	(3)	1,183	(3)	(3)	(3)	(3)
Turkey	11,800	12,300	13,130	13,300	11,850	23,097
U. S. S. R.	(8)	(8)	(8)	(8)	(8)	(8)
Total Asia [4] [8] [10]	55,000	65,000	86,000	99,000	105,000	130,000
frica:						
Algeria	----------	----------	----------	81	120	52
Angola	28	394	742	1,279	1,100	1,000
Belgian Congo [9]	150,840	155,481	141,399	175,920	191,959	205,749
French Morocco	49	518	360	18	28	808
Northern Rhodesia	197,288	226,472	259,084	297,487	319,373	329,481
Southern Rhodesia	174	131	80	117	95	109
South-West Africa	[4] 3,100	8,270	9,622	10,961	12,355	14,022
Tanganyika [11]	----------	----------	----------	37	137	21
Union of South Africa	29,330	29,450	30,454	33,982	33,731	35,112
Total Africa	[4] 380,800	420,716	441,741	519,882	558,898	586,354
Australia	13,334	12,567	13,678	15,144	16,874	18,636
World total [4] [10]	2,225,000	2,310,000	2,250,000	2,510,000	2,630,000	2,735,000

[1] This table incorporates a number of revisions of data published in previous copper chapters.
[2] Copper content of exports.
[3] Data not available; estimate by authors of chapter included in continental and world totals.
[4] Approximate production.
[5] American and British zones only.
[6] According to Yearbook of American Bureau of Metal Statistics.
[7] Does not include content of iron pyrites, the copper content of which may or may not be recovered.
[8] Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.
[9] Smelter production.
[10] Includes estimates for Burma.
[11] Copper content of exports and local sales.

TABLE 33.—World smelter production of copper, 1947–52, in metric tons [1]

[Compiled by Pauline Roberts]

Country	1947	1948	1949	1950	1951	1952
North America:						
Canada	179,997	200,736	205,098	216,094	222,682	178,659
Mexico	58,475	48,761	49,359	48,477	59,241	51,167
United States [2]	857,007	839,550	779,842	914,917	940,416	929,340
Total North America	1,095,479	1,089,047	1,034,299	1,179,488	1,222,339	1,159,166
South America:						
Chile	408,400	424,910	350,737	345,460	360,099	383,283
Peru	17,824	11,824	21,119	23,227	24,351	20,539
Total South America	426,224	436,734	371,856	368,687	384,450	403,822
Europe:						
Austria	378	2,143	3,761	5,369	6,450	6,438
Finland	21,087	20,672	18,224	13,572	17,851	18,317
France [3]	318	277	(4)	(4)	(4)	(4)
Germany:						
East	(4)	(4)	(4)	(4)	28,700	(4)
West [5]	[6] 32,016	[6] 62,244	145,536	202,500	212,868	194,784
Italy	105	167	30	18	185	190
Norway	7,920	8,935	9,306	9,035	8,656	10,002
Spain	5,971	5,069	6,155	5,211	5,122	6,249
Sweden	14,258	17,180	14,359	16,708	14,411	16,239
U. S. S. R. [7] [8]	165,000	180,000	200,000	218,000	254,000	295,000
Yugoslavia	32,350	36,870	34,384	40,080	32,011	32,819
Total Europe [7] [8] [9]	295,000	350,000	445,000	530,000	580,000	605,000
Asia:						
China [5]	915	472	1,874	[7] 4,000	[7] 6,000	[7] 6,000
India	6,026	5,957	6,493	6,720	7,197	6,176
Japan	28,812	29,124	38,544	37,176	43,848	49,308
Korea:						
Republic of	392	642	372	17	222	34
North	[7] 3,000	(4)	(4)	(4)	(4)	(4)
Taiwan (Formosa)	456	575	465	360	[7] 629	720
Turkey	10,080	10,979	11,283	11,700	16,445	23,330
Total Asia [7] [8]	50,000	50,000	61,000	62,000	75,000	86,000
Africa:						
Angola			800	1,375	1,157	1,039
Belgian Congo	150,840	155,481	141,399	175,920	191,959	205,749
Northern Rhodesia	195,866	217,044	263,491	279,987	314,103	317,367
Union of South Africa	29,026	28,993	29,717	33,342	32,922	34,203
Total Africa	375,732	401,518	435,407	490,624	540,141	558,358
Australia	19,818	11,572	10,016	13,726	12,683	17,326
World total [7]	2,260,000	2,340,000	2,360,000	2,645,000	2,815,000	2,830,000

[1] This table incorporates a number of revisions of data published in previous copper chapters.
[2] Smelter output from domestic and foreign ores, exclusive of scrap. Production from domestic ores only, exclusive of scrap, was as follows: 1947, 782,780 tons; 1948, 764,278; 1949, 687,580; 1950, 826,760; 1951, 844,379; 1952, 841,287.
[3] Exclusive of material from scrap.
[4] Data not available; estimate by authors of chapter included in continental and world totals.
[5] Includes scrap.
[6] American and British zones only.
[7] Approximate production.
[8] Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.
[9] Belgium reports a large output of refined copper which is believed to be produced principally from crude copper from Belgian Congo and is not given here, as that would duplicate output reported under the latter country.

utilized to eliminate part of the gangue. The latest and most modern washer installation is at the Ruwe mine, near where a large-capacity plant was treating an argillaceous breccia containing small particles of malachite, rather free and large enough for treatment by this method. The breccia contained 4–5 percent ores and yielded a 30–34 percent washed product, and the rejects averaged less than 0.8 percent. The recovery exceeded 80 percent. The Ruwe washer was working 3 shifts and operating at its capacity of 100,000 tons of ore a month. The coarser product went directly to the electrolytic copper plant at Jadotville, the middling was further concentrated in the Kolwezi mill, and the tailing was wasted. A small washer at the Kamoto mine, where low-grade copper-cobalt ores were produced but which was idle, was handling 18,000 tons of ore previously mined. At the Panda mill hand-picked ore was treated first by gravity and then by flotation concentration. During the last years of operation this mill was handling 50,000 to 60,000 tons of products a month, but progressive depletion of the ore bodies of the mines in the central section and exhaustion of the stock of gravity rejects led to closing of the plant July 8, 1951. It was to be held in standby condition for prospective handling of sulfide ores from the Kambove-West mine, an underground mine near Jadotville, under development.

Exhaustion of mines in the central section made it imperative that other mines be brought into operation. The Kolwezi-Musonoi group in the west was chosen, but because of its distance from Jadotville transportation to the Panda mill was uneconomic and a new plant was built at Kolwezi, beginning operations July 14, 1941. Both gravity and flotation concentration were used for a time, but the former was abandoned early. Monthly capacity of the plant was 150,000 tons, and expansion to 200,000 tons was anticipated. Some lower workings in the Musonoi mine were yielding a mixed oxide-sulfide and a sulfide ore, and provision was made for handling these ores in part of the Kolwezi plant. In May 1946 the feed was said to be running 8.24 percent copper, the concentrates 27.39 percent, and the rejects 1.69 percent, with a recovery of 84.07 percent; more recently it was reported as ore 7 percent, concentrates 28 percent, and rejects 1.2 percent. Kolwezi concentrates went to the Shituru electrolytic plant at Jadotville. The Kolwezi mill treated 1,603,000 tons of ore and produced 288,000 tons of copper concentrates, averaging 27.5 percent copper and 1.01 percent cobalt, and 43,000 tons of concentrates, averaging 8.62 percent cobalt, in 1952.

The Kipushi flotation mill treated sulfide ore from Prince Leopold underground mine, producing both copper and zinc concentrates. The monthly capacity of the plant was 80,000 tons.[37] This mill produced in 1952 nearly 10,000 tons of copper concentrates, averaging 23.58 percent copper, and 254,000 tons of copper concentrates (28.92 percent copper) and 189,000 tons of zinc concentrates (52.25 percent zinc).

In addition to the electric power supplied by the Francqui Central and more recently the Bia Central hydroelectro stations, the Union Minière was to have, probably before the end of 1952, power from the first unit of a new plant, the Delcommune Central, on the Lualaba River. When the last-named plant was completed, the combined capacity was to be 230,000+kilovolt-amperes or over 1 billion kilowatt-hours under conditions of normal rainfall. It was decided in 1951 to construct a second station on the Lualaba, downstream from the Delcommune station. This station, to be known as the Central

[37] Murdock, Thos. G. (Consul), Ore Concentrating Operations of the Union Minière du Haut Katanga: State Dept. Dispatch 13, Elisabethville, Belgian Congo Oct. 4, 1952, 14 pp.

le Marinel, was to have a probable capacity of 300,000 kilovolt-amperes or about 1½ billion kilowatt-hours in years of moderately good rainfall.

Canada.—Mine output of copper declined 5 percent in 1952, returning to the approximate level of 1949–50 and continuing considerably above 1945–48, inclusive. All important copper-producing Provinces shared the 1952 decline, but only Manitoba showed a noteworthy drop. On the contrary, in Nova Scotia 416 tons of copper was produced compared with none in 1951. Output of refined copper declined from 245,500 tons in 1951 to 196,900 in 1952 owing to a 4-month labor strike at the refinery of Canadian Copper Refiners, Ltd., at Montreal East, Quebec. Copper consumption in Canada declined to 130,300 tons in 1952 from 134,200 in 1951, probably marking only a temporary halt in the growth of the copper-consuming industry in this country.

TABLE 34.—Copper produced (mine output) in Canada, 1943–47 (average) and 1948–52, by Provinces, in short tons [1]

Province	1943–47 (average)	1948	1949	1950	1951	1952 (preliminary)
British Columbia	16,358	21,502	27,055	21,088	21,932	21,858
Manitoba	19,215	18,960	16,960	20,817	15,839	9,190
Newfoundland (not Canadian 1943–48)	------	------	3,617	3,221	2,899	2,848
Northwest Territories	1	------	------	------	1	2
Nova Scotia	------	------	------	------	------	416
Ontario	120,989	120,383	113,043	117,210	128,809	124,737
Quebec	49,682	48,813	67,822	72,891	68,866	68,300
Saskatchewan	35,438	31,074	34,960	28,982	31,625	30,356
Total	241,683	240,732	263,457	264,209	269,971	257,707

[1] Dominion Bureau of Statistics, Department of Trade and Commerce, Government of Canada, Preliminary Report on Mineral Production, 1952.

Four fabricating plants handle over 95 percent of the primary copper consumed in the country, that is, Anaconda American Brass, Ltd., New Toronto; Noranda Copper & Brass, Ltd., Montreal East; Canada Wire & Cable Co., Ltd., Montreal East; and Phillips Electrical Works, Ltd., Brockville, Ontario. The first two are brass mills manufacturing sheet, strip, rod, and tubing. The other two are copper-wire-rod rolling mills and the sole suppliers of copper rod for wire drawing in Canada.[38]

Ontario is by far the largest copper-producing Province in Canada but in recent years has not accounted for its usual 50 percent or more of the total; in 1952 it produced over 48 percent, virtually all from the copper-nickel ores of the Sudbury area. The International Nickel Co. of Canada, Ltd., easily outranks other producers of copper in Canada. The company delivered 117,200 tons of refined copper in 1952 compared with 118,500 tons in 1951 and 106,500 in 1950. The quantity of nickel was 6 percent larger than that of copper in 1952 and brought a much higher unit price. Noteworthy progress continued during the year in the program to develop underground production to compensate for losses in open-pit output. The 13,200,000 tons of ore mined in 1952 was the largest attained in any year, and consisted of 10,200,000 tons of underground and 3,000,000 tons of surface ore, compared with 7,800,000 and 4,000,000, respectively, in

[38] Scott, Albert W., (Consul), Notes on Canadian Copper Fabricating Industry: State Dept. Dispatch 182, Montreal, Canada, Feb. 1, 1952, 3 pp.

1951. The underground goal is 13,000,000 tons. Proved reserves at the end of 1952 were 256,000,000 tons of ore, an increase of 2,000,000 tons from the beginning of the year. The nickel-copper content was 7,800,000 and 7,700,000 tons, respectively.

The Falconbridge Nickel Mines, Ltd.—the other important copper-mining company in Ontario—produced 888,000 tons of ore at the main Falconbridge mine in 1952. Output was expanded 45 percent at the McKim mine to 225,000 tons of ore. Company ore processed totaled 1,119,000 tons, establishing a new record tonnage. A total of 10,600 tons from the East Rim and Milnet Nickel mines was treated in Falconbridge plants. Ore reserves were increased markedly; developed ore in the Falconbridge and McKim mines totaled 10,000,000 tons, averaging 1.64 percent nickel and 0.87 percent copper, and indicated ore in Sudbury district holdings totaled 23,000,000 tons, averaging 1.63 percent nickel and 0.95 percent copper, or totals of 33,000,000 tons, containing 1.63 and 0.93 percent, respectively.

Quebec, as usual, ranked as the second most important copper-producing Province in Canada, with slightly over one-fourth of the total for the country. The largest producer is Noranda Mines, Ltd., operating the Horne mine. A total of 1,400,000 tons of ore, of which over 589,000 was direct-smelting ore averaging 1.90 percent copper, and 0.174 ounce gold and 0.34 ounce silver per ton, and over 810,000 tons was concentrating ore averaging 1.97 percent copper and 0.143 ounce gold and 0.29 ounce silver, was shipped to the mill or smelter. A total of 1,250,000 tons of ores, concentrates, and secondary materials was smelted, of which 519,000 tons was for custom accounts. The estimated recovery from Horne mine ore and concentrate was 25,400 tons of copper, 200,000 ounces of gold and 611,000 ounces of silver. Indicated ore reserves above the 2,975-foot level were as follows:

	Tons	*Copper percent*	*Gold (ounce per ton)*
Sulfide ore over 4 percent copper	3, 632, 000	7. 08	0. 159
Sulfide ore under 4 percent copper	11, 000, 000	. 66	. 195
Total sulfide ore	14, 632, 000	2. 25	. 186
Siliceous fluxing ore	948, 000	. 09	. 122
Total ore	15, 580, 000		

The foregoing does not include tonnages containing little or no copper in the Chadbourne ore body and the No. 5 zone of the Horne mine, as well as 1,500,000 tons of ore averaging 0.7 percent copper and 0.120 ounce gold per ton, in the No. 5 zone.

East Sullivan Mines, Ltd., milled 898,000 tons of ore in 1952. Copper production totaled 14,200 tons. Reserves at the end of the year were 3,827,000 tons of ore averaging 1.58 percent copper.

The Quemont Mining Corp., Ltd., which adjoins the Horne mine, treated 775,000 tons of ore averaging 1.32 percent copper, 2.74 percent zinc, 0.152 ounce gold, and 1.05 ounces of silver per ton in 1952. Copper and zinc concentrates produced were 51,000 and 32,000 tons, respectively. The copper concentrate was smelted at Noranda, and the zinc was shipped to the United States. Commercial metals in shipments were 9,400 tons of copper, 16,500 tons of zinc, 96,900 ounces of gold, and 416,000 ounces of silver. Ore reserves at the end of 1952 were 9,574,000 tons, averaging 1.39 percent copper, 2.77 percent zinc, 0.158 ounce gold, and 1.06 ounces of silver per ton, an increase of 136,000 tons after allowance for ore mined during the year.

The Normetal Mining Corp., Ltd., milled 360,500 tons of ore, averaging 2.02 percent copper, 7.49 percent zinc, and 0.25 ounce gold and 2.32 ounces of silver per ton. Copper and zinc concentrates produced were 30,000 and 43,000 tons, respectively. Copper concentrate went to the Noranda smelter and zinc concentrate to the United States. Commercial metals in shipments were 6,300 tons of copper, 21,800 tons of zinc, 4,100 ounces of gold, and 412,000 ounces of silver. Ore reserves totaled 2,637,000 tons, averaging 2.63 percent copper and 8.25 percent zinc, an increase of 203,000 tons after allowance for ore mined during the year.

At the Waite Amulet mine of Waite Amulet Mines, Ltd., 173,000 tons of ore was hoisted and at the Amulet Dufault, 241,000 tons. A total of 428,000 tons of ore, averaging 3.62 percent copper, 4.59 percent zinc, and 0.043 ounce of gold and 1.06 ounces of silver per ton, was milled, and production totaled 14,500 tons of copper, 16,000 tons of zinc, 11,900 ounces of gold, and 283,000 ounces of silver, plus pyrite concentrate. Ore reserves were 1,025,000 tons at Waite Amulet, of which 920,000 contained 4.53 percent copper, 3.60 percent zinc, and gold and silver values. Reserves at the Amulet Dufault mine totaled 650,000 tons of ore, of which 555,000 tons contained 6.81 percent copper, 4.01 percent zinc, and gold and silver values.

Output of Canadian Copper Refineries, Ltd. (controlled by Noranda), was adversely affected by a labor strike that lasted from July 14 to November 19.

Campbell Chibougamau Mines, Ltd., entered into a contract with the Defense Materials Procurement Agency (United States) in August. The company was to supply 31,500 tons of electrolytically refined copper to the United States by December 31, 1956, from its property on Merrill Island in Dore Lake. It agreed to develop the property at its own expense. A mill, with a minimum capacity of 2,000 tons a day, was to be constructed, and production was to begin in not less than 2½ years, and copper production was to reach an annual rate of 18,600 tons. The DMPA was to be permitted to buy any or all of the company output at the market price, or 24.5 cents a pound f. o. b. Connecticut Valley, whichever was higher.

An additional 2 million tons of ore was indicated by exploratory diamond drilling at the property of Gaspé Copper Mines, Ltd., bringing total reserves to 67,000,000 tons, averaging 1.3 percent copper. Construction of mine buildings, townsite, etc., proceeded on schedule, and construction of the mill and smelter was scheduled to start early in 1953. Gaspé is owned by Noranda.

Saskatchewan and *Manitoba* together supplied 15 percent of Canada's production in 1952. Output in the past was almost entirely from the mine of the Hudson Bay Mining & Smelting Co., Ltd., at Flin Flon, Manitoba, near the Manitoba-Saskatchewan border and the Sherridon mine of Sherritt Gordon Mines, Ltd., at Sherridon, Manitoba. The Hudson Bay property lies in both Provinces, with the major part of the production coming from the Saskatchewan segment. The Sherridon mine was exhausted in 1951, and in 1952 company operations were in process of being transferred to Lynn Lake.

At Hudson Bay's mine 1,559,000 tons of ore was mined; 1,528,000 tons, containing 2.51 percent copper, 4.9 percent zinc, and gold and silver values, was milled. The company shipped blister copper, containing 39,900 tons of copper, 118,500 ounces of gold, 1,589,000 ounces of silver, and 100,000 pounds of selenium, to the refinery. Ore reserves at the end of the year, including properties wholly owned or controlled and within trucking distance of Flin Flon, but excluding Cyprus Mines, Ltd., were 17,028,000 tons, containing 3.21 percent copper, 4.0 percent zinc, and 0.075 ounce of gold and 1.06 ounces of silver per ton. Cyprus Mines, Ltd., controlled by Hudson Bay, mined 86,000 tons of ore, averaging 2.79 percent copper, 6.3 percent zinc, and 0.042 ounce of gold and 0.82 ounce of silver per ton. Ore reserves totaled 114,500 tons, containing 3.19 percent copper, 5.6 percent zinc, plus gold and silver.

Progress was made by Sherritt Gordon Mines, Ltd., in 1952 in moving buildings from Sherridon to Lynn Lake. A 147-mile railway was being constructed from Sherridon to Lynn Lake, and a hydroelectric power plant was being built on the Laurie River (completed in October 1952). Milling practice was to be the same as that used at Sherridon, and little new equipment was to be required. Copper and nickel contents of the ore were to be separated by flotation concentration. Early reports that the copper concentrates were to be smelted at the Hudson Bay plant were later revised to the Noranda smelter. The nickel concentrates were to be leached at Fort Saskatchewan.[39] An article published in June described the new chemical metallurgical process to be used as follows:

> Refiners using the new process will first concentrate ore by conventional flotation methods. Then the concentrate, as a slurry, will be introduced into an autoclave designed to withstand high temperature and pressure. The vessel is equipped with an agitator. In the autoclave, the concentrate is leached with either ammonia or acid, then oxidized. From the resulting aqueous leach solution, metals will be recovered by suitable reducing agents. By varying conditions, individual metals can be separated as pure powders. These powders can be pressed, continuously cast or, as with copper, extruded. Reagents used in the process are recovered.[40]

Ore reserves at Lynn Lake remained at 14,100,000 tons, assaying 0.618 percent copper and 1.223 percent nickel.

In *British Columbia* the Granby Consolidated Mining, Smelting & Power Co., Ltd., and the Britannia Mining & Smelting Co., Ltd., dominated production. At the Copper Mountain mine of Granby Consolidated a total of 1,752,000 tons of ore, averaging 0.9 percent copper, was treated. Copper concentrate contained 12,400 tons of salable copper. Concentrate was shipped, as usual, to the Tacoma smelter of the American Smelting & Refining Co. A substantial tonnage of ore amenable to open-pit mining was developed. Total ore reserves at the end of the year were 3,824,000 tons, averaging 0.95 percent copper, of which 500,000 tons could be economically mined by open-pit methods.

The Britannia mine produced 858,500 tons of ore and 830,000 tons was concentrated. Copper concentrates produced totaled 23,200 tons and precipitates totaled 575 tons. These products also went to

[39] Kilvert, Cory, Lynn Lake—Manitoba's New North: Precambrian, vol. 25, No. 8, August 1952, pp. 20–21.

[40] Chemical Engineering, Chemical Refining of Metals: Vol. 59, No. 6, June 1952, pp. 164–168, 368, 370, 372–374, 376.

the Tacoma plant of American Smelting & Refining Co. Production of zinc concentrate totaled 25,600 tons, which went to Montana for treatment.[41]

In *Newfoundland* the Buchans Mining Co., Ltd., treated 330,500 tons of copper-lead-zinc ore, from which 12,500 tons of concentrate containing 2,900 tons of copper was produced. The Falconbridge Nickel Mines, Ltd., continued active investigations at the old Gull Pond, Rambler and Tilt Cove properties.[42]

In *Yukon* the Hudson Bay Mining & Smelting Co., Ltd., has staked or holds under option 2 properties which it reports to be of major interest; 1 is the Wellgreen, a copper-nickel deposit containing precious metals, in the Kluane Lake district. Discovery was made in June 1952, and the company holds by staking or under option to purchase from the Yukon Mining Co. (in which Hudson Bay Exploration & Development Co. has a controlling interest) an area roughly 3 miles wide by 12 miles long, comprising 538 claims. Drill results at the time of suspending operation, because of water shortage, had proved 67,000 tons of ore assaying 1.33 percent copper, 1.96 percent nickel, 0.056 percent cobalt, and 0.004 ounce of gold, 0.078 ounce of platinum, and 0.053 ounce of palladium per ton.

Exports of ingots, bars, and billets from Canada in 1952, as compared with 1951, was as follows, by countries of destination, in short tons:

Destination:	1951	1952
United States	28, 843	52, 630
United Kingdom	51, 918	41, 643
France	5, 700	8, 537
Brazil	2, 688	2, 835
India	3, 649	2, 582
Sweden	3, 998	1, 786
Australia	-------	1, 707
Pakistan	-------	1, 119
Other	5, 036	836
Total	101, 832	113, 675

Exports of copper in ore, matte, regulus, etc., totaled 34,437 (36,853 in 1951) tons, of which the United States was the destination of 24,640 (28,941) tons, Norway 8,180 (6,310) tons, the United Kingdom 1,127 (1,044) tons, Germany 471 (558) tons, Japan 18 (no) tons, and Belgium 1 (no) tons. In addition, 22,827 (13,291) tons of rods, strips, sheet, and tubing was shipped from the country; copper-scrap slag skimmings totaling 1,736 tons also was exported in 1952.

Imports of refined copper totaled 12,973 tons in 1952 compared with 1,511 tons in 1951.

Chile.—Mine production of copper in Chile rose again in 1952 and was the largest since 1948. Output declined slightly at the Chuquicamata mine of the Chile Exploration Co. (Anaconda Copper Mining Co. subsidiary) but rose 14 percent at the Potrerillos mine of the Andes Copper Mining Co. (also an Anaconda subsidiary) and 8 percent at the El Teniente mine of the Braden Copper Co. (Kennecott Copper Corp. subsidiary). At Chuquicamata an 18-day labor strike, from April 25 to May 12 and a series of illegal sectional

[41] Canada Department of Mines and Technical Surveys, Copper in Canada in 1952 (Preliminary): Ottawa, Canada, 8 pp.
[42] Work cited in footnote 41

strikes and slowdowns hampered production, which was adversely affected also by a decline in the grade of ore produced. A 22-day strike during the year at Potrerillos resulted in a loss of about 3,000 tons. The labor strike at the Braden mine, beginning December 20 and lasting past the end of the year, was more than offset by the higher grade of ore produced, combined with other factors, and a new high record production was established. Output in 1952 was over 10,000 tons above the earlier record in 1944.

In May, Chile abrogated its agreement with the United States Government, which provided, among other things, for Chile's withholding of not to exceed 20 percent of the outputs of American mines for disposition by Chile. The various aspects of the matter are discussed under Prices.

The Annual Report to Stockholders of the Anaconda Copper Mining Co. stated that the Exchange-Tax Agreement (between the Chilean Government and the American copper companies) had not been acted upon by the Chilean Congress, but that some relief had been afforded by exchange rate adjustments covering certain types of expenditures. It also stated that a law passed by the Chilean Congress in December 1952, provided that taxes on income be paid from January 1, 1953, with an increase of 20 percent. This was to result in increasing income taxes of copper companies from 50 to 60 percent in 1953.

Outputs of the three leading mines in 1951 and 1952 in metric tons were as follows:

	1951		1952	
	Ore treated	Bar copper produced	Ore treated	Bar copper produced
Andes	8,043,000	41,600	7,368,600	47,300
Braden	8,842,000	155,600	8,867,900	167,800
Chuquicamata	15,122,000	163,500	14,767,400	161,100

Of the production at Chuquicamata 672,400 tons, yielding 9,500 tons of copper, was sulfide ore.

The Government-owned Paipote smelter treated 94,500 tons of ore and recovered 9,100 tons of blister copper in its first full year of operation.

The first section of the new concentrator at the Chuquicamata mine was started on July 5, and by December 31 six sections were in service. The first blister was produced in the smelter in November. It was expected that the other four sections of the concentrator and the remainder of construction and installations in the smelter would be completed early in 1953. Total expenditures for the project amounted to over $110,000,000 by the end of 1952, of which $28,000,000 was spent in 1952.

The December issue of Mining Engineering featured the Chuquicamata enterprise, giving its history, the geology of the deposit, a description of open-pit mining, and descriptions of the new concentrating and smelting plants for the treatment of sulfide ores. In the new smelter were four 30- by 125-foot reverberatory furnaces of 650 tons of charge capacity per day, 8 waste-heat boilers, 4 turbogenerators of 7,500 kilowatts each, operating at 725° F. and 400 p. s. i. g., 4 Pierce-

Smith 13- by 30-foot converters, 2 casting furnaces (13- by 25-foot) of 175 tons capacity each, a casting wheel with 26 anode molds in either of 2 sizes or 52 blister cake molds, and a straight-line casting machine of conventional design, being an endless chain equipped with molds for the continuous casting of blister cakes.

The Chuquicamata open-pit mine has been in continuous operation since 1915; and in the period 1915 through September 1952, 523,000,000 tons of ore was removed, of which 363,000,000 was oxide ore and 160,000,000 waste material. Total copper production was 5,106,000 tons to September 30, 1952. When the sulfide plant was completed 105,000 tons was to be mined daily, as follows: 30,000 tons each of sulfide and oxide ore and 45,000 tons of waste. Twenty-one benches were opened as of the September 30 date, and all were still active except the 3 top ones at the northeast limit of the pit. The pit was 8,850 feet long, 3,540 feet wide, and 980 feet deep. Total ore remaining in the pit was given as 120,000,000 tons of oxide and 140,000,000 tons of sulfide ore. Vast reserves of sulfide ore below the pit were not included in the estimates given.[42]

At the Braden property substantial progress was made in the expansion program started in 1951. Extensive new grinding equipment installed was to make possible increased recovery of copper. Completion of a 40-foot extension to the No. 1 reverberatory furnace enabled the company to reduce the quantity of concentrates in storage. Mining operations at the property were described during the year.[43]

A recent dispatch commented as follows on the operations of small and medium-size producers in Chile in 1952:[44]

> For the small and medium copper producers, 1952 was a banner year, the unusually high output having resulted from high prices, completion of the Paipote smelter (December 1951) and legislation favoring miners. A substantial percentage of production came from the bigger mines (Disputada, M'Zaita, Cerro Negro, Tocopilla and Farrelon Sanchez) while Cía. Minera Merceditas produced over 400 tons per month of 28% concentrates and Cía. Mineral Tamaya nearly 500 tons of concentrates from the old Tamaya dumps. However, a variety of factors (plant capacity, location, water availability, transportation problems, etc.) tend to limit the amounts which these more important operations can produce and the bulk of the new copper came from a great many small operations.
>
> Among these smaller mines, the accent has been upon production of oxide ores, more readily available than the underlying sulphide deposits, and in the re-working of a great many old mine dumps still containing between one percent and two percent copper. Attempts are being made to develop satisfactory systems of floating the oxide ores for concentration (both the Caja de Crédito Minero and the Santiato representative of American Cyanamid Company are working on this problem and Cía. Minera Cerro Negro is concentrating mixed oxides and sulphides with indifferent success) but the most apparent effect of the new oxide production has been the installation of numbers of small, Jerry-built lixiviation plants in the Norte Grande and the Norte Chico. Substantial deposits of oxide copper are available but a shortage of sulphuric acid acts as a limiting factor on the further development of the lixiviation system.
>
> The most ambitious of the copper development programs is that being undertaken by Cía. Minera Punitaqui at its Tamaya operation. Although over 80,000 tons of material remain on the Tamaya dumps, these tailings assay an average of no better than 1.4 percent copper, the rate of recovery is not high and a good deal of material, mixed sulphides and oxides, may not be recoverable. For this

---

[42] Mining Engineering (various articles), vol. 4, No. 12, December 1952, pp. 1161–1214.

[43] Turton, F. E., Mining Operations at the Teniente Mine of the Braden Copper Company, Rancagua, Chile: Min. Eng., vol. 4, No. 6, June 1952, pp. 573–577.

[44] Smith, H. Gerald (counselor of Embassy), Annual Report (Chile) Minerals, Iron and Steel, and Petroleum: State Dept. Dispatch 1062, Santiago, Chile, Mar. 19, 1953, 24 pp.

reason, Punitaqui is now reentering the mine itself in order to clean out the old workings and to drill into virgin areas where geological work indicates the presence of better than 2 percent copper. The work is not very far advanced and the reopened Tamaya mine is not expected to be ready for operation until mid-1954.

At the end of 1952, United States refineries were still beneficiating most of the ores and concentrates exported by Chile but the year saw the reappearances of Germany and Japan as important markets. Nearly all of the materials for Germany have gone to the Norddeutsche Affinerie of Hamburg which refines the Paipote National Smelter's blister copper. The Caja de Crédito Minero (administering the sale of Paipote's output) first began shipping ores and concentrates to Norddeutsche late in 1951 because a three months' delay in the opening of the Paipote smelter had prevented delivery on schedule of the first shipments of blister copper which the German firm had contracted to refine. Embarkations of ores and concentrates to Norddeutsche have continued because production has risen far in excess of Paipote's requirements and internal transportation costs are so high that direct exportations of ores and concentrates from the Norte Grande and the central zone are to be desired whenever possible. The shipments to Japan, some in chartered Japanese vessels, began soon after mid-year under an 8,000-ton contract entered jointly by Cía. Minera Y Commercial Sali Hochschild and Mauricio Hochschild y Cía. Ltda., Japan offering premium prices which have constituted a new threat to American ore buyers.

TABLE 35.—Principal types of copper exported from Chile, in 1952 by countries, in metric tons

	Refined		Standard (blister)	Total
	Electrolytic	Fire-refined		
United States	118,613	121,518	51,087	291,218
Austria	1,130	14,951		16,081
Italy	6,843	330	8,812	15,985
Germany		1,274	10,395	11,669
United Kingdom		2,692	1,321	4,013
France		3,510	500	4,010
Brazil	3,909	80		3,989
Spain		1,991		1,991
India	1,750			1,750
Switzerland	200	589		789
Other countries	282	925		1,207
Total	132,727	147,860	72,115	352,702

Chilean exports of the chief types of copper, by countries, are shown in table 35. Other copper exports from Chile were 4,057 tons of ore (3,770 to Germany and 287 to the United States), 24,608 tons of concentrates (18,805 to the United States, 4,135 to Japan, and 1,668 to Germany), 1,422 tons of cement copper (805 to Japan and 617 to the United States), 622 tons of precipitates (572 to Germany and 50 to Japan), and 176 tons of remelted scrap bars (169 to Belgium and 7 to Italy). In 1951 other copper exports from Chile were 3,780 tons of ore (1,418 to Germany, 1,200 to Belgium, 1,000 to Japan, and 162 to the United States), 17,613 tons of concentrates (16,460 to the United States, 1,053 to Germany, and 100 to Sweden), 1,091 tons of scrap (570 to Belgium, and 521 to the United States), 1,630 tons of cement copper (800 to Japan, 628 to Belgium, 85 to Argentina, 66 to Germany, and 51 to Italy), and 180 tons of precipitates (all to Germany). Ore and concentrates are in terms of copper content.

Cyprus.—A recent article described operations of the Cyprus Mines Corp. at the Mavrovouni mine.[45] It stated that the corporation had

[45] Schlechten, A. W., and Bruce, J. L., New Acid Leaching Section Raises Cyprus Copper Recovery by 10 percent: Eng. and Min. Jour., vol. 153, No. 12, December 1952, pp. 88-91.

been producing cupreous pyrites products since 1922, except for June 1940 to May 1946, during World War II. The new acid-leaching section went into operation in the early months of 1952 and was credited with raising recovery markedly.

Japan.—A comprehensive report on copper metallurgy in Japan was recently published.[46] The report stated in part:

> The copper-mining industry is one of Japan's oldest, dating back about 1,200 years. Until the early 1930's Japan produced sufficient copper to meet domestic requirements. Ore resources were ample, and power and labor in adequate supply. Shortly thereafter, Japan began her military expansion program and consequently imports of copper became necessary in 1933 and increased in quantity progressively through 1940 when they were about ten times the imports of 1933.
>
> Basically, the metallurgy of copper is essentially the same as in other parts of the world, with certain modifications necessary to meet the needs of low tonnage production plants. Japanese metallurgists travelled extensively 1920–1939 and brought back to Japan ideas and equipment used by other copper producers.
>
> Most of the plant equipment is similar to that used in the United States over 20 years ago. One exception is modern electrical power generating and conversion machinery acquired in recent years from England, Switzerland, Germany, and the United States, as well as that manufactured in Japan. It is not uncommon to see two or more motor-generator sets operating side by side, each manufactured in a different country.
>
> Operation of copper metallurgical plants halted with the cessation of hostilities and it was not until several months after the beginning of the Occupation of Japan that operations were resumed. Production since 1945 has averaged 50 percent of designed capacity. Of this production about 50 percent is accounted for by copper recovered from brass scrap.
>
> During World War II Japanese plants were forced into maximum production without regard to cost. As the war progressed, maintenance and upkeep of plant equipment declined progressively, resulting, during the latter days of the war, in shutting down certain operations. By 1952 the copper plants were operating at almost 80 percent of their capacity.
>
> The copper industry suffered only minor war damage from bombing and shelling.

During 1952 Japanese smelters made increased efforts to obtain necessary raw materials from many sources in the world to permit continued or higher rates of operations, despite dwindling supplies of scrap.

Northern Rhodesia.—Mine production of copper in Northern Rhodesia established a new alltime peak for the third successive year; output rose 3 percent above 1951 and 11 percent above the earlier record in 1950. 225,000 short tons of blister and 125,000 tons of electrolytic copper were produced. In establishing the new record, further gains were made in the program to produce a substantial part of total production in the form of refined copper. A 3-week strike of African mine workers at the copper properties prevented an even higher output than the record attained. About 20,000 tons of copper production was said to be lost as a result of the strike. Supplies of coal continued unsatisfactory, and copper companies again were forced to resort to wood as a substitute. This factor also caused a smaller output of copper than there otherwise would have been. A total of 586,000 tons of coal and the equivalent of 206,000 tons in wood was burned in 1952. Interconnection of the power grid was completed during 1952, and all four operating mines in the country were connected to a central switching station near Nkana. To meet increasing power demands of the copper belt, arrangements were in

---

[46] SCAP, Copper Metallurgy in Japan: Rept. 155, Tokyo, April 1952, 108 pp.

progress between the Northern Rhodesia Power Corp., Ltd., and the Union Minière du Haut Katanga to obtain hydroelectric power from the proposed Lualaba River station, in the Belgian Congo, expected to be completed in a few years. The Northern Rhodesian corporation, a subsidiary of the producing companies, was also concerned with investigation on the development of further hydroelectric power from either the Kafue or Kariba project.

A 5-year housing improvement program for native workers in the copper belt, to cost £2,000,000, was announced in December.

It was reported that late in the year 2 shafts were being sunk at each of 2 new copper mines, the Chibuluma and the Baluba, and that diamond drilling was being carried on over a very large area and test holes were to be sunk to determine the best positions for the shafts at the Bancroft mine (Kirila Bomwe and Konkola ore bodies), 15 miles north of the Nchanga mine. The Kirila Bomwe ore body was estimated to contain 46,700,000 tons with an average copper content of 4.39 percent and the Konkola to contain 32,900,000 tons, averaging 2.48 percent. Chibuluma has a smaller, but richer ore body, containing 7,300,000 tons, averaging 5.23 percent copper; Baluba's reserves were 21,000,000 tons averaging 3.47 percent copper. The Rhokana Corp., Ltd., announced in November formation of a new company to develop the Bancroft mine, the Mufulira Copper Mines, Ltd., was contemplating a new company to develop the Baluba mines, and a new company, Chibuluma Mines, Ltd., a wholly owned subsidiary of Mufulira, was formed to develop Chibuluma.

A total of 4,368,000 tons of ore, containing 2.40 percent copper, was mined by Roan Antelope Copper Mines, Ltd., in the fiscal year ended June 30, 1952, or 10 percent higher than in the previous fiscal year. Company concentrates smelted yielded 90,750 tons compared with 83,500 tons in 1951. Both the ore and blister totals represented new alltime peaks for Roan Antelope despite the loss of 5,600 tons of copper production owing to coal shortage. The company smelter also produced 9,500 tons of blister for Nchanga. Ore reserves at the end of June 1952 were reported as 92,100,000 short tons averaging 3.19 percent copper. The increase as compared with 1951 was due to inclusion in the later year of tonnages of low-grade ore averaging 1 to 1.8 percent copper.

Mufulira Copper Mines, Ltd., produced 2,932,000 short tons of ore in the fiscal year ended June 30, a total of 2,922,700 tons was milled, and 76,400 long (85,500 short) tons of blister copper was produced from concentrates and fluxing ore. The decrease of 10,300 long (11,500 short) tons, approximately 12 percent was due largely to the protracted fuel shortage. Concentrates smelted for Nchanga yielded 4,700 long (5,300 short) tons of copper and was in addition to the foregoing. Progress was made at the mine in switching to the block-caving mining, and 65 percent of the output was produced by this method. By the end of the fiscal year the tankhouse for a production of 36,000 long (40,000 short) tons of cathodes was completed. The second stage will double this capacity and enable the plant to turn out various electrolytic shapes. As a result of difficulties in obtaining steel and other items, the second stage probably will not be completed before 1955. The cost of the complete refinery, including copper locked up in it, was expected to be about £4,000,000.

Estimated ore reserves at the end of the fiscal year were as follows: Mufulira, 139,927,000 short tons, averaging 3.48 percent copper; and Chambishi, 25,000,000 tons, averaging 3.46 percent copper. The large increase in tonnage and lowering in grade of ore at Mufulira was caused by the inclusion of the ground between A and B ore bodies as reserves, resulting from the decision to mine the three ore bodies by block caving. Reserves in the Baluba and Chibuluma mines were reported earlier in the discussion on Northern Rhodesia.

The Rhokana Corp., Ltd., mined 3,730,000 short tons of ore and milled 3,738,000 tons from the Nkana and Mindola mines in the fiscal year ended June 30, 1952. Finished copper produced was 25,900 long (29,000 short) tons of blister and 56,900 (63,700) tons of electrolytic copper. The smelter produced 153,100 tons of copper compared with 137,900 tons in the fiscal year ended June 30, 1951. Of the 1951–52 total 29,000 (6,000 in 1950–51) tons was blister and 55,700 (87,200) was anode copper for Nkana, and 22,900 (9,600) was blister and 45,500 (35,100) was anode copper for Nchanga. In 1951–52, in addition, 33 tons of blister was produced from Broken Hill lead-copper matte. Production at the smelter was affected adversely by the shortage of coal, but nonetheless a new record was established. Ore reserves at the end of June 1952, were as follows:

	Short tons	*Copper (percent)*
Nkana north ore body	28, 000, 000	2. 93
Nkana south ore body	20, 000, 000	2. 78
Mindola ore body	48, 000, 000	3. 50
Total	96, 000, 000	3. 18

In the year ended March 31, 1952, 1,530,000 short tons of ore was mined and 1,513,000 tons, containing 6.46 percent copper, was milled by Nchanga Consolidated Copper Mines, Ltd. Finished copper produced totaled 31,000 long (35,000 short) tons of blister and 38,000 long (42,000 short) tons of electrolytic. Company plans called for expansion of production to an annual rate of 108,000 long (121,000 short) tons by the early part of 1953. Ore reserves on April 1, 1952, were 135,000,000 tons, averaging 4.63 percent copper.

TABLE 36.—Exports of copper from Northern Rhodesia 1952, in short tons [1]

Destination	Blister	Electrolytic			Copper slimes
		Bar and ingot	Cathodes	Wire bars	
United Kingdom	192, 278	1, 119	16, 674	69, 750	4
United States	27, 294				
Belgium	19, 993			420	2, 719
Sweden				15, 006	
Union of South Africa		914		13, 496	
Australia	5, 936			4, 648	
Germany, Federal Republic	7, 952				
Netherlands	3, 125				
India	560			672	
Kenya		112			
Southern Rhodesia	4		51	34	
New Zealand			22	6	
Total	257, 142	2, 145	16, 747	104, 032	2, 723

[1] Taken from Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 12.

Rhodesia Copper Refineries, Ltd., produced 102,300 long (114,500 short) tons of electrolytic copper in the year ended June 30, 1952, compared with 96,400 (107,900 short) tons in the 1951 fiscal year. At no time during 1952 was it possible to operate the plant at capacity owing to coal and power shortages. The proportion of the total for Nchanga increased in line with that company's greater output, resulting in some reduction in the quantity handled for Rhokana. When extensions and improvements are completed, the plant should be able to handle all of the output of the two companies.

In addition to the foregoing, 6,761 tons of copper concentrates were shipped to Sweden.

Peru.—Output of copper declined 3 percent owing in part to the drop in average grade of ores treated. Production of the Cerro de Pasco Corp., leading producer by a substantial margin, was 17,200 short tons from corporation mines and 5,200 from purchased materials, a total of 22,400 tons, compared with 19,100, 7,700, and 26,800 tons, respectively, in 1951. The corporation entered into an agreement with Newmont Mining Corp. for joint exploration of a copper sulfide deposit owned by Cerro de Pasco at Cuajone in the southern part of Peru. Cerro de Pasco was to transfer a 20-percent interest in the Cuajone property in return for cash advances toward cost of a drilling program and for certain technical advice. The exploration program was not expected to be completed before mid-1954.[47] The property adjoins the Toquepala deposit.

Drilling by the American Smelting & Refining Co. at the Toquepala deposit was completed in 1952 and proved an ore reserve exceeding 400,000,000 tons, averaging slightly over 1 percent copper.

The type of deposit was reported to be such that the grade mined for the first 20 years of operation will be higher than the average. To prepare an open pit for mining at a rate of about 22,000 tons a day, the company stated, approximately 92,000,000 tons of waste capping would have to be stripped. Thereafter, the average stripping ratio of waste to ore would be 1.55 to 1. Engineering and cost estimates are well advanced, based on producing 100,000 tons of blister copper annually for the first 10 years, 85,000 annually for the next 20, and 68,000 for the estimated remaining 16-year life of the operation. Capital requirements, according to preliminary estimates, were about $160,000,000.[48] Toquepala is about 56 miles northeast of the port of Ilo, 10,000 feet above sea level, in the Andes Mountains.

No further work was carried out by American Smelting & Refining Co. at the Quellaveco property in southern Peru, where exploration drilling, completed in 1950, proved a porphyry-type copper deposit containing about 200,000,000 tons of ore, averaging slightly less than 1 percent copper.

South-West Africa.—The only copper producer in the territory is the Tsumeb mine, where copper is produced in conjunction with lead and zinc. The history, management policies, geology, and mining

[47] Cerro de Pasco Corp., Annual Report to Stockholders, 1952.
[48] American Smelting & Refining Co., Annual Report to Stockholders, 1952.

methods, concentrator, and power plants, were described in two issues of the Mining World.[49]

Tanganyika.—Uruwira Minerals, Ltd., signed a contract with the United States Government whereby the company was to receive a loan of $1,640,000, which, together with 5 percent interest, was to be repaid, in lead and/or copper. The loan was to assist in expanding mine development and installing a 1,000-ton-a-day mill at the Mpanda mine. Repayment deliveries were scheduled to begin January 1, 1954, and to be completed by December 31, 1956. Optional purchases up to 50 percent of Mpanda's lead and copper production, for 10 years after the loan plus interest was repaid, were also covered.

Uganda.—Plans call for the production of copper at the Kilembe mine, on the eastern slopes of the Ruwenzori Mountains, probably by 1955. It was arranged that the Uganda Electricity Board was to erect a transmission power line from the Owen Falls hydro plant. Ore reserves were estimated as 14,800,000 tons averaging 1.92 percent copper and 0.18 percent cobalt, as of January 1953. The engineer's report expressed the view that many additional millions of tons of ore would probably be found at greater depth and along the strike of the ore to the west.[50]

United Kingdom.—Consumption of copper increased 4 percent in 1952; thus the use of copper increased for the third successive year and exceeded every other year since 1944. The United Kingdom ranked, as in recent years, as the second most important consumer of copper in the world. Of a total consumption of 571,800 long tons in 1952, 347,600 tons was virgin copper and 224,200 tons secondary and copper in scrap; 313,400 tons was used in unalloyed and 243,800 tons in alloyed form. A total of 14,600 tons of copper sulfate was produced. Stocks of blister and refined copper (held by Government and consumers) increased to 132,000 tons at the end of 1952 from 113,000 tons on January 1. These inventories include electrolytic (including rods), fire-refined, and blister copper on hand.

Price changes for copper in the United Kingdom are covered under the section on Prices.

TABLE 37.—United Kingdom imports of copper in 1951–52, by countries and classes of copper, in long tons [1]

	1951			1952		
	Electrolytic	Standard	Total	Electrolytic	Standard	Total
Northern Rhodesia	77,164	127,433	204,597	76,385	168,945	245,330
United States	64,154		64,154	44,624		44,624
Canada	46,014		46,014	37,424		37,424
Belgium	14,049		14,049	27,783		27,783
Germany, West	16,493		16,493	16,002		16,002
Chile		8,848	8,848		4,953	4,953
Other	1,292	182	1,474	5,093	1,504	6,597
Total	219,166	136,463	355,629	207,311	175,402	382,713

[1] Metal Age, No. 15, March 1953, p. 18.

[49] Ong, J. N., The Tsumeb Story, parts I and II: Min. World, vol. 14, Nos. 6 and 7, May and June 1952, pp. 21–26, 74, and 34–39.
[50] Ventures, Ltd., Annual Report to Stockholders, 1952.

According to the British Bureau of Nonferrous Metal Statistics, United Kingdom exports of copper in 1951 and 1952, in long tons, were as follows:

	1951	1952
Blister or rough	2, 711	6, 273
Plates, sheets, etc	9, 256	8, 185
Wire	10, 424	9, 196
Tubes	4, 846	4, 395

Diatomite

By Henry P. Chandler [1] and Annie L. Marks [2]

PRODUCTION of diatomite in the United States declined during 1952 owing to a temporary suspension of operations resulting from labor disputes in an area of large production. A satisfactory wage adjustment was made and normal output resumed before the end of the year.

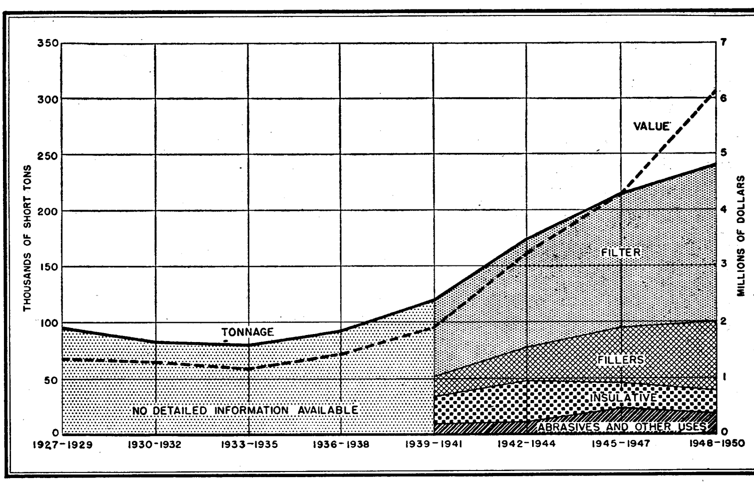

FIGURE 1.—Production, value, and use of diatomite in the United States, 1927–50.

DOMESTIC PRODUCTION

Diatomite, also known as diatomaceous earth or kieselguhr, is an opaline silica material consisting chiefly of the fossil remains of aquatic organisms known as diatoms. Many thousand varieties of diatoms have been recognized. The purest varieties of diatomite are chalklike in appearance, porous, and friable and have, when dry, a specific gravity of less than 1.

California leads in the production of diatomite, followed in order by Nevada, Oregon, and Washington. Diatomite is known to occur in 17 other States and at certain localities has been produced commercially, but production is now restricted to the States mentioned.

The output of diatomite in the United States increased from 81,000 short tons valued at $1,206,000 in the 3-year period 1933–35 to 241,000 short tons valued at $6,154,000 in 1948–50. To avoid disclosing

[1] Commodity-industry analyst.
[2] Statistical clerk.

annual statistics of individual companies, the Bureau of Mines publishes only 3-year averages for this commodity.

The average value per ton of diatomite at the mine has advanced from $14.81 in 1933–35 to $25.55 in 1948–50, an increase of 73 percent.

CONSUMPTION AND USES

Over a period of years the diatomite industry in the United States has developed new uses for its products, and consequently market demands have increased.

Acceptance of diatomite by consumers depends upon its physical structure and other properties in relation to use.

Filtration Medium.—Diatomite is used widely in the filtration of sugar, beverages, water, pharmaceuticals, oils and many other liquid materials. For this use the size, shape, purity, and density are important factors in good filter performance. Forty-eight percent of the 1952 production was used for this purpose.

Mineral Fillers.—Diatomite as a filler serves two purposes—it supplies bulk with little increase in weight, and it imparts desirable physical properties to the end products in which it is used. Color, freedom from grit, low density, inertness, and particle size must be carefully controlled for this use. Twenty-nine percent of the 1952 diatomite output was used as filler in rubber, paper, asphalt products, plastics, explosives, insecticides, paints, and many other products.

Insulation Material.—Because of its high percentage of voids and high melting point, diatomite is a good insulating agent, both for sound and heat. It finds many such uses in industrial equipment and structures. Eleven percent of the production was so used in 1952.

Miscellaneous Uses.—As diatomite is an excellent absorbent without change in form, it finds many uses where this property is required. It is useful also as a mild abrasive, as a catalyst carrier, in ceramics and glazes, as a raw material for ultramarine pigment and sodium silicate, and in various other ways. Twelve percent of the production was consumed for these miscellaneous purposes.

A new motion picture, Celite—The Story of How Diatoms Are Put to Work, has been shown.[3]

PRICES

The Oil, Paint and Drug Reporter quoted the following 1952 prices for diatomite: Domestic, bags, c. l., Atlantic coast, ton, $52–$55; California, ton, $42–$45; l. c. l., warehouse, $85–$90; purified, bags, c. l., Atlantic coast, ton, $65; California, $53; l. c. l., warehouse, $95–$100; Atlantic coast, $95–$100; imported Mexican, white, bags, c. l., Atlantic coast, lb., 3 cents; l. c. l., Atlantic coast, lb., 6 cents.

---

[3] Rock Products, vol. 55, No. 10, October 1952, p. 116.

FOREIGN TRADE

Export and import statistics of diatomite are not reported separately by the Department of Commerce, but significant tonnages are known to be exported.

TECHNOLOGY

The new diatomaceous earth-processing facilities of Great Lakes Carbon Corp. at Lompoc, Calif., were described in the trade press.[4]

Also appearing in the press were articles describing the use of diatomaceous earth for filtering water,[5] oil,[6] and boiler feed water.[7]

The University of Idaho Agricultural Experiment Station is conducting research on a mixture of sawdust-diatomite-clay as a possible source of lightweight aggregate.[8]

A concrete aggregate composed of a mixture of perlite and finely ground diatomaceous earth is claimed to reduce the stratification of aggregate and cement that often occurs in a regular perlite-cement mix, to impart to the concrete marked strength, and to show other desirable characteristics.[9]

RESERVES

Near Lompoc in northern Santa Barbara County, Calif., are large deposits of high-grade diatomite. Nevada, Oregon, and Washington also have large reserves, and a deposit in Rio Arriba County, N. Mex., is under development. The reserves in other States where deposits are known are relatively small and in many instances of low quality. Reserves are believed to be ample to supply domestic requirements for many years.

WORLD REVIEW

World production of diatomite is shown in table 1.

Exports of kieselguhr—or diatomite—have been reported from Algeria,[10] and a review of the expansion of the diatomite industry in Australia, with a list of producers, appeared in a trade magazine.[11]

Existence of diatomite deposits in the Belgian Congo has been noted.[12]

---

[4] Paint, Oil and Chemical Review, Dicalite Builds Outdoors; Diatomite Plant of Great Lakes Carbon Corp.: Vol. 115, No. 11, May 22, 1952, p. 40; Chemical Week, Engineered for Efficiency; Lompoc (Calif.) Plant of Great Lakes Carbon's Dicalite Division: Vol. 70, No. 26, June 28, 1952, pp. 37-38; Chemical Engineering, Mechanized Plant Means More Diatomite: Vol. 59, No. 7, July 1952, pp. 272-274, 276-277.

[5] Martin, D. M., Portable Diatomite Filters for Emergency Use: Water and Sewage Works, vol. 98, No. 11, November 1951, pp. 485-487.

[6] Baskette, L., Filter Aid Cleans Oil of Heavy Sludge: Elec. World, vol. 138, No. 6, Aug. 11, 1952, pp. 153-154.

[7] Norris, T. H., Filtration of Boiler Feed Water Using Diatomaceous Earth: Pulp and Paper Mag. Canada, vol. 53, No. 2, February 1952, pp. 187-193.

[8] Kauffman, A. J., Jr., Industrial Minerals of the Northwest: Bureau of Mines Inf. Circ. 7641, 1952, p. 18.

[9] Bollaert, A. R., et al. (assigned to the Great Lakes Carbon Corp.), Lightweight Concrete Mixture: U. S. Patent 2,585,366, Feb. 12, 1952.

[10] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 3, March 1952, p. 35; vol. 35, No. 1, July 1952, pp. 36-37.

[11] Chemical Engineering and Mining Review, Diatomite Industry in Australia: Vol. 45, No. 1, Oct. 10, 1952, p. 36.

[12] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, p. 48.

TABLE 1—World production of diatomite, by countries,[1] 1948–52, in metric tons

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
North America:					
Canada	42	54	44	83	23
United States [2]	232,800	232,800	232,800	232,800	232,800
South America: Chile	1,061	3,313	154	(3)	(3)
Europe:					
Austria	4,795	3,536	3,285	3,894	(3)
Denmark:					
Diatomite	5,809	4,038	4,122	(3)	(3)
Moler [4]	70,000	70,000	70,000	95,000	(3)
Finland	1,684	1,457	1,025	(3)	(3)
France	48,347	37,632	35,400	37,000	40,000
Germany, West	(3)	29,335	33,707	43,952	(3)
Italy	5,210	6,629	(3)	(3)	(3)
Sweden	1,765	1,844	1,750	(3)	(3)
United Kingdom:					
Great Britain	7,112	10,770	3,796	7,338	(3)
Northern Ireland	6,968	7,914	6,546	8,866	(3)
Africa:					
Algeria	8,409	13,581	13,710	20,992	18,400
Egypt	1,365	1,178	1,062	2,752	711
Kenya	1,035	2,224	2,613	4,286	6,027
Union of South Africa	1,310	1,155	436	----------	1,080
Oceania:					
Australia	4,509	4,128	6,321	8,869	6,980
New Zealand	105	96	121	121	(3)
Total (estimate)	480,000	480,000	470,000	530,000	520,000

[1] Diatomaceous earth believed to be also produced in Argentina, Brazil, Hungary, Japan, Korea, Norway, Portugal, Rumania, Spain, and U. S. S. R., but complete data are not available; estimates by senior author of chapter included in total.
[2] Average annual production 1948–52.
[3] Data not available; estimate by author of chapter included in total.
[4] Estimate.

Feldspar

By Brooke L. Gunsallus[1] and Frances P. Uswald[2]

PRODUCTION of crude feldspar in 1952 increased 5 percent in tonnage and 31 percent in value, according to reports by producers. Ground feldspar increased 1 percent in quantity but decreased 3 percent in value. Inventories of crude feldspar increased during 1952, following a decrease in 1951. Quantity sales of ground feldspar to the pottery industry decreased 23 percent, and sales to the enamel industry decreased less than 1 percent; but the quantity of ground feldspar shipped to the glass industry increased 27 percent in 1952 over 1951. The uptrend in pottery production in 1950 and 1951 did not continue in 1952, largely because of a decreased production of whiteware caused mainly by competition from other materials and imports. The use of feldspar in sanitary ware and electrical insulators decreased because of greater use of substitute materials.

The removal of certain restrictions in the use of steel by the National Production Authority permitted expanded automobile production, which was accompanied by an increased demand for flat glass, a large consumer of feldspar.

Realinement of feldspar producers occurred in 1952 when the International Minerals & Chemical Corp. acquired Consolidated Feldspar Corp., the largest feldspar producer in the United States, and the American Encaustic Tile Co. purchased United Feldspar & Minerals Corp. The Consolidated Feldspar Corp. operated 13 plants in the United States and 1 plant in Canada and was reported to have substantial feldspar reserves.[3]

Imports of crude feldspar from Canada decreased 67 percent in 1952 compared to 1951. Imports of crude nepheline syenite were negligible in 1952, as in 1951. Imports of ground nepheline syenite increased 4 percent in 1952 compared to 1951; Canada was the sole supplier. Total sales of aplite in 1952 decreased 8 percent compared with 1951.

TABLE 1.—Salient statistics of the feldspar industry in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Crude feldspar:						
Domestic sales:						
Long tons	395,386	460,713	369,378	407,925	[1] 400,439	[1] 420,831
Value	$2,097,356	$2,564,387	$2,278,441	$2,558,390	$2,815,587	$3,696,018
Average per long ton	$5.30	$5.57	$6.17	$6.27	$7.03	$8.78
Imports:						
Long tons	14,084	31,047	15,826	12,367	17,128	5,576
Value	$109,237	$219,785	$107,925	$84,136	$146,565	$53,016
Average per long ton	$7.76	$7.08	$6.82	$6.80	$8.56	$9.51
Ground feldspar:						
Sales by merchant mills:						
Short tons	402,728	506,451	386,707	446,523	454,615	458,920
Value	$4,581,841	$6,462,231	$5,609,101	$6,343,619	$6,932,878	$6,712,481
Average per short ton	$11.38	$12.76	$14.50	$14.21	$15.25	$14.63

[1] Includes flotation concentrates.

[1] Commodity-industry analyst.
[2] Statistical clerk.
[3] Rock Products, vol. 55, No. 12, December 1952, p. 108.

DOMESTIC PRODUCTION

CRUDE FELDSPAR

Crude feldspar sold or used by producers in 1952 (table 2) increased 5 percent in quantity and 31 percent in value over 1951. The 1952 production was the largest since 1948, and the value reported in 1952 exceeded all previous years. The average value per ton was $8.78 compared with $7.03 in 1951. Ten States reported production in 1952 compared with 11 in 1951.

North Carolina was the only State that showed an increase in feldspar production in 1952 compared with 1951 and was the largest producer, with 57 percent of the total quantity (42 percent in 1951). South Dakota was second with 10 percent of the total (12 percent in 1951), and Colorado was third with 9 percent of the total (13 percent in 1951).

TABLE 2.—Crude feldspar sold or used by producers in the United States, 1943–47 (average) and 1948–52

Year	Long tons	Value		Year	Long tons	Value	
		Total	Average			Total	Average
1943–47 (average)	395,386	$2,097,356	$5.30	1950	407,925	$2,558,390	$6.27
1948	460,713	2,564,387	5.57	1951	400,439	2,815,587	7.03
1949	369,378	2,278,441	6.17	1952	420,831	3,696,018	8.78

TABLE 3.—Crude feldspar sold or used by producers in the United States, 1950–52, by States

State	1950		1951		1952	
	Long tons	Value	Long tons	Value	Long tons	Value
Colorado	59,457	$329,120	50,451	$283,153	38,268	$224,385
Connecticut	13,580	101,851	13,811	107,083	10,929	87,432
Maine	17,487	124,821	19,273	154,695	18,644	147,371
North Carolina	183,027	1,107,061	166,361	1,230,404	240,364	2,416,031
South Dakota	43,875	249,176	48,559	290,520	40,163	220,954
Texas	(1)	(1)	(1)	(1)	2,600	31,200
Virginia	26,879	188,153	30,979	232,099	(1)	(1)
Other States [2]	63,620	458,208	71,005	517,633	69,863	568.645
Total	407,925	2,558,390	[3] 400,439	2,815,587	[3] 420,831	3,696,018

[1] Included with Other States in order to avoid disclosure of individual company operations.
[2] Includes Arizona, California, Georgia (1950–51), New Hampshire, Texas (1950–51), and Virginia (1952).
[3] Flotation concentrates included in total.

The tonnage of feldspar and feldspathic rock treated in flotation plants became a factor in feldspar production in 1951 and increased in 1952.

The application of froth flotation to pegmatites has provided the feldspar industry with a new source of raw material. Indications are that this process will be more widely used in the future.

GROUND FELDSPAR

Ground feldspar sold by merchant mills in the United States increased 1 percent in 1952 compared with 1951 and was the largest quantity sold since 1948. The total value decreased 3 percent compared with 1951, and the average selling price decreased from $15.25

to $14.63. Ground feldspar was reported by mills in 14 States in 1952, the same as for the past several years.

North Carolina again reported the largest quantity of ground feldspar, followed by Tennessee, Colorado, and South Dakota. Ground-feldspar production in Tennessee increased while the quantity in Colorado and South Dakota decreased during 1952 compared to 1951. New Jersey and New York also reported decreases.

The percentage of total shipments of ground feldspar for several States was: North Carolina-Tennessee, 59 percent (43 percent in 1951); New York-New Hampshire, 6 percent (7 percent in 1951); Connecticut-New Jersey, 4 percent (6 percent in 1951); and Maine, 4 percent (5 percent in 1951).

TABLE 4.—Ground feldspar sold by merchant mills [1] in the United States, 1943–47 (average) and 1948–52

Year	Active mills	Domestic feldspar			Canadian feldspar			Total	
		Short tons	Value		Short tons	Value		Short tons	Value
			Total	Average		Total	Average		
1943–47 (average)	28	391,254	$4,346,581	$11.11	11,474	$235,260	$20.50	402,728	$4,581,841
1948	28	487,070	5,991,059	12.30	19,381	471,172	24.31	506,451	6,462,231
1949	27	369,824	5,212,246	14.09	16,883	396,855	23.51	386,707	5,609,101
1950	23	429,787	5,952,019	13.85	16,736	391,600	23.40	446,523	6,343,619
1951	23	441,816	6,633,378	15.01	12,799	299,500	23.40	454,615	6,932,878
1952	24	448,839	6,473,203	14.42	10,081	239,278	23.74	458,920	6,712,481

[1] Excludes potters and others who grind for consumption in their own plants.

TABLE 5.—Ground feldspar sold by merchant mills [1] in the United States, 1950–52, by States

State	1950			1951			1952		
	Active mills	Short tons	Value	Active mills	Short tons	Value	Active mills	Short tons	Value
Colorado	2	62,879	$663,712	(2)	(2)	(2)	(2)	(2)	(2)
Connecticut	2	25,532	510,501	2	25,740	$528,246	2	19,109	$386,191
New Jersey	1			1			1		
Georgia	(2)	(2)	(2)	1	47,755	668,347	(2)	(2)	(2)
Virginia	(2)	(2)	(2)	2					
Maine	3	19,938	352,809	3	20,504	376,258	3	16,791	317,365
New Hampshire	(2)	(2)	(2)	2	34,149	716,660	2	28,592	605,342
New York	(2)	(2)	(2)	1			1		
North Carolina	3	200,373	2,526,268	3	197,704	2,886,655	3	270,775	3,714,084
Tennessee	1			1			1		
Texas							1	2,000	30,000
Other States [3]	11	137,801	2,290,329	7	128,763	1,756,712	10	121,653	1,659,499
Total	23	446,523	6,343,619	23	454,615	6,932,878	24	458,920	6,712,481

[1] Excludes potters and others who grind for consumption in their own plants.
[2] Included with "Other States."
[3] Includes (number of active mills in parentheses) Arizona (1), California (1 in 1950–51, 2 in 1952), Colorado (2 in 1951–52), Georgia (1 in 1950), Illinois (1), New Hampshire (2 in 1950), New York (1 in 1950), South Dakota (2), and Virginia (2 in 1950 and 1952).

CONSUMPTION AND USES

CRUDE FELDSPAR

Many merchant grinders also mine feldspar, either themselves or through affiliated firms. A large part of their supply of crude feldspar, however, is purchased from small operators.

Most of the consumers of feldspar buy material already ground, sized, and ready for use in their manufactured products. Some pottery, enamel, and soap manufacturers, however, purchase all or part of their requirements crude and crush and grind it to their own specifications in their own mills. Consumers in the United States buy some crude feldspar from producers in Canada. A small, but carefully selected, tonnage is used in the manufacture of artificial teeth.

GROUND FELDSPAR

Glass, pottery, and enamel industries in 1952 consumed 99 percent of the ground feldspar sold by merchant mills, the same as in 1951, 1950, and 1949 (table 6). In 1952 glass accounted for 55 percent (43 percent in 1951); pottery, 39 percent (51 percent in 1951); and enamel, 5 percent (5 percent in 1951). The remaining 1 percent was consumed in other industries, including soaps and abrasives. The tonnage shipped to the pottery industry decreased 23 percent, but shipments to the glass industry increased 27 percent. Shipments to the enamel industry decreased less than 1 percent. Shipments to all other industries increased about 70 percent in 1952 over 1951.

The percentage of total consumption by States in 1952 (table 7) was as follows; the comparable 1951 figure being shown in parentheses: Pennsylvania, 14 percent (13 percent); Ohio, 13 percent (15 percent); West Virginia, 11 percent (8 percent); Illinois, 11 percent (12 percent); New Jersey, 10 percent (12 percent); and New York, 7 percent (7 percent).

TABLE 6.—Ground feldspar sold by merchant mills in the United States, 1950–52, by uses

Use	1950		1951		1952	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Ceramic:						
Glass	212,481	47.6	197,483	43.4	251,489	54.8
Pottery	197,817	44.3	231,725	51.0	179,469	39.1
Enamel	33,037	7.4	21,778	4.8	21,809	4.8
Other ceramic uses					2,478	.5
Soaps and abrasives	3,028	.7	2,832	.6	3,267	.7
Other uses	160		797	.2	408	.1
Total	446,523	100.0	454,615	100.0	458,920	100.0

Names and addresses of merchant grinders of feldspar in the United States are listed below:

Abingdon Potteries, Inc., 801 West Main St., Abingdon, Ill.
Carolina Mineral Co., Inc., Erwin, Tenn.
Clinchfield Sand & Feldspar Corp., 413 Washington Ave., Towson 4, Baltimore, Md.
Consolidated Feldspar Corp., Dept. of International Mineral & Chemical Corp., Erwin, Tenn.
Del Monte Properties Co., 620 Market St., San Francisco, Calif.
Dezendorf Marble Co., P. O. Box 121, Austin, Tex.
Eureka Mica Mining & Milling Co., Portland, Conn. (Eureka Flint & Spar Co., Inc., 190 West State St., Trenton, N. J., sales agent).
Feldspar Flotation, Inc., Spruce Pine, N. C.
Feldspar Milling Co., Burnsville, N. C.
Gladding, McBean & Co., 2901 Los Feliz Blvd., Los Angeles, Calif.
Golding-Keene Co., 1401 New York Ave., Trenton, N. J.
J. F. Morton, Inc., P. O. Box 246, Bellows Falls, Vt.
North Carolina Feldspar Corp., Erwin, Tenn.

Standard Flint & Spar Corp., New York Ave., Trenton 8, N. J.
Topsham Feldspar Co., Topsham, Maine.
United Feldspar & Minerals Corp., 1104 E. Wendover, Greensboro, N. C.
Western Feldspar Milling Co., Box 671, Salida, Colo.
Worth Spar Co., P. O. Box 763, Middletown, Conn.

Aplite

Carolina Mineral Co., Inc., Kona, N. C.
Dominion Minerals, Inc., Piney River, Va.

TABLE 7.—Ground feldspar shipped, by States of destination, from merchant mills in the United States, 1948–52, in short tons

Destination	1948	1949	1950	1951	1952
California	8,406	8,385	(1)	(1)	(1)
Illinois	66,064	51,202	56,513	53,940	51,808
Indiana	37,774	25,962	28,875	25,692	30,976
Maryland	19,832	16,371	20,861	19,109	17,214
Massachusetts	4,437	1,944	5,733	6,176	4,715
New Jersey	52,587	44,243	53,430	54,968	47,046
New York	20,887	19,900	22,362	31,086	31,614
Ohio	64,805	52,533	68,186	70,245	60,884
Oklahoma	13,315	15,722	(1)	(1)	(1)
Pennsylvania	87,021	57,160	57,190	60,306	65,167
Tennessee	10,211	7,917	11,202	10,679	13,392
West Virginia	60,310	30,393	37,246	37,062	52,421
Wisconsin	11,741	10,749	12,580	11,558	9,880
Other destinations [2]	49,061	44,226	72,345	73,794	73,803
Total	506,451	386,707	446,523	454,615	458,920

[1] Included with "Other destinations"; separate figure for State not available.
[2] Includes Arkansas, California (1950–52), Colorado, Connecticut, Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Oklahoma (1950–52), Puerto Rico (1948–50 and 1952), Rhode Island, Texas, Washington (1948–50 and 1952), shipments which cannot be segregated by States, and small shipments to Belgium, Canada, England, France, Mexico, and Peru. Also includes specified shipments to Alabama (1949 and 1952), Arizona (1952), Connecticut (1952), Florida (1949 and 1952), Georgia (1952), Kansas (1948 and 1952), Maine (1948 and 1950), North Carolina (1952), North Dakota (1952), and Virginia (1952).

PRICES

Price quotations for crude feldspar do not appear in the trade press. Average values are computed from the returns of producers reporting their output annually to the Bureau of Mines. In 1952 the average selling price per long ton for all feldspar mined in the United States was $8.78 compared to $7.03 in 1951 and $6.27 in 1950.

The average realization per short ton for ground feldspar in 1952 was $14.63, a 4-percent decrease from 1951 but a 3-percent increase over 1950. Of the large producing States, the State having the highest average value per short ton was New Jersey, $27.85 ($26.64 for 1951), followed by New York, $23.74 ($23.40 for 1951), and Illinois, $21.49 ($20.47 for 1951). North Carolina, by far the largest producer, realized only $13.71 per short ton in 1952. The State reporting the lowest average value per short ton in 1952 was Colorado, $10.76 ($11.11 for 1951).

Quotations on ground feldspar appearing in E&MJ Metal and Mineral Market Reports for December 1952 were the same as in each previous year, starting with 1949, as follows: North Carolina, bulk carlots, 200-mesh, $18.50 per short ton; 325-mesh, $22.50; glass feldspar, No. 18, $12.50; and semigranular, $11.75 (add $3.00 per ton to bulk quotation for bags and bagging). Quotations on Virginia feldspar were not listed in E&MJ for 1952. The following prices were given for 1951: No. 1, 230-mesh, $18.50 per ton, and 200-mesh, $17.50; No. 17 glassmakers' feldspar, $11.75, and No. 18, $12.50. Enamelers' feldspar was listed at $15 to $18.

FOREIGN TRADE [4]

Crude feldspar imports for consumption in 1952 totaled 5,576 long tons (all from Canada), valued at $53,016. Compared with 1951, there was a 67-percent decrease in tonnage and a 64-percent decrease in value. This was the lowest imported tonnage of feldspar since 1933.

According to reports by the merchant grinders, ground feldspar exported from the United States in 1952 totaled 3,431 short tons, a 43-percent increase above 1951. Countries of destination were Canada, Mexico, France, Belgium, Peru, Puerto Rico, and the United Kingdom.

TABLE 8.—Feldspar imported for consumption in the United States, 1947–52

[U. S. Department of Commerce]

Year	Crude		Ground		Year	Crude		Ground	
	Long tons	Value	Long tons	Value		Long tons	Value	Long tons	Value
1947	16,685	$124,587			1950	12,367	$84,136		
1948	31,047	219,785	(1)	$328	1951	17,128	146,565	(1)	$26
1949	15,826	107,925			1952	5,576	53,016		

[1] Less than 1 ton.

Cornwall Stone.—Imports for consumption of unmanufactured cornwall stone in 1952 decreased 68 percent compared with 1951. Imports of ground cornwall stone decreased 73 percent. The source of imports, either crude or ground, is the United Kingdom.

TABLE 9.—Cornwall stone imported for consumption in the United States, 1947–52

[U. S. Department of Commerce]

Year	Unmanufactured		Ground		Year	Unmanufactured		Ground	
	Long tons	Value	Long tons	Value		Long tons	Value	Long tons	Value
1947	706	$9,522	148	$3,124	1950	1,128	$11,792	111	$2,160
1948	1,124	15,633	117	2,719	1951	944	9,453	110	3,462
1949	772	11,200	20	572	1952	300	3,170	30	800

NEPHELINE SYENITE

Domestic Deposits.—Samples from the only reported occurrence of nepheline syenite in California are being tested. These samples were taken from the Quartz Spring area in the northern Panamint Mountains, near Death Valley.[5] Nepheline syenite also occurs in New Jersey, Arkansas, and other localities in the United States, but all the domestic material found thus far in any appreciable tonnage has contained too much iron for ceramic purposes.

Uses.—Nepheline syenite originally was used almost entirely in the manufacture of glass when it was first introduced commercially, about

[4] Figures on imports are compiled by Mae B. Price and Elsie D. Page of the Bureau of Mines, from records of the U. S. Department of Commerce.

[5] California Department of Natural Resources, Division of Mines, Mineral Information Service, vol. 5, No. 2, February 1952, p. 7.

1940. During the last decade many other applications have been developed for nepheline syenite in the ceramic industry, resulting in a steadily increasing demand.

Prices.—Quotations on crude nepheline syenite are not reported in trade journals. Imports of the crude material have been negligible since the American Nepheline, Ltd., of Ontario, Canada, moved its grinding plant from Rochester, N. Y., the only syenite-grinding plant in the United States, to Ontario, Canada, in 1951. Even though this grinding plant no longer existed, the Oil, Paint and Drug Reporter continued to quote nepheline syenite prices f. o. b., works, N. Y. The quotations in 1952 were as follows: Glass grade (24-mesh), bulk, f. o. b., works, N. Y., $14.25; and Pottery grade (200-mesh), bulk, f. o. b., works, N. Y., $18.25. An additional cost of $3.00 per ton was quoted for bagged material. These prices were the same as in December 1950.

Foreign Trade.—Imports of ground nepheline syenite increased 4 percent in 1952 over 1951. The average value per ton (foreign market value) of ground nepheline syenite imported was $14.39 in 1952. Canada was the sole supplier of both crude and ground material to the United States.

Although deposits of nepheline syenite have been reported in India and Finland, no activity has been reported. It is known that deposits of nepheline syenite were being worked in U. S. S. R. on a commercial scale, but production data are not available.

TABLE 10.—Nepheline syenite imported for consumption in the United States, 1947–52

[U. S. Department of Commerce]

Year	Crude		Ground		Year	Crude		Ground	
	Short tons	Value	Short tons	Value		Short tons	Value	Short tons	Value
1947	54,382	$194,283			1950	8,966	$36,453	54,242	$703,008
1948	53,570	214,747	7,577	$130,860	1951	(1)	(1)	[2] 65,773	[2] 936,256
1949	41,215	167,567	18,779	248,224	1952	4	125	68,398	984,050

[1] Revised to none.
[2] Revised figure.

APLITE

The tonnage of aplite produced has decreased progressively for the past 4 years, but the Bureau of Mines is not at liberty to publish production or sales data. The only producers of aplite were Dominion Minerals, Inc., Piney River, Nelson County, Va., and Carolina Mineral Co., Inc., Kona, N. C., from mines in Amherst County, Va., near Piney River.

TECHNOLOGY

Samples of granites and pegmatites from several New Jersey localities were investigated by mineral-dressing methods to determine the feasibility of producing marketable grades of feldspar.[6] The results of tests on samples from three areas indicated potential commercial reserves.

A study of sand samples from the vicinity of Kansas City, Kans.,

[6] Lodding, William, New Jersey's Potential Feldspar Resources, Mineral, Technology, and Economic Evaluation: Rutgers Univ. Min. Res., Bull. 5, part 2, Rutgers, N. J., 70 pp.

was made by the State geological survey. The samples were treated by flotation methods to determine the feasibility of producing feldspar and silica concentrates suitable for use in glass and allied industries.[7]

A simple procedure for correction of mineral compositions calculated from feldspar analyses was illustrated.[8] The fluxing ability of commercial feldspars in glasses, glazes, or enamels and their tendency to produce disruptive expansion as a result of quartz inversion when used in bodies were reported as a function of their mineral composition. The flotation process, as applied to feldspar, was discussed.[9]

A study of eutectic glasses and fluxes in whiteware bodies was made.[10] Feldspar is the normal vitrifying agent in most whiteware bodies, and in this research the reaction of the various auxiliary fluxes with various feldspars was studied under commercial plant conditions.

WORLD REVIEW

The estimated world production of feldspar in 1952 increased 6 percent compared to 1951. The output of China and U. S. S. R., for which no data are available, is not included in the total.

The ratio of United States output to estimated world output in 1952 was 52 percent compared with 53 percent in 1951 and 58 percent in 1950. West Germany showed a remarkable increase of 67 percent in 1952 over 1951. The location of Italian feldspar deposits and production figures were given.[11]

[7] Bowdish, F. W., and Runnels, R. T., Experimental Production of Feldspar and Silica from Severa River Sands in Kansas: State Geol. Survey of Kansas, Bull. 96, part 6, 1952, 21 pp.

[8] Cofflen, William W., Simple Procedure for Correction of Mineral Compositions Calculated from Feldspar Analyses: Ceram. Age, vol. 60, No. 6, December 1952, p. 29.

[9] Ceramic Industry, vol. 58, No. 4, April 1952, pp. 114–115, 175.

[10] Watts, Arthur S., A Study of Eutectic Glasses as Fluxes in Whiteware Bodies: Ceram. Bull., vol. 31, No. 11, November 1952, pp. 456–461.

[11] Ceramic Age, vol. 60, No. 2, 1952, p. 441.

TABLE 11.—World production of feldspar by countries,[1] 1948–52, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
North America:					
Canada (sales)	49,760	33,518	32,248	36,967	19,740
United States (sold or used)	468,107	375,307	414,472	406,866	427,585
South America:					
Brazil	189	11,111	12,000	(3)	(3)
Chile	885	125	871	1,200	(3)
Peru	210	300		131	
Uruguay	4,877	811	710	675	898
Europe:					
Austria	1,106	1,912	3,802	3,751	2,578
Finland	6,064	10,074	8,000	8,198	9,790
France	55,343	47,514	42,000	66,000	65,000
Germany, West	32,921	48,262	76,712	71,531	119,291
Italy	15,309	13,522	18,071	29,144	25,476
Norway	33,117	27,482	23,695	31,118	[4] 23,000
Portugal	1,560	1,240		470	(3)
Spain (quarry) [5]	6,600	396	1,650	1,760	(3)
Sweden	38,687	38,959	36,031	41,072	(3)
Asia:					
India	1,003	863	1,800	3,195	(3)
Japan [6]	25,077	20,055	13,187	26,528	24,194
Africa:					
Eritrea	300	200			
Kenya	10	20			
Southern Rhodesia			3,520	1,148	
Union of South Africa	2,574	3,549	6,001	3,343	7,479
Australia [7]	9,767	10,902	13,276	14,473	13,903
Total (estimate) [1]	770,000	660,000	720,000	770,000	815,000

[1] In addition to countries listed, feldspar is produced in Argentina, China, Czechoslovakia, Rumania, and U. S. S. R., but data are not available; estimates by senior author of chapter are included in the total except for China and U. S. S. R.
[2] This table incorporates a number of revisions of data published in previous feldspar chapters.
[3] Data not available; estimate by senior author of chapter included in total.
[4] Estimate.
[5] In addition, the following quantity of feldspar is reported as ground, but there is no crude production data to support this ground figure: 1948, 7,967 tons; 1949, data not available; 1950, 8,254 tons; 1951, 11,043 tons; 1952, 10,359 tons.
[6] In addition, the following quantities of aplite and other feldspathic rock were produced: 1948, 35,840 tons; 1949, 50,943 tons; 1950, 45,679 tons; 1951, 59,919 tons; 1952, data not available.
[7] Includes some china stone.

Ferroalloys

By Robert W. Geehan [1]

DESPITE a decline in production of ferroalloys during 1952, compared with the alltime high of 1951, the year was marked by major construction of facilities designed to increase capacity.[2] The construction program was designed to provide capacity needed to match the scheduled increase in steelmaking. The steel strikes of 1952 led to a decline in production of ferromanganese and ferrosilicon. Significant developments during the year included substantial use of electrolytic manganese in stainless steel, an increased use of rare-earth products in steel, and an increase in the relative quantity of ferromanganese produced in electric furnaces.

DOMESTIC PRODUCTION

In 1952 ferroalloys were made in 12 blast-furnace plants, 38 electric-furnace plants, and 3 aluminothermic-furnace plants. Pennsylvania again led all other States in production (28 percent), shipments (29 percent), and value (35 percent) of ferroalloys. Ohio was second in production and shipments; however, New York was second in value of shipments. Production was also reported from Alabama, California, Florida, Idaho, Indiana, Iowa, Kentucky, Montana, New Jersey, Oregon, South Carolina, Tennessee, Virginia, Washington, and West Virginia.

Ferromanganese, ferrosilicon, and spiegeleisen are produced in blast furnaces; however, the only ferroalloy containing a high percentage of the alloying metal that is mainly so produced is ferromanganese. Most of the ferromolybdenum, a small part of the ferromanganese and ferrotitanium, and some ferrotungsten are produced by the aluminothermic method. The other ferroalloys and a portion of all those mentioned above, except spiegeleisen, are produced in electric-furnace plants.

Ferromanganese produced in 1952 averaged 77 percent manganese (76 percent in 1951) and came from 7 blast-furnace plants, 9 electric-furnace plants, and 1 aluminothermic plant. The blast-furnace group contributed nearly 3 times as much material in 1952 as the others combined; however, the ratio of blast furnace to total ferromanganese declined 7 percent from that of 1951. Manganese ore used to produce ferromanganese in 1952 comprised 92 percent from foreign sources and 8 percent from domestic mines. The steel industry consumed nearly all the ferromanganese used in 1952. High-carbon ferromanganese is satisfactory for the bulk of steel production; but the low-carbon alloy is required in some alloy steels, for example, austenitic stainless steels.

[1] Assistant chief, Ferrous Metals and Alloys Branch.
[2] Brown, D. I., Ferroalloys; New Plants Shown: Iron Age, vol. 170, No. 5, July 31, 1952, p. 39. Keeley, W. C., Ferroalloys Production to Increase Further in 1953: Daily Metal Reporter, vol. 53, No. 2, Jan. 3, 1953, pp. 1–2. American Metal Market, Expansion Goal for Ferrosilicon Seen Adequate: Vol. 59, No. 212, Nov. 1, 1952, p. 1; Jour. Metals, vol. 4, No. 1, January 1952, p. 19.

TABLE 1.—Ferroalloys produced and shipped from furnaces in the United States, 1951–52

Alloy	1951			1952		
	Production (short tons)	Shipments		Production (short tons)	Shipments	
		Short tons	Value		Short tons	Value
Ferromanganese	791, 260	795, 745	$122, 346, 198	758, 721	738, 088	$133, 996, 006
Ferrosilicon	861, 889	846, 111	93, 668, 232	781, 888	760, 981	84, 095, 168
Ferrochromium [1]	227, 467	233, 209	84, 021, 476	248, 421	242, 572	88, 937, 103
Ferrophosphorus	52, 145	67, 891	1, 573, 215	50, 850	53, 960	2, 672, 731
Ferrotitanium, Ferrovanadium	12, 261	12, 165	15, 214, 759	12, 051	11, 577	13, 328, 409
Ferrotungsten, Ferromolybdenum, Other molybdenum products	34, 624	36, 351	58, 226, 821	33, 372	33, 366	52, 019, 126
Spiegeleisen, Silicomanganese, Manganese briquets	194, 707	196, 951	29, 397, 032	176, 628	177, 074	26, 586, 156
Other ferroalloys [2]	19, 400	18, 927	6, 846, 363	20, 768	20, 848	7, 224, 269
Total	2, 193, 753	2, 207, 350	411, 294, 096	2, 082, 699	2, 038, 466	408, 858, 968

[1] Includes ferrochrome-silicon.
[2] Ferrocolumbium, ferroboron, zirconium-ferrosilicon, and miscellaneous ferroalloys.

The Ferromanganese Industry Advisory Committee, National Production Authority, recommended a change in specifications.[3] The group reported that standard ferromanganese, containing 78 to 82 percent manganese, was difficult to produce from the lower-grade ore being received. It was suggested that the standard-grade for ferromanganese be set at 72 to 76 percent manganese.

Production of spiegeleisen declined 24 percent in 1952 as compared with 1951. Spiegeleisen is an iron-blast-furnace product of high manganese content (average 20 percent in 1952); it is normally made from manganese-bearing material too low-grade for use in production of ferromanganese. Uses are essentially the same as those of ferromanganese, but more time is required for melting and for removal of carbon from the product if equivalent quantities of manganese are compared.

Silicomanganese is used in the production of low-carbon ferromanganese and for introducing manganese into low-carbon steels. Production of silicomanganese increased 19 percent compared with 1951.

From the standpoint of tonnage, more ferrosilicon is produced than any other ferroalloy. Of the total ferroalloy production in 1952, 38 percent was ferrosilicon. Production and shipments of ferrosilicon listed on table 1 include silvery pig iron, ferrosilicon of various grades, and ferrosilicon briquets. Silvery pig iron is produced in blast furnaces, ferrosilicon is manufactured in electric furnaces, and ferrosilicon briquets are produced from the latter and standardized as to silicon content (normally either 1 or 2 pounds per briquet). During 1952 there was a significant change in foreign trade; a substantial decline in imports of ferrosilicon and an increase in exports reflected increased productive capacity in the United States.

[3] American Metal Market, vol. 59, No. 213, Nov. 4, 1952, p. 1.

342070—55——27

TABLE 2.—Producers of ferroalloys in the United States in 1952

Producer	Plant	Alloy
American Agricultural Chemical Co.	South Amboy, N. J.	Ferrophosphorus (byproduct).
Anaconda Copper Mining Co.	Anaconda, Mont.; Black Eagel, Mont.	Ferromanganese.
Bethlehem Steel Co.	Johnstown, Pa.	Do.
Chromium Mining & Smelting Co., Ltd.	Riverdale, Ill.	Chrom Sil-X, Chrom-X.
Climax Molybdenum Co.	Langeloth, Pa.	Ferromolybdenum, calcium molybdate, molybdenum silicide, ammonium molybdate, molybdenum oxide, oxide briquets, molybdenum trioxide, sodium molybdate, cobalt molybdenum, molybdenum sulfide.
Electro-Metallurgical Co.	Alloy, W. Va.; Ashtabula, Ohio; Columbiana, Ohio; Holcomb Rock, Va.; Marietta, Ohio; Niagara Falls, N. Y.; Portland, Oreg.; Sheffield, Ala.	Ferromanganese, silicomanganese, manganese briquets, manganese metal, ferrosilicon, silicon metal, silicon briquets, zirconium-ferrosilicon, ferrochromium, chromium briquets, chromium metal, ferrotungsten, ferrovanadium, ferroboron, ferrocolumbium, ferrotitanium.
General Abrasive Co., Inc.	Niagara Falls, N. Y.	Ferrosilicon (byproduct).
Globe Iron Co.	Jackson, Ohio	Silvery pig iron, ferrosilicon.
Hanna Furnace Corp.	Buffalo, N. Y.	Silvery pig iron.
Inland Steel Co.	E. Chicago, Ind.	Spiegeleisen.
Jackson Iron & Steel Co.	Jackson, Ohio	Silvery pig iron.
Kaiser Aluminum & Chemical Corp.	Permanente, Calif.	Ferrosilicon.
Keokuk Electro-Metals Co.	Keokuk, Iowa; Wenatchee, Wash.	Ferrosilicon, silvery pig iron, silicon metal.
E. J. Lavino & Co.	Reusens, Va.; Sheridan, Pa.	Ferromanganese.
Metal & Thermit Corp.	Carteret, N. J.	Ferrotitanium.
Molybdenum Corp. of America	Washington, Pa.	Ferromolybdenum, molybdic oxide, ferrotungsten, manganese boride, ferroboron.
Monsanto Chemical Co.	Anniston, Ala.	Ferrosilicon.
	Columbia, Tenn.	Ferrophosphorus (byproduct).
Montana Ferro-Alloys Co.	Memphis, Tenn.	Ferrochromium, chrome silicide.
New Jersey Zinc Co.	Palmerton, Pa.	Spiegeleisen, ferromanganese.
Ohio Ferro-Alloys Co.	Brilliant, Ohio	Ferrochromium, ferrosilicon.
	Philo, Ohio	Ferrosilicon, ferrosilicon-boron, simanal, silicon metal.
	Tacoma, Wash.	Ferrosilicon, silicon metal.
Oldbury Electro-Chemical Co.	Niagara Falls, N. Y.	Ferrophosphorus (byproduct).
Pacific Northwest Alloys, Inc.	Mead, Wash.	Ferrosilicon.
Pittsburgh Metallurgical Co.	Calvert City, Ky.	Ferrosilicon, silicon metal, ferrochromium, ferrochrome silicon.
	Charleston, S. C.	Ferrosilicon, ferrochromium, ferrochrome silicon.
	Niagara Falls, N. Y.	Ferrosilicon, ferrochromium.
Tennessee Products & Chemical Corp.	Chattanooga, Tenn.	Ferrosilicon, ferrosilicon briquets, ferromanganese, ferromanganese briquets.
Tennessee Valley Authority	Muscle Shoals, Ala.	Ferrophosphorus (byproduct).
Titanium Alloy Mfg. Div., National Lead Co.	Niagara Falls, N. Y.	Ferrotitanium, ferrocarbontitanium.
U. S. Steel Corp., subsidiaries	Clairton, Pa.; Etna, Pa.; Duquesne, Pa.; Ensley, Ala.	Ferromanganese.
Vanadium Corp. of America	Bridgeville, Pa.; Graham, W. Va.; Niagara Falls, N. Y.	Ferrotitanium, ferrocarbontitanium, ferrovanadium, ferrosilicon, silicon briquets, silicon metal, ferrochromium, ferrochromium briquets, chrome silicon alloy, alsifer, grainals, alumino vanadium, ammonium meta vanadate, titanium aluminum.
Victor Chemical Works	Mount Pleasant, Tenn.	Ferrophosphorus (byproduct).
Virginia-Carolina Chemical Corp.	Charleston, S. C.; Nichols, Fla.	Do.
Westvaco Chemical Div., Food Machinery & Chemical Corp.	Pocatello, Idaho	Do.

Production of ferroboron in 1952 was about half that of 1951; this, in part, reflected the greater availability of other ferroalloys in 1952.

Production and shipments of ferrophosphorus declined 2 percent and 21 percent, respectively, compared with 1951 data.

Table 3 lists the various grades of ferrosilicon and the silicon metal consumed, along with an end-use breakdown based on a tabulation that lists the entire consumption of each reporting plant under the most important use at that location. Silvery pig iron is used chiefly by iron foundries. Standard-grade ferrosilicon (about 50 percent silicon), consumed mainly by the steel industry, is used as a deoxidizer and solidifier in manufacturing most grades of killed and semikilled steel. The higher grade alloys are used in ladle additions in gray-iron foundries, in the manufacture of high-silicon steel for use in electrical equipment and spring steel, and in plants producing magnesium by the ferrosilicon method. Ferrosilicon briquets are used at both steel plants and iron foundries. Silicon alloys containing other elements are produced for special uses.

Silicon metal is used by establishments manufacturing low-carbon alloys, by manufacturers of silicon products, and large quantities are consumed by the aluminum industry.[4]

TABLE 3.—Consumption of ferrosilicon, silicon metal, and miscellaneous silicon alloys in the United States in 1952, by end use, in short tons

Alloy	Percent silicon content	Steel ingots and castings	Steel castings [1]	Iron foundries and miscellaneous	Total
Silvery pig iron	5–13	12,456	23,197	185,194	220,847
Do	14–20	51,666	7,213	115,552	174,431
Ferrosilicon	[2] 21–55	144,651	20,508	12,365	177,524
Do	56–70	20,522	182	384	21,088
Do	71–80	39,448	967	22,571	62,986
Do	81–89	3,721	76	1,506	5,303
Do	90–95	4,948	104	2,195	7,247
Silicon metal or refined silicon		7	8	14,237	14,252
Other silicon alloys [3]		25,731	5,109	38,262	69,102
Total		303,150	57,364	392,266	752,780

[1] Data for castings made by companies that also produce steel ingots are included with "Steel ingots and castings" and excluded from "Steel castings."

[2] Nearly all this material is in the range from 40 to 55 percent silicon.

[3] Including Sil-X, Alsifer, and ferrosilicon briquets.

PRICES

A summary of monthly prices for ferromanganese and spiegeleisen since 1936 and 50-percent ferrosilicon since 1939 was published.[5]

[4] Iron Age, Silicon: Vol. 170, No. 14, Oct. 9, 1952, pp. 282–283.

[5] Iron Age, vol. 171, No. 1, Jan. 1, 1953, p. 435.

TABLE 4.—Prices of ferroalloys, 1952

Material	Unit	Price	
		Jan. 1, 1952	Dec. 31, 1952
Ferrochrome:			
High-carbon	Lb. of Cr [1]	$0.2175	[2] $0.2475
Low-carbon	do. [1]	.3050	[2] .3450
Ferrocolumbium	Lb. of Cb	4.90	4.90
Ferromanganese: 78-82 percent Mn	Gross ton	185.00	[3] 225.00
Ferromolybdenum	Lb. of Mo	1.32	1.32
Ferrophosphorus:			
18 percent P	Gross ton	58.50	58.50
24 percent P	do	75.00	75.00
Ferrosilicon:			
50 percent Si	Lb. of Si [1]	.124	.124
75 percent Si	do. [1]	.156	[4] .143
Ferrotungsten: 75-80 percent W	Lb. of W	5.00	[5] 4.85
Ferrovanadium:			
Open-hearth grade	Lb. of V	3.00	3.00
Crucible grade	do	3.10	3.10
Low C and Si	do	3.20	3.20
Silicomanganese	Lb. [6]	.099	[7] .114
Spiegeleisen: 19-21 percent Mn	Gross ton [6]	75.00	[7] 85.00

[1] Carlots, delivered in Eastern zone.
[2] Change Nov. 25.
[3] Change Aug. 8.
[4] Change Nov. 13.
[5] Change June 26.
[6] Carlots.
[7] Change Aug. 8.

FOREIGN TRADE [6]

The most significant changes in imports during 1952 as compared with 1951 were decreases of high-carbon ferrochrome, high-carbon ferromanganese, and ferrotungsten; a very marked decrease in imports of ferrosilicon; and increases in imports of chromium metal and ferromanganese from 1 to 4 percent carbon. Sources of ferromanganese and ferrosilicon are listed in table 5.

During 1952 exports greater than those of 1951 included ferrochrome, ferromanganese, and ferrosilicon; those less than 1951 included ferromolybdenum and ferrophosphorus.

[7] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 5.—Ferroalloys and ferroalloy metals imported for consumption in the United States, 1951–52, by varieties

[U. S. Department of Commerce]

Variety of alloy	1951			1952		
	Gross weight (short tons)	Content (short tons)	Value	Gross weight (short tons)	Content (short tons)	Value
Chromium metal	93	(1)	$149,808	151	(1)	$255,476
Chromium-silicon	5	(1)	438			
Ferrocerium and other cerium alloys	(2)	(1)	4,543	3	(1)	43,733
Ferrochrome or ferrochromium:						
Containing 3 percent or more carbon	24,255	14,370	5,209,687	18,540	10,165	3,672,671
Containing less than 3 percent carbon	3,036	2,062	913,399	2,814	1,940	1,177,836
Ferrochromium tungsten, chromium tungsten, and chromium cobalt tungsten (tungsten content)	(1)	(3)	9,013	(1)	(4)	4,814
Ferromanganese:						
Containing not over 1 percent carbon	235	197	75,561			
Containing over 1 and less than 4 percent carbon	18,924	15,618	4,426,898	23,535	18,890	6,905,950
Containing not less than 4 percent carbon	100,605	79,131	15,543,680	40,560	32,139	7,852,994
Ferromolybdenum, molybdenum metal and powder, calcium molybdate and other compounds and alloys of molybdenum (molybdenum content)	(1)	(5)	46	(1)	(6)	7,887
Ferrosilicon	29,482	10,997	2,532,821	12,824	2,235	671,802
Ferrosilicon-aluminum, ferroaluminum silicon and Alsimin	248	(1)	97,224			
Ferrotitanium	248	(1)	147,478	112	(1)	116,744
Ferrotungsten	1,009	787	3,535,033	315	239	1,150,999
Ferrovanadium	62	(1)	100,261	11	(1)	22,132
Manganese-boron, manganese metal, and spiegeleisen not over 1 percent carbon (manganese content)	(1)	(7)	91			
Manganese silicon	(1)	106	28,165	(1)	50	20,936
Silicon-aluminum and aluminum-silicon	37	(1)	20,548	2	(1)	988
Silicon metal (silicon content)	169	164	54,590	(8)	(8)	624
Spiegeleisen				44	(1)	3,658
Tungsten and combinations, in lump, grains, or powder:						
Tungsten metal (tungsten content)	(1)	43	141,206	(1)	1	7,123
Tungsten carbide (tungsten content)				(1)	(9)	1,677
Tungsten nickel, and other compounds of tungsten, n. s. p. f. (tungsten content)				(1)	(10)	658
Tungstic acid and other alloys of tungsten, n. s. p. f. (tungsten content)	(1)	1	13,020	(1)	3	8,578

1 Not recorded.
2 699 pounds.
3 114 pounds.
4 64 pounds.
5 70 pounds.
6 144 pounds.
7 100 pounds.
8 2 pounds.
9 137 pounds.
10 134 pounds.

TABLE 6.—Ferromanganese and ferrosilicon imported for consumption in the United States, 1951–52, by countries

[U. S. Department of Commerce]

Country	Ferromanganese (manganese content)				Ferrosilicon (silicon content)			
	1951		1952		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Canada	52,878	$10,918,197	22,735	$5,473,927	8,942	$2,187,418	2,230	$669,421
France	10,444	1,714,963	2,995	579,759			5	2,381
Germany	32	5,198	25	5,198				
Japan	133	22,773			59	21,066		
Netherlands					11	4,189		
Norway	31,344	7,358,514	24,674	8,550,625	1,985	320,148		
Yugoslavia	115	26,494	600	149,435				
Total	94,946	20,046,139	51,029	14,758,944	10,997	2,532,821	2,235	671,802

TABLE 7.—Ferroalloys and ferroalloy metals exported from the United States, 1948–52, by varieties

[U. S. Department of Commerce]

Variety of alloy	1948		1949		1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Spiegeleisen	51	$2,227	------	---------	363	$21,351	85	$4,130	34	$3,888
Ferrochrome	6,754	2,371,367	2,200	$942,792	347	134,341	240	96,635	1,274	518,721
Ferromanganese	19,696	2,990,645	6,627	1,360,279	580	139,876	633	206,614	1,453	474,686
Ferromolybdenum	594	806,420	478	718,722	589	927,271	742	1,224,257	545	925,324
Ferrophosphorus	52,988	1,310,260	5,050	168,205	42,789	868,480	55,044	2,218,790	44,351	2,592,245
Ferrosilicon	2,476	427,259	2,555	436,402	1,983	242,245	2,775	387,664	7,240	1,439,465
Ferrotitanium and ferrocarbontitanium	480	82,874	179	40,918	171	42,741	175	107,718	325	88,664
Ferrotungsten	628	1,838,397	310	861,189	166	408,958	142	1,007,424	148	1,150,465
Ferrovanadium	119	390,428	97	350,558	41	183,307	61	190,346	147	529,360
Other ferroalloys	183	102,709	316	161,297	88	31,969	274	131,641	193	73,680
Total	83,969	10,322,586	17,812	5,040,362	47,117	3,000,539	60,171	5,575,219	55,710	7,796,498

TECHNOLOGY

Ferroalloys are used for introducing alloying elements into iron and steel, as scavengers to remove (or render harmless) impurities, and in fields outside the iron and steel industry. The last group comprises such uses as the production of magnesium using ferrosilicon as the reducing agent, and the use of ferrosilicon in heavy-medium-type beneficiation plants.

New technical developments in production of ferroalloys included experiments with self-baking electrodes [7] and rotating hearth furnaces.[8] The Bureau of Mines investigated the use of waste wood products as a reducing agent in production of silicomanganese.

Ferroalloys containing manganese are used to remove oxygen and sulfur from steel, but an important function is to provide manganese in quantities sufficient to combine with any sulfur that remains in the steel. Steel containing sulfur but low in manganese becomes brittle when hot; if the sulfur is combined with manganese it forms relatively harmless segregations, and the difficulties in hot-working are minimized. Another important use is in the production of manganese-type alloy steels and castings. A very significant development in 1952 was the use of large quantities of electrolytic manganese, particularly as the source of manganese in stainless steel containing 16 percent Cr, 16 percent Mn, 1 percent or less Ni, 0.1 percent C, and 0.15 percent N.[9] Low-carbon ferromanganese (0.07 percent maximum C) was quoted at 28.45 cents per pound of contained Mn at year's end; at the same time electrolytic manganese was quoted at 30 cents a pound. Two new electrolytic manganese plants were under construction.

Briquets are made from crushed ferromanganese or silicomanganese. Each briquet contains a fixed quantity of manganese and silicon. The normal-size ferromanganese briquet contains 2 pounds of manganese; a normal silicomanganese briquet contains 2 pounds of man-

[7] Iron Age, Self-Baking Electrodes Spur Development of Bigger, Better Furnaces: Vol. 170, No 9, Aug. 28, 1952, p. 95.
[8] Iron Age, vol. 171, No. 1, Jan. 1, 1953, p. 297.
[9] Iron Age, Electrolytic Manganese Acceptance Grows: Vol. 170, No 12, Sept. 18, 1952, p. 168.

ganese and 0.5 pound of silicon. The foundry industry is the principal user.

Methods for cleaning ferromanganese blast-furnace gas were described.[10]

Ferroboron.—Boron is a substitute for other alloying elements if they are intended only to aid hardenability. The quantity of boron added is ordinarily only a few thousandths of 1 percent; it is most effective in the lower carbon steels.

Several other boron compounds were available to the trade in 1952; these include borosil, manganese-boron, nickel-boron, boron carbide, and calcium boride.

Ferrochromium.—All ferrochromium produced in the United States in 1952 was made in electric furnaces; the average chromium content was 65 percent. Several grades were manufactured, including high-carbon, low-carbon, nitrogen-bearing, and silicon-manganese ferrochromes.[11] Ferrochromium production increased 9 percent in 1952; this was particularly significant because overall production of ferroalloys declined. Production of stainless steel, which consumes important quantities of chromium, was nearly the same as in 1951, whereas total steel production for 1952 was 11 percent lower.

Production of ferrochrome silicon, also referred to as chrome silicide, continued to increase during 1952. This product serves as a convenient and economical source of chromium and silicon in melts where both are desired. It also provides a means for utilizing high-carbon ferrochrome and some chromium ore in the production of low-carbon steel; these products are lower priced than low-carbon ferrochrome. The exact methods of use vary, but one process involves charging most of the desired chromium as scrap and high-carbon ferrochrome, blowing oxygen to the heat to reduce the carbon content—this also oxidizes much chromium, which then enters the slag—and then charging ferrochrome silicon to supply the balance of the chromium needed and to provide silica to reduce the chromium from the slag.

The Bureau of Mines has conducted extensive research regarding the use of low-grade domestic ores; a summary of the problem and the progress was published,[12] including data on ferrochromium produced. Canadian authorities also were concerned with similar problems.[13]

The Gwelo ferrochrome plant in Rhodesia was scheduled to be in production in 1953.[14]

Ferrocolumbium.—Columbium is used chiefly in manufacturing stabilized austenitic stainless steels. It is also employed to reduce the air-hardening characteristic of straight-chromium steels of the corrosion-resistant type. Production of ferrocolumbium in 1952 increased 32 percent, compared with 1951, and all came from electric furnaces. The average grade was 57 percent columbium.

Molybdenum Products.—Ferromolybdenum is used to introduce molybdenum into steel and iron; however, molybdenum in the form of molybdic oxide, calcium molybdate, and other molybdenum compounds is lower priced and technically suitable for the same purpose

---

[10] McCabe, Louis C., Atmospheric Pollution: Ind. Eng. Chem., vol. 43, November 1951, p. 135A.
[11] Iron Age, Low Carbon Ferrochromium Cuts Stainless Ingot Costs: Vol. 170, No. 8, Feb. 21, 1952, p. 109.
[12] Doerner, H. A., Can the U.S. Use Its Low-Grade Domestic Chrome Ore?: Eng. and Min. Jour., vol. 153, No. 8, August 1952, pp. 90–92.
[13] Downes, K. W., and Morgan, D. W., The Utilization of Domestic Chromite: Canadian Min. and Met. Bull. vol. 45, No. 479, March 1952, p. 167 (abstract); Report No. 116, Mem. Ser., Mines Branch, Ottawa.
[14] American Metal Market, vol. 59, No. 3, Jan. 4, 1952, p. 1.

in many alloys. In 1952 there was a slight decline in production and shipments; in part this was the result of National Production Authority allocations and end use restrictions. Domestic raw materials supplied virtually all the molybdenum used to produce the products listed above.

Ferrophosphorus.—Although ferrophosphorus can be produced in the blast furnace or the electric furnace, all ferrophosphorus in 1952 was produced in electric furnaces as a byproduct in the manufacture of phosphate fertilizers and other chemicals. Ferrophosphorus is used primarily as an addition agent in manufacturing certain open-hearth sheet steels to prevent sticking of sheets on packrolling.

Ferrotitanium.—Most of the ferrotitanium produced in 1952 was manufactured in electric furnaces, but a small quantity was made by the aluminothermic process. Several grades were available. The low-carbon grades were used chiefly for manufacturing stabilized austenitic stainless steels to render them resistant to intergranular corrosion in service. The high-carbon grades were used as deoxidizers, scavengers, to prevent segregation, and in some instances, to control grain size. Ferrotitanium was one of the few ferroalloys with an increase in production during 1952.

Silicon-titanium and manganese-nickel-titanium were also available in 1952.

Ferrotungsten.—Ferrotungsten is used mainly as a source of tungsten in high-speed steels. High-purity scheelite concentrates and scrap high-speed steel are used for the same purpose. NPA Order M–80 was revoked on December 10, 1952; this action terminated allocations of ferrotungsten.

Ferrovanadium.—All ferrovanadium produced in 1952 was manufactured in electric furnaces. Production declined 19 percent compared with 1951. The average vanadium content of ferrovanadium produced in 1952 was 53 percent. Fractional percentages of vanadium are used in some engineering steels; from 1.0 to 2.5 percent is used in high-speed steel. Vanadium also is used to prevent age-hardening in low-carbon rimmed steels.

Other vanadium products available for alloying purposes in 1952 included vanadium metal and vanadium pentoxide.

Zirconium-Ferrosilicon.—The zirconium-ferrosilicon produced in 1952 averaged 14 percent Zr, as in the previous 2 years; however, there was a substantial decline in the quantity produced compared with 1951. The alloy is employed in place of ferrosilicon but is more effective as a deoxidizer and scavenger. Zirconium combines readily with oxygen, nitrogen, and sulfur, eliminating them from the steel bath or minimizing their effect. Nickel-zirconium was available in 1952; this product was used for deoxidizing and degasifying nickel alloys.

Other Ferroalloys and Substitutes.—Aluminum is used as a deoxidizer in steel. During 1952, silicon carbide, particularly scraped grinding wheels, was used for the same purpose.

Rare earth products were marketed for alloying, and considerable research in this field was in progress throughout 1952.[15]

[15] Iron Age, Rare Earths Improve Properties of Many Ferrous Alloys: Vol. 169, No. 17, April 24, 1952, p. 129; vol. 169, No. 18, May 1, 1952, p. 141.

Calcium metal, calcium-manganese-silicon, calcium silicon, and barium-silicon were available for deoxidizing.

Exothermic products, designed to prevent chilling of the steel when alloys are added, include exothermic ferrochrome and exothermic silicon-chrome.

Complex alloying products such as silicon-manganese-zirconium, manganese-nickel-titanium, ferrotantalum-columbium, aluminum-silicon-iron, silicon-aluminum, titanium-aluminum, vanadium-aluminum, silicon-manganese-aluminum, and boron-silicon were used increasingly for special applications in 1952. Also in this group are the hardness intensifiers such as vanadium-aluminum-titanium, and graphitizers such as calcium-silicon-titanium. The use of sodium chloride and mixtures containing this salt as a nodulizing material in ductile iron was reported.[16]

[16] Iron Age, vol. 171, No. 1, Jan. 1, 1953, p. 282.

Fluorspar and Cryolite

By John E. Holtzinger[1] and Joseph C. Arundale[2]

ALTHOUGH demand for fluorspar in 1952 attained a record high, shipments from domestic mines were less than in 1951 and were far short of meeting requirements. The deficit was made up by imports, which established a new record and for the first time exceeded domestic production of finished fluorspar.

The drop in shipments from domestic mines was partly accounted for by strikes at three major producing installations and a strike in the steel industry which greatly curtailed shipments of metallurgical-grade fluorspar during the middle of the year. Illinois and Kentucky continued to be the leading producing States, but new operations in some Western States were increasing production capacity in that area.

TABLE 1.—Salient statistics of fluorspar in the United States, 1943–47 (average) and 1948–52, in short tons

Year	Shipments from domestic mines	Foreign trade		Consumption	Industry stocks at end of year		
		Imports for consumption	Exports		Domestic mines [1]	Consumers' plants	Total
1943–47 (average)	350,236	68,894	3,075	366,895	21,994	104,068	126,062
1948	331,749	111,626	666	406,269	37,344	146,869	184,213
1949	236,704	95,619	802	345,221	37,039	130,621	[2] 167,660
1950	301,510	164,634	740	426,121	19,038	164,685	[2] 183,723
1951	347,024	181,275	1,173	497,012	13,283	169,126	[2] 182,409
1952	331,273	352,503	675	520,197	27,464	252,193	[2] 279,657

[1] Finished fluorspar only.
[2] In addition, importers held 11,000 tons in 1949, 7,500 tons in 1950, 2,845 tons in 1951, and 31,400 tons in 1952 (none in 1943–48).

For the third consecutive year, consumption of fluorspar increased and established a new record. The increased usage was attributed to a record consumption in the manufacture of hydrofluoric acid and other fluorine chemicals.

The increased availability of supplies in 1952 made possible a buildup in consumer stocks to a record high. Mine stocks also increased.

DOMESTIC PRODUCTION

Production of finished fluorspar totaled 345,400 short tons in 1952, including 178,677 tons of flotation concentrates. This compared with 341,300 tons of finished fluorspar produced in the previous year, of which 183,624 tons was flotation concentrates. In addition, crude fluorspar equivalent to about 13,100 tons of finished fluorspar was

[1] Commodity-industry analyst.
[2] Assistant chief, Construction and Chemical Materials Branch.

mined but not milled in 1952, making total new production from domestic mines, expressed in terms of finished fluorspar, 358,500 short tons compared with 339,000 tons in 1951. Of the mine output in 1952, 8 mines (producing over 10,000 tons each) supplied 128,600 tons or 36 percent; 16 mines (producing 5,000 to 10,000 tons each) supplied 117,400 tons or 33 percent; 24 mines (producing 1,000 to 5,000 tons each) supplied 60,300 tons or 17 percent; and 13 mines (producing 500 to 1,000 tons each) supplied 9,300 tons or 2 percent. Thus, 61 mines produced 315,600 tons or 88 percent of the total. The remainder was produced from an undetermined number of small mines or prospects or was derived from tailings of previous milling operations.

Consumer-operated mines produced 95,200 tons of finished fluorspar in 1952 compared with 85,200 tons in 1951. All major producers of aluminum, 2 steel producers, and 2 producers of hydrofluoric acid operated fluorspar mines and mills in 1952.

TABLE 2.—Fluorspar shipped from mines in the United States, 1951–52, by States

State	1951			1952		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Colorado	20,661	$820,322	$39.70	29,185	$1,505,968	$51.60
Illinois	204,328	9,294,703	45.59	188,293	9,481,223	50.35
Kentucky	68,635	2,334,485	34.01	48,308	1,863,262	38.57
New Mexico	24,402	1,163,098	47.66	16,443	823,320	50.07
Utah	17,827	398,480	22.35	17,304	438,699	25.35
Other States:						
Montana				16,160	1,241,162	39.10
Nevada, Idaho	9,408	358,433	32.09	14,798		
Arizona	1,623			434		
Tennessee	140			348		
Total	347,024	14,369,521	41.41	331,273	15,353,634	46.35

Output from mines in Illinois—the largest producing State—dropped to 192,600 tons of finished fluorspar in 1952, compared with a record production of 205,300 tons in 1951. Strikes at three major fluorspar mills and temporary closing of other producing installations because of the steel strike and resultant decreased market for metallurgical fluorspar virtually stopped production in the Illinois district during the middle of the year.

Ownership of three major fluorspar properties in Illinois changed during the year. The Victory Fluorspar Mining Co., which had operated near Cave in Rock, Hardin County, since 1926, was sold to A. H. Stacey & Sons by Martin Schwerin. The purchase was said to have included the Victory mine, mill, and all equipment.[3] Properties of the Crystal Fluorspar Co—the Crystal and Jefferson mines and a heavy-medium separation mill—were sold to Minerva Oil Co. in September after being closed in June. The new owners resumed production of metallurgical-grade fluorspar at the Crystal mine but did not reopen the Jefferson mine. The Minerva Oil Co. also acquired

[3] Engineering and Minning Journal, vol. 153, No. 7, July 1952, p. 138.

the Rose Creek fluorspar mine, in Hardin County, in a purchase from the Yingling Oil & Mining Co.

The Illinois fluorspar deposits have been described in a bulletin which also contains a discussion of the geology of the deposits, mining history of the district, mining and beneficiation methods employed by major producers, and general information about the fluorspar industry.[4] The Bureau of Mines published the results of an investigation of the Knox and Yingling mines in Hardin County, Ill. In this project 2,733 feet of diamond-drill holes were drilled in the hanging wall to test continuation of the fluorspar to a greater depth than that reached by the mine workings and to relate the deposit with the Rosiclare formation.[5]

For the fifth consecutive year, production of finished fluorspar in Kentucky declined; output dropped to 55,600 short tons, compared with 63,700 tons in 1951. Initial shipments of acid-grade concentrates were made from the Pennsylvania Salt Manufacturing Co. mill at Marion, Ky., to its plant at Calvert City, Ky. United States Steel Co. began construction of a new heavy-medium and froth-flotation plant at Mexico, Ky., which was expected to be in operation by early 1953.

In Livingston County, Ky., the Aluminum Co. of America was reported to have begun development work at the Klondike and Silver-Royal mines, both properties to be ready for operation in about a year.[6] The Nancy Hanks mine, idle for several years, was reopened by A. Tinsley and S. D. Lloyd.

In the West, output in Arizona and New Mexico dropped sharply in 1952 but increased in Colorado, Utah, Nevada, Idaho, and Montana.

Production of finished fluorspar in Colorado was 29,600 short tons in 1952, compared with 20,600 tons in 1951. Most of the 1952 production came from Boulder County, although sizeable quantities were also mined and treated in Jackson and Chaffee Counties. Productive capacity in Colorado was substantially increased during the year, with completion of a new flotation plant at Northgate, Jackson County, which was placed in operation by the Ozark-Mahoning Co. Crude ore from open-pit mining and mine development work, and tailings from previous sink-float operations comprise the mill feed.

Utah continued as a major supplier of metallurgical-grade fluorspar, with an output of 17,300 short tons, a 7-percent increase over the 1951 production.

In the Southwest, production declined considerably. Mines in Arizona and New Mexico produced 400 and 16,200 tons, respectively, in 1952 compared with output of 1,600 and 24,300 tons, respectively, in 1951. Production was reported from Cochise, Greenlee, and Maricopa Counties in Arizona, and from Dona Ana, Grant, Luna, Sierra, and Valencia Counties in New Mexico.

Substantial increases in production were made in Nevada and Idaho in 1952. To avoid disclosure of individual company operations, separate production figures for these States may not be shown. However, the combined production in 1952 totaled 15,900 tons,

[4] Weller, J. M., Grogan, R. M., and Tippie, F. E., Geology of the Fluorspar Deposits of Illinois: Illinois State Geol. Survey Bull. 76, 1952, 147 pp.

[5] Burmeister, H. L., Knox and Yingling Fluorite Mines, Hardin County, Illinois: Bureau of Mines Rept. of Investigations 4856, 1952, 8 pp.

[6] Engineering and Mining Journal, vol. 153, No. 5, May 1952, p. 144.

compared with 9,500 tons in 1951. In Nevada, a new flotation plant was put into operation by the Kaiser Aluminum & Chemical Co. to treat ore from the Kaiser mine (formerly known as the Baxter mine), as well as local custom ore. Concentrates produced from the mill are converted to hydrofluoric acid and subsequently to aluminum fluoride used by Kaiser in manufacturing aluminum.

For the first time, Montana became a major supplier of fluorspar, as initial production of metallurgical-grade fluorspar was begun at the Crystal Mountain mine near Darby, Ravalli County. Although the deposit was discovered in 1951, mining operations were not begun at this property until 1952; however, in October, November, and December it was the largest producer of fluorspar in the United States.

Investigations of the deposits by the Bureau of Mines revealed 7 principal outcrops of fluorite in 2 areas. Three of the largest outcrops were trenched, drilled, and sampled, and preliminary metallurgical tests of the ore were made. Samples of the ore indicated an average grade of 97.2 percent CaF_2 and 1.44 percent SiO_2, with indication from the metallurgical tests that it could be concentrated to acid-grade specifications by flotation methods.[7]

Although production increased slightly, shipments of fluorspar from domestic mines declined about 5 percent from 1951. Of the 1952 total, 64,800 tons were shipped by river or river-rail for delivery to consumers, compared with 63,300 tons in 1951.

TABLE 3.—Fluorspar shipped[1] from mines in the United States, by States, 1943–47 (average) and 1948–52, with shipments of maximum year and cumulative shipments from earliest record to end of 1952, in short tons[2]

State	Maximum shipments		Shipments by years							Total shipments[1] from earliest record to end of 1952	
								1952			
	Year	Short tons	1943–47 (average)	1948	1949	1950	1951	Short tons	Percent of total	Short tons	Percent of total
Arizona	1951	1,623	1,084	1,271	846	952	1,623	434	0.1	19,151	0.2
California	1934	181	32							341	(3)
Colorado[4]	1944	65,209	46,297	27,698	22,324	18,489	20,661	29,185	8.8	624,463	7.3
Idaho	1951	(5)									
Nevada	1948	9,615	7,452	9,615	5,847	7,577	9,408	14,798	4.5	124,732	1.5
Illinois[4]	1951	204,328	168,796	172,561	120,881	154,623	204,328	188,293	56.8	4,536,799	53.3
Kentucky[4]	1941	142,862	94,236	84,889	63,438	80,137	68,635	48,308	14.6	2,711,420	31.9
Montana	1952	16,160		318	422	41		16,160	4.9	16,941	.2
New Hampshire	1917	1,274								8,302	.1
New Mexico	1944	42,973	27,916	24,968	12,844	20,036	24,402	16,443	5.0	361,878	4.3
Tennessee	1906	360	11				140	348	.1	1,685	(3)
Texas	1944	4,769	2,256	906	1,770	719				14,779	.2
Utah	1950	18,936	2,118	9,523	8,332	18,936	17,827	17,304	5.2	87,390	1.0
Washington	1945	132	34							382	(3)
Wyoming	1944	19	4							19	(3)
Total	1944	413,781	350,236	331,749	236,704	301,510	347,024	331,273	100.0	8,508,282	100.0

[1] Figures for 1880–1905 represent production.
[2] Quantity and value figures, by States, for 1880–1925 in Mineral Resources, 1925, pt. 2, pp. 13–14, and for 1910–40 in Minerals Yearbook, Review of 1940, p. 1297.
[3] Less than 0.05 percent.
[4] Figures on production not recorded for Colorado before 1905, for Illinois before 1880, and for Kentucky before 1886 and for 1888–95. Total unrecorded production (estimated) included in "Total shipments" column as follows: Colorado, 4,400 tons; Illinois, 20,000 tons; and Kentucky, 600 tons.
[5] Figure withheld to avoid disclosure of individual company operations.

[7] Taber, John W., Crystal Mountain Fluorite Deposits, Ravalli County, Mont.: Bureau of Mines Rept. of Investigations 4916 ,1952, 8 pp.

Fluorspar shipments in 1952 comprised 136,600 tons of fluxing gravel and foundry lump (including 8,700 tons of flotation concentrates, which were blended with fluxing gravel) and 194,700 tons of ground fluorspar and flotation concentrates. The bulk of the fluxing gravel and foundry lump fluorspar was shipped to steel plants and iron foundries, but small quantities also were sold to ferroalloy plants, cement plants, smelters of secondary metals, and manufacturers of fluxing compounds. Of the flotation concentrates sold, 70 percent went for the manufacture of hydrofluoric acid or the National Stockpile, and 17 percent was shipped to glass and enamel plants. The remainder went to manufacturers of steel and ferroalloys, to aluminum and magnesium reduction works, to welding-rod manufacturers, and to smelters of secondary metals.

TABLE 4.—Fluorspar shipped from mines in the United States, by grades and industries, 1951–52, in short tons

Grade and industry	1951	1952
Fluxing gravel and foundry lump:		
Ferrous	[1] 158,346	[1] 135,227
Nonferrous	975	580
Cement	330	50
Miscellaneous	876	702
Exported	139	40
Total	[1] 160,666	[1] 136,599
Ground and flotation concentrates:		
Ferrous [2]	[1] 15,053	[1] 15,940
Nonferrous	3,160	4,601
Glass and enamel	39,392	33,487
Hydrofluoric acid	[3] 123,125	[3] 136,949
Cement		
Miscellaneous	4,619	3,072
Ground and flotation concentrates—Continued		
Exported	1,009	625
Total	[1] 186,358	[1] 194,674
All grades:		
Ferrous	173,399	151,167
Nonferrous	4,135	5,181
Cement	330	50
Glass and enamel	39,392	33,487
Hydrofluoric acid	[3] 123,125	[3] 136,949
Miscellaneous	5,495	3,774
Exported	1,148	665
Grand total	347,024	331,273

[1] Fluxing gravel includes (and flotation concentrates exclude) the following quantities of flotation concentrates blended with fluxing gravel: 1951, 19,660 tons; 1952, 8,701 tons.
[2] Includes pelletized gravel.
[3] Includes shipments to National Stockpile.

TABLE 5.—Fluorspar shipped from mines in the United States, 1951–52, by uses

Use	1951				1952			
	Quantity		Value		Quantity		Value	
	Percent of total	Short tons	Total	Average	Percent of total	Short tons	Total	Average
Steel	48.2	167,042	$5,742,358	$34.38	42.9	142,058	$5,013,018	$35.29
Iron foundry	1.2	4,139	170,051	41.09	1.1	3,641	147,444	40.50
Glass	9.5	33,036	1,407,741	42.61	9.0	29,781	1,322,172	44.40
Enamel	1.8	6,356	293,359	46.15	1.1	3,706	181,018	48.84
Hydrofluoric acid	35.5	[1] 123,125	[1] 6,162,064	[1] 50.05	41.2	[1] 136,514	[1] 7,927,232	[1] 58.07
Miscellaneous	3.5	12,178	542,139	44.52	4.5	14,908	731,577	49.07
Exported	.3	1,148	51,809	45.13	.2	665	31,173	46.88
Total	100.0	347,024	14,369,521	41.41	100.0	331,273	15,353,634	46.35

[1] Includes shipments to National Stockpile.

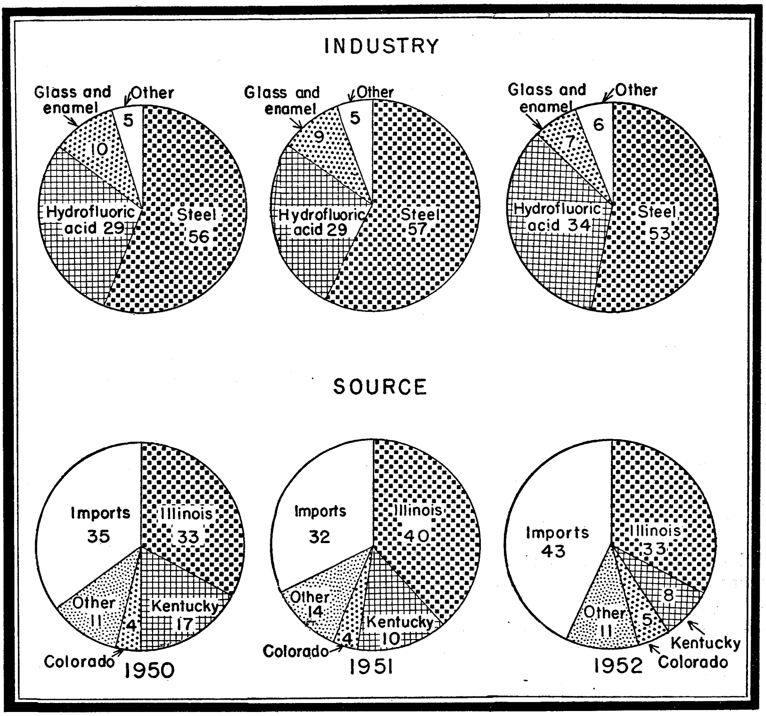

FIGURE 1.—Fluorspar sales (domestic and foreign) to consumers in the United States, 1950–52, by consuming industries and by sources, in percent.

CONSUMPTION AND USES

Fluorspar is an important raw material for the steel and aluminum, chemical, and ceramic industries. The largest single use is as a flux in the manufacture of basic open-hearth and basic-electric steel; a relatively small quantity is consumed in the manufacture of bessemer steel. Small quantities also are used in other metallurgical operations, such as the production of iron castings, ferroalloys, and nickel and its alloys; smelting and casting of aluminum and magnesium; smelting of secondary metals; and manufacture of fluxing compounds.

The second largest use of fluorspar, and one that has increased greatly in recent years, is in the manufacture of hydrofluoric acid, an essential material used in manufacturing aluminum fluoride and synthetic cryolite for the aluminum industry, as a catalyst in the production of high-octane gas, and as the principal source of fluorine in the manufacture of various fluorine chemicals.

In the ceramic industry, fluorspar is used in manufacturing opal or opaque glass and some colored glasses and as an ingredient in enamels for coating iron and steel.

Consumption of fluorspar reached the unprecedented total of 520,200 short tons in 1952, about 5 percent more than that used in the previous record year, 1951. The overall increase in use resulted from record consumption for the manufacture of hydrofluoric acid; consumption in

TABLE 6.—Fluorspar (domestic and foreign) consumed and in stock in the United States, by industries, 1951–52, in short tons

Industry	1951			1952		
	Consumption	Stocks at consumers' plants Dec. 31	In transit to consumers' plants Dec. 31	Consumption	Stocks at consumers' plants Dec. 31	In transit to consumers' plants Dec. 31
Basic open-hearth steel	242,180			237,483		
Electric-furnace steel	34,058	138,113	5,062	34,627	200,530	416
Bessemer steel	416			366		
Iron foundry	6,460	2,354	41	7,005	3,428	59
Ferroalloys	2,888	1,051		2,952	1,242	
Hydrofluoric acid [1]	151,698	15,253	1,285	178,267	34,511	
Primary aluminum [2]	1,489	948		3,731	1,629	107
Primary magnesium	1,262	226	170	5,739	548	50
Glass	35,505	6,731	735	33,837	6,126	91
Enamel	6,736	1,467	218	5,205	1,151	
Cement	213	1,174		346	1,090	
Miscellaneous	14,107	1,809	38	10,639	1,938	1
Total	497,012	169,126	7,549	520,197	252,193	724

[1] Fluorspar used in making artificial cryolite and aluminum fluoride (aluminum raw materials) is included in the figures for hydrofluoric acid, an intermediate in their manufacture.
[2] Figures on consumption represent fluorspar used as a flux; *see* footnote 1.

TABLE 7.—Production of basic open-hearth steel and consumption and stocks of fluorspar (domestic and foreign) at basic open-hearth steel plants, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Production of basic open-hearth steel ingots and castings...long tons	65,626,400	70,830,000	62,634,000	76,873,000	83,118,000	75,297,000
Consumption of fluorspar in basic open-hearth steel production...short tons	183,871	207,342	183,045	212,928	242,180	237,483
Consumption of fluorspar per long ton of basic open-hearth steel made...pounds	5.6	5.9	5.8	5.5	5.8	6.3
Stocks of fluorspar at basic open-hearth steel plants at end of year...short tons	60,840	106,300	97,400	128,300	133,100	195,700

TABLE 8.—Fluorspar (domestic and foreign) consumed in the United States, by States, in 1952, in short tons

State	1952
Alabama, Florida, Georgia, Mississippi, North Carolina, and South Carolina	13,963
Arkansas, Kansas, Louisiana, and Oklahoma	47,434
California	14,626
Colorado, Utah, and Wyoming	17,551
Connecticut	1,496
Delaware, District of Columbia, and New Jersey	31,590
Illinois	94,259
Indiana	29,155
Iowa, Minnesota, Nebraska, South Dakota, and Wisconsin	5,609
Kentucky	19,520
Maryland	6,310
Massachusetts and Rhode Island	1,757
Michigan	20,625
Missouri	5,069
New York	16,644
Ohio	71,240
Oregon and Washington	4,256
Pennsylvania	91,261
Tennessee	719
Texas	20,612
Virginia	702
West Virginia	5,799
Total	520,197

the manufacture of steel declined slightly, chiefly because of the strike in the steel industry.

Fluorspar consumption was reported in 39 States and the District of Columbia in 1952, with 3 States—Ohio, Pennsylvania, and Illinois—using about half of the total. Illinois replaced Pennsylvania as the leading consumer in 1952, although the latter State was the leading consumer for the production of steel, glass, and enamel. Illinois was the leading consumer in the manufacture of hydrofluoric acid.

STOCKS

As supplies of fluorspar became more readily available in 1952, stocks held by consumers increased and by the end of the year were at an alltime high of 252,200 short tons. This was equivalent to approximately 6 months' supply at the 1952 rate of consumption.

According to reports of producers, the quantity of fluorspar in stock at mines or shipping points at the close of 1952 totaled 149,600 short tons. These stocks comprised 27,500 tons of finished fluorspar and 122,100 tons of crude fluorspar, estimated as equivalent to about 37,900 tons of finished fluorspar.

TABLE 9.—Stocks of fluorspar at mines or shipping points in the United States by States, at end of year, 1950–52, in short tons

	1950		1951		1952	
	Crude [1]	Finished	Crude [1]	Finished	Crude [1]	Finished
Arizona						10
Colorado	6,837	869	14,986	812	49,417	1,263
Idaho			150		100	100
Illinois	29,954	5,822	32,541	6,781	42,380	11,118
Kentucky	5,789	10,076	6,598	5,092	11,190	12,404
Montana						1,227
Nevada		100		150	6,351	1,205
New Mexico	13,472	392	7,558	348	12,707	119
Tennessee				100		18
Utah		1,779				
Total	56,052	19,038	61,833	13,283	122,145	27,464

[1] This crude (run-of-mine) fluorspar must be beneficiated before it can be marketed.

PRICES

Prices of fluorspar in most areas remained constant during 1952. Metallurgical-grade fluorspar containing 70 percent or more effective CaF_2 was quoted at $43 a short ton f. o. b. Illinois-Kentucky mines throughout the year; that containing 60 percent or less calcium fluoride was quoted at $40 and $41 per ton on the same basis and pellets containing 60 percent calcium fluoride at $34 per short ton f. o. b. mine. Imported metallurgical fluorspar was quoted throughout 1952 at $38 to $40 per short ton at Atlantic seaboard, duty paid. Acid-grade fluorspar was quoted at $60 per short ton f. o. b. Illinois or Colorado mines throughout the year and at $65 per short ton f. o. b. Los Lunas, N. Mex., until the middle of the year, when the price dropped to $60. Ceramic-grade fluorspar, with a minimum of 95 percent calcium fluoride, calcite and silica variable, and maximum 0.14 percent Fe_2O_3, was quoted at $45 per short ton f. o. b. Rosiclare, Ill. The average selling price for all grades shipped from domestic mines, as reported by producers, was $46.35 per short ton—$4.94 more per ton than the previous high average reported in 1951.

Controls on the price of metallurgical and ceramic grades of fluorspar remained in effect throughout 1952. Acid-grade fluorspar was exempted from price control late in 1951.

TABLE 10.—Fluorspar imported for consumption in the United States in 1952, by countries and customs districts

[U. S. Department of Commerce]

Country and customs district	Containing more than 97 percent calcium fluoride		Containing not more than 97 percent calcium fluoride		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Canada:						
Buffalo			829	$32,953	829	$32,953
Ohio			3,857	152,039	3,857	152,039
Philadelphia	13,849	455,537	56	1,684	13,905	457,221
Total	13,849	455,537	4,742	186,676	18,591	642,213
France: Philadelphia	1,120	53,764			1,120	53,764
French Morocco:						
Buffalo			1,698	33,880	1,698	33,880
Philadelphia			551	10,500	551	10,500
Total			2,249	44,380	2,249	44,380
Germany:						
East:						
New Orleans	497	11,932			497	11,932
Virginia			442	22,150	442	22,150
West:						
Galveston	885	56,516			885	56,516
New Orleans			1,657	70,420	1,657	70,420
Philadelphia	25,547	1,257,516	28,535	703,713	54,082	1,961,229
Virginia	1,205	66,955	1,683	83,066	2,888	150,021
Total	28,134	1,392,919	32,317	879,349	60,451	2,272,268
Italy:						
New Orleans	1,653	71,994			1,653	71,994
Philadelphia	12,928	535,783	12,354	229,405	25,282	765,188
Virginia	3,468	209,795			3,468	209,795
Total	18,049	817,572	12,354	229,405	30,403	1,046,977
Mexico:						
Arizona			9,696	144,465	9,696	144,465
El Paso	29,378	1,536,579	22,896	349,967	52,274	1,886,546
Galveston	79	3,978	45	890	124	4,868
Laredo	12,733	469,944	100,248	1,919,434	112,981	2,389,378
New Orleans			58	1,049	58	1,049
San Diego	53	1,513			53	1,513
Total	42,243	2,012,014	132,943	2,415,805	175,186	4,427,819
Spain:						
Maryland			2,800	130,000	2,800	130,000
New Orleans			2,786	112,578	2,786	112,578
Philadelphia	24,587	1,050,908	29,514	666,039	54,101	1,716,947
Total	24,587	1,050,908	35,100	908,617	59,687	1,959,525
Tunisia: Philadelphia			2,259	40,740	2,259	40,740
Union of South Africa:						
Los Angeles			(1)	5	(1)	5
New Orleans	(1)	5			(1)	5
Philadelphia			2,557	39,888	2,557	39,888
Total	(1)	5	2,557	39,893	2,557	39,898
Total: 1952	127,982	5,782,719	224,521	4,744,865	352,503	10,527,584
1951	52,991	1,899,081	128,284	2,211,000	181,275	4,110,081

[1] Less than 1 ton.

FOREIGN TRADE[8]

Imports.—In 1952 imports exceeded domestic production of finished fluorspar for the first time, and were almost twice as great as in 1951, the previous record year. Mexico, the leading foreign supplier, shipped almost three times as much fluorspar to the United States in 1952 as in 1951; increased quantities were also shipped by Italy, Germany, Spain, and Africa.

As shown in table 11, which is compiled from data supplied the Bureau of Mines by importers and domestic producers milling or otherwise handling imported material, most of the imported fluorspar delivered to consumers goes to steel plants and hydrofluoric acid manufacturers. The quantities in table 11 represent the finished product recovered from milling or drying foreign ores or concentrates rather than the crude ore milled or concentrates dried.

TABLE 11.—Imported fluorspar delivered to consumers in the United States, 1951–52, by uses

Use	1951			1952		
	Short tons	Selling price at tidewater, border, or f. o. b. mill in the United States, including duty		Short tons	Selling price at tidewater, border, or f. o. b. mill in the United States, including duty	
		Total	Average		Total	Average
Steel	119, 989	$4, 105, 764	$34. 22	166, 849	$5, 722, 780	$34. 30
Hydrofluoric acid	26, 506	1, 341, 339	50. 61	59, 706	3, 487, 635	58. 41
Ferroalloys	1, 124	33, 894	30. 15	240	7, 340	30. 58
Glass and enamel	4, 232	220, 665	52. 14	4, 381	266, 107	60. 74
Other	8, 568	349, 151	40. 75	17, 574	966, 799	55. 01
Total	160, 419	6, 050, 813	37. 72	248, 750	10, 450, 661	42. 01

Exports.—Fluorspar producers reported exports to Canada and Venezuela of 665 tons of fluorspar in 1952 valued at $31,173. In addition to the exports reported by producers, dealers exported small tonnages to Mexico, Chile, Netherlands, France, West Germany, and the Union of South Africa.

TABLE 12.—Fluorspar reported by producers as exported from the United States, 1943–47 (average) and 1948–52

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1943–47 (average)	3, 071	$93, 259	$30. 37	1950	728	$29, 746	$40. 86
1948	644	24, 819	38. 54	1951	1, 148	51, 809	45. 13
1949	783	32, 521	41. 53	1952	665	31, 173	46. 88

[8] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TECHNOLOGY

Patents assigned to the American Zinc, Lead & Smelting Co. describe methods of producing hydrofluoric acid or ammonium fluoride from fluorine-bearing gases evolved from the treatment of materials containing fluorine; the gases are passed in contact with a bed of crushed magnesium silicate to form magnesium silicofluoride which may be treated with sulfuric acid to produce hydrofluoric acid or reacted with ammonia to form ammonium fluoride.[9]

Another patent claimed a method of producing synthetic cryolite from fluorine and hydrofluoric acid contained in the waste gases from the electrolytic production of aluminum. The process involves treating the waste gases with a solution of a sodium compound, filtering insoluble impurities from the resultant solution of sodium fluoride, and adding aluminum monohydroxide (AlOOH) to the solution to precipitate cryolite (Na_3AlF_6); additional cryolite may be precipitated by the addition of sodium bicarbonate.[10]

Utilization of a photoelectric cell in a device employed to separate optical-grade fluorspar from an impure feed was described.[11] The feed is immersed in a liquid having the same index of refraction as fluorite. When passed through the beam of light, crystals having occluded impurities absorb part of the light, causing the cell to activate a mechanical concentrator.

The suitability of sodium fluoride, sodium silicofluoride, hydrofluosilicic acid and hydrofluoric acid as sources of fluoride ion for the fluoridation of public water supplies was discussed in a review of the problems incident to fluoridation.[12]

The production and possible applications of several fluorine compounds were reviewed.[13] According to the article, highly fluorinated materials commonly have unusual chemical and thermal stability, very low surface tensions, low indices of refraction, low dielectric constants, high densities, incompatibility with water and hydrocarbons, and nonflammability.

WORLD REVIEW

Canada.—Most of the output of fluorspar in Canada came from Newfoundland, although a small tonnage was mined in the Province of Ontario.[14]

Output from Newfoundland is expected to increase substantially as the result of an agreement between the St. Lawrence Corp. of Newfoundland, Ltd., its affiliate, St. Lawrence Fluorspar, Inc., and the Defense Materials Procurement Agency. By the terms of this agreement, the United States Government will advance up to $1,250,000 to finance proposed expansion programs in Newfoundland and at Wilmington, Del. The programs include construction of a new sink-and-float plant at St. Lawrence, Newfoundland, with a capacity of

[9] MacIntire, W. H. (assigned to American Zinc, Lead & Smelting Co.), Treatment of Fluoric Effluents to Obtain Magnesium Silicofluoride and/or Hydrofluoric Acid: U. S. Patent 2,584,894, Feb. 5, 1952. Treatment of Fluoric Effluents to Produce Ammonium Fluoride: U. S. Patent 2,584,895, Feb. 5, 1952.

[10] Dale, H. (assigned to Ardal Verk), Process for the Utilization of the Gas Washing Lye From Aluminum Electrolysis in Cryolite Production: U. S. Patent 2,597,302, May 20, 1952.

[11] Mining Engineering, Photoelectric Sorting of Optical Fluorspar: Vol. 4, No. 8, August 1952, pp. 803–806.

[12] Industrial and Engineering Chemistry, Review of Practical Fluoridation: Vol. 45, No. 1, January 1953, pp. 105–111.

[13] Industrial and Engineering Chemistry, Industrial Fluorochemicals: Vol. 45, No. 1, January 1953.

[14] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 6, June 1953, pp. 42–44.

about 40 tons of mill feed per hour to produce concentrates containing 70 to 80 percent CaF_2. This material will be sent to Wilmington for conversion to acid-grade concentrates in a new flotation plant to be built by St. Lawrence Fluorspar, Inc.[15] The new flotation plant will have a capacity of about 300 tons of mill feed per day, with an annual production rate of 50,000 tons of acid-grade concentrates. The contract with the Government covers a period of 4 years or until 150,000 short tons of acid-grade concentrates has been produced from the new facilities.

TABLE 13.—World production of fluorspar, by countries,[1] 1947–52, in metric tons[2]

[Compiled by Helen L. Hunt]

Country [1]	1947	1948	1949	1950	1951	1952
Argentina (shipments)	2,400	(3)	(3)	(3)	(3)	(3)
Australia	1,219	520	571	585	497	87
Belgium	2,060	4,220	(3)	(3)	(3)	(3)
Bolivia (exports)	28	227	264	61	38	(3)
Brazil	841	751	537	[4] 600	(3)	(3)
Canada	42,710	58,120	58,492	58,253	67,323	75,616
France	31,596	33,442	46,029	35,400	47,082	56,873
French Morocco	---	10	445	40	1,968	3,304
Germany:						
East	21,000	(3)	(3)	(3)	(3)	(3)
West	19,235	49,344	46,942	92,520	143,741	157,338
Italy	20,860	40,635	20,810	29,183	41,019	58,684
Japan	84	68	960	2,425	3,996	3,780
Korea, Republic of	2,600	---	1,230	(3)	4,243	5,948
Mexico	[5] 45,737	[5] 75,381	[5] 55,772	[5] 65,667	[5] 66,761	[4] 180,000
Norway	1,089	1,120	895	838	903	---
Southern Rhodesia	154	12	239	447	111	---
South-West Africa	---	---	---	73	779	4,418
Spain	13,885	42,549	59,594	33,168	59,674	73,332
Sweden (sales)	2,780	4,303	---	4,284	(3)	(3)
Tunisia	---	560	352	---	---	2,970
Turkey	---	---	500	---	---	(3)
Union of South Africa	4,815	3,754	4,857	6,948	12,280	10,290
United Kingdom	45,016	58,948	52,867	50,767	64,914	77,040
United States (shipments)	298,901	300,956	214,733	273,524	314,813	300,524
Total (estimate)	655,000	795,000	695,000	815,000	1,000,000	1,190,000

1 In addition to countries listed, China, North Korea, and U. S. S. R. produce fluorspar, but data on output are not available; estimates by authors of chapter included in total.
2 This table incorporates a number of revisions of data published in previous fluorspar chapters.
3 Data not available; estimate by author of chapter included in total.
4 Estimate.
5 Exports.

French Morocco.—Most of the fluorspar produced in French Morocco reportedly came from an operation at Djebel Tirremi, near Taourirt; a smaller quantity was mined at Bergamou-El-Hammam in the Oued-Beth Valley. Modernization at the latter site is expected to result in increased output in 1953.[16]

Germany.—For the fifth consecutive year, production of fluorspar in West Germany increased. Germany, one of the major suppliers of foreign fluorspar to the United States, exported 54,840 metric tons of fluorspar to this country in 1952, compared with 44,519 metric tons in 1951. The most important deposits of fluorspar in West Germany are said to be in Bavaria, in the upper Palatinate, and in the Black Forest in Baden.[17]

15 Letter to Bureau of Mines, November 1952.
16 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 6, June 1953, pp. 44–45.
17 Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 2, August 1952, p. 30.

Mexico.—The record demand for fluorspar in the United States was reflected in greatly increased activity in the Mexican fluorspar industry. Production, as measured by exports, reached 180,000 metric tons in 1952, over twice the record production of 1951. Exports to the United States in 1952 and 1951 were 158,850 and 58,082 metric tons, respectively. The expansion in the fluorspar industry has benefited the economy of the Piedras Negras district by giving employment to a large number of persons and increasing sales of materials and equipment.[18]

Spain.—Fluorspar production in Spain continued to increase in 1952. That country was the third largest supplier of foreign fluorspar to the United States and shipped 54,147 metric tons in 1952. It was reported that a large manufacturer of chemicals in Spain had began to produce synthetic cryolite late in 1951.[19]

Tunisia.—Renewed foreign demand for fluorspar was said to have stimulated production in Tunisia in 1952 at the fluorspar mine at Hammam Zriba, in the Zaghouan district. Output reached a peak of 2,980 metric tons in 1952, more than the total quantity produced from the mine since 1939.[20]

CRYOLITE

Demand for cryolite—an essential raw material for the production of aluminum—continued at a high level in 1952 and exceeded the supply available to domestic consumers. To alleviate the shortage, arrangements were made to increase the quantity of natural cryolite imported from the sole producing deposit in Greenland and to expand the output of synthetic cryolite by domestic producers. An annual production goal of 50,000 tons of synthetic cryolite by 1956 was established by the Defense Production Administration.

Synthetic cryolite is produced in the United States by the Reynolds Metal Co. at Hurricane Creek, Ark., and the Aluminum Ore Co. at East St. Louis, Ill. Production at the latter plant is expected to be increased by about 11,000 tons per year as the result of an agreement with the Defense Materials Procurement Agency. Under the agreement, the Government will be supplied with 42,600 tons of cryolite in the period 1952–56 at a base price of $0.139 per pound for 91 percent cryolite.

The principal use of cryolite is in the electrolytic production of aluminum, where it serves as the electrolyte. Cryolite also has numerous other metallurgical applications and is used in the glass and enamel industries, in bonded abrasive, as a filler, and in insecticides. These uses were described in an article.[21] It has been estimated that about 68,700 tons was required by the aluminum industry in 1952 and an additional 3,300 tons by insecticide, enamel, glass, and other industries.[22]

Imports of natural and artificial cryolite into the United States totaled 34,262 long tons valued at $3,124,801 in 1952, compared with 34,688 long tons valued at $2,190,123 in 1951. Of these, 32,966 tons

[18] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 2, February 1953, pp. 48–49.
[19] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 2, August 1952, p. 28.
[20] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 2, February 1953, pp. 49–50.
[21] Mining Journal (London), Cryolite—Its Properties and Uses: Vol. 238, No. 6088, April 25, 1952, pp. 418–419.
[22] Iron Age, vol. 170, No. 4, July 24, 1952, p. 55.

was from Greenland, 92 tons from Canada, 596 tons from West Germany, and 608 tons from Italy. Exports of cryolite from the United States totaled 75 long tons valued at $21,778 in 1952, compared with 1,426 long tons valued at $317,413 in 1951. The bulk of the 1952 exports went to Canada and the Union of South Africa; small quantities were shipped to Mexico and Chile.

A plant for recovering cryolite from scrapped linings of the pots used in the reduction of aluminum was reported under construction at Mead, Wash., by the Kaiser Aluminum & Chemical Co.[23]

The National Production Authority issued an order controlling purchases of cryolite by different types of consumers and limiting the quantity of stocks held by consumers.[24] Exports of cryolite also were restricted during the year.

The only commercially workable deposit of natural cryolite known is at Ivigtut, Greenland, where it is mined by a Danish concern under a concession from the Government of Denmark. Cryolite has been mined from this deposit for almost 100 years. Extensive exploration in recent years has revealed no new occurrences.[25] Under an agreement with the Defense Materials Procurement Agency, mining operations at the deposit were to be expanded. A contract negotiated with Pennsylvania Salt Co.—sole distributor of natural cryolite in the United States—involved payment of a premium of $70 per ton, bringing the total price to $100 per ton for 19,000 long tons of cryolite ore. About 13,700 short tons of finished cryolite would be produced from this tonnage of ore. All of the concentrate was to be purchased by the Government for $260 per short ton and resold at the market price (which was then $190 per short ton) to consumers who require it for defense production.[26]

[23] Mining World, vol. 14, No. 9, August 1952, p. 63.
[24] National Production Authority Order M-99, U. S. Dept. of Commerce, Feb. 29, 1952.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 6, December 1952, pp. 22-23.
[26] Defense Materials Procurement Agency, DMPA No. 56, June 26, 1952.

Gem Stones

By George Switzer[1] and Robert D. Thomson[2]

As in the past, the United States continued to be an unimportant factor in world gem production. A wide variety of gems was produced but in small quantity.

DOMESTIC PRODUCTION

The efforts of thousands of amateur lapidaries, who spend their vacations and weekends searching for gem materials, yield most of the gem materials produced in the United States. The many varieties of quartz, such as agate, jasper, and petrified wood, are the chief materials recovered in this way. The demand for cuttable rough gem stones by these hobbyists also supports a few small gem-mining companies, which operate deposits from time to time, chiefly for turquoise, tourmaline, kunzite, and jade. Since only a small percentage of the total is produced on a commercial scale, no accurate statistics can be compiled on the value of the domestic output of gems; an estimate may approximate $400,000 to $500,000.

The many forms of quartz, chiefly the cryptocrystalline varieties, represented the greatest quantity and value of gem stones produced in 1952. Other gems included were turquoise, topaz, garnet, jade, tourmaline, onyx, chrysocolla, opal, variscite, idocrase, and spinel. Of the producing States, California, Oregon, Texas, Nevada, Washington, Wyoming, and Arizona, in decreasing order, were the leaders.

Agate.—The Marfa-Alpine area in the northern part of Presidio and Brewster Counties, Big Bend area, in Brewster County, and Laredo-Zapata area in Webb and Zapata Counties, Texas, were among the leading producers of agate in 1952, with an estimated output of 50,000 pounds valued at $0.50 to $60.00 per pound and a total value exceeding $35,000.

In Arizona the Saddle Mountain area, covering parts of Maricopa, Pinal, and Graham Counties, reportedly produced 8 to 10 tons of agate valued at $7,000–$8,000, and total production from this State may have been as much as 100 tons.

Production of agate in California in 1952, largely from the Mohave Desert region, had an estimated value of about $100,000.

Over 10 tons of agate valued at $10,500 were reported produced in the Bend area, Deschutes County, Oreg. Production at the Fulton agate beds (formerly the Priday ranch, Jefferson County) was not reported. However, each visitor was charged a fee and was permitted

[1] Smithsonian Institution; consulting mineralogist to the Bureau of Mines.
[2] Commodity-industry analyst, Bureau of Mines.

to gather up to 30 pounds of agate. Hundreds of visitors collected from the Fulton agate beds during the year, and some nodules reportedly sold for as much as several hundred dollars.

The famous moss-agate deposits along the Upper Yellowstone River in Wyoming produced an estimated 6,000 to 8,000 pounds of agate, valued at $1 to $6 per pound and averaging $2.50 per pound, for a total value of about $20,000.

New Mexico production was reported as essentially unchanged from 1951.

Considerable quantities of agate were produced also in Utah, Michigan, Colorado, and Florida, and almost every State yielded small quantities of cuttable forms of chalcedonic quartz.

Information on agates in the Lake Superior area and the history of the use of agates was published in 1952.[3]

Topaz.—The Streeter-Kotempsie area of Mason County, Tex., known to have produced sizable quantities of gem-quality topaz at various times for over 50 years, produced during all of 1952, largely as the result of the efforts of amateur bobbyists or "diggers" whose findings later were sold to amateurs. Both white and blue topaz were found by washing or sifting stream gravels in small creeks. The 1952 production totaled about 10,000 grams, of which approximately 65 percent was white topaz with a commercial value of about $0.35 per gram. Twenty-five percent of the topaz found was blue-white valued at $0.75 per gram, and about 1,000 grams of high-quality blue material was produced, valued at $1.25 per gram. Estimated value of the 1952 production ranged from $5,400 to $25,000.

A small quantity of fine-quality gem topaz was reported from a locality near Boise, Idaho.

Turquoise.—Turquoise production continued essentially unchanged from 1951. Lee F. Hand, operating a lease near Battle Mountain, Nev., produced about $12,000 worth of turquoise. The Miami-Globe district of Gila County, Ariz., reportedly produced about 3,000 pounds valued at $3 to $15 per pound. Arizona turquoise was stated to be soft and of inferior quality, but a method of oiling it was discovered, which greatly improved its color. Some of the old mines in the vicinity of Mineral Park, Mohave County, Ariz., were opened, and about 2,000 pounds of oiling grade (chalk) turquoise was produced, valued at $2.50 to $3.00 per pound.

A small quantity of turquoise was produced near Villa Grove, Saguache County, Colo.

The famous turquoise mine near Cerrillos, Santa Fe County, N. Mex., was described in an article.[4]

Opal.—During 1952 the famous Rainbow Ridge mine of Virgin Valley, Humboldt County, Nev., produced what is perhaps the world's largest precious opal, weighing 6 pounds. This opal was described as being of exceptional quality and beauty and was valued at $50,000. In addition to this unusual find, several additional pounds of opal was produced. Unfortunately, the Virgin Valley opal is not durable, and for this reason it is not used in the jewelry trade.

[3] Vanasse, T. C., Lake Superior Agate: The Sun, Spring Valley, Wis., 2d. ed., 1952, 66 pp.
Pratt, Ethel M., Agate-Gemstone of the Ancients: Mineralogist, vol. 20, No. 11, November 1952, pp. 394, 396.

[4] Foster, E. E., Famous Turquoise Mine: Mineralogist, vol. 20, No. 12, December 1952, pp. 452, 454.

Jade.—There was a great decline in jade mining in Wyoming owing to depletion of the known deposits. The 1952 production was estimated at 3 tons of black jade, a few tons of dark-green and gray jade, and about 300 pounds of good apple-green material. The price ranged from $1 to $2 per pound up to as much as $60 per pound for the best quality.

In California a small quantity of jade, none of fine quality, was produced in Mendocino, Monterey, and San Benito Counties.

Some black jade with green streaks was reported from near Tonopah, Nev.

Other Natural Gem Stones.—Some rock-crystal quartz was produced in California, Arkansas, and Idaho, but very little was of gem quality. A small quantity of star-rose quartz was reported from the Bumpus quarry, Albany, Maine. No rose quartz was produced in South Dakota during 1952.

The Barton Mines Corp., North Creek, N. Y., reported a 1952 production of 76 pounds of gem-quality garnet valued at $132.20.

Tourmaline valued at approximately $2,000 was produced in San Diego County, Calif. Three mines in San Diego County—the Himalaya at Mesa Grande and the Reynolds and Ashley mines at Pala—were operated part time.

About 5 tons of chrysocolla reportedly was produced at the Inspiration mine, Gila County, Ariz. Only a small proportion of this was good cutting-grade material that sold for $5 to $100 per pound.

Three hundred pounds of californite (idocrase) valued at $0.50 per pound was produced at the Happy Camp, Siskiyou County, Calif., locality.

The Onyx ranch, Murray, Salt Lake County, Utah, reported a production of 20 tons of onyx valued at $2,400, all used in the lapidary trade. Near Salida, Chaffee County, Colo., 500 pounds of black onyx valued at $500 was produced.

A small quantity of variscite was mined in Utah.

No sapphire was produced during 1952 from the Yogo Gulch area in Fergus, Judith Basin, and Meagher Counties, Mont., and no diamonds were mined in Arkansas.

Synthetic Gems.—Synthetic emerald was produced only by the Chatham Research Laboratories in San Francisco, Calif. Production in 1952 was about 60,000 carats, of which 50 percent was very low quality, 40 percent medium quality, and 10 percent fine gem quality. Retail prices of fine-quality stones remained at $90 to $120 per carat. Flawless stones of more than 2 carats are not produced.

Diamonds colored by exposure to bombardment of alpha particles in a cyclotron, or to neutron bombardment in an atomic pile to produce green stones, were made before 1952. A quantity of green diamonds produced in this manner appeared on the market in 1952. One dealer reported that he produced and sold about 500 carats of green cyclotron-treated diamonds in 1952, in sizes ranging from ½ carat to 30 carats each.

Literature.—Articles on gem stones appearing in the press in 1952 discussed amber, beryl, meteorites, obsidian, opal, pearl, peridot, sinhalite, thunder eggs, tourmaline, quartz, and gem stones in California, Connecticut, and Maine.[5]

CONSUMPTION AND USES

Total sales of gem stones by retail jewelers rose slightly in 1952 as a result of greater than usual Christmas buying, which partly offset slow sales in the early months of the year. The greatest consumption of gems was for decorative purposes, mainly in jewelry. Bracelets, brooches, hair ornaments, necklaces, and earrings were very popular.

An outstanding use of gem stones during the year was for gem collections. Enthusiasm of collecting gem stones by thousands of amateur gem collectors for hobby collections or commercial use continued to increase. Supply houses, trading posts, and lapidaries required sizable quantities for resale.

A unique use of jade in 1952 was in the construction of a church window in Chicago by J. L. Kraft. About 446 pieces of beautifully cut and polished jade from his private collection were used. Kraft stated, "From the beginning of time, jade has symbolized truth, goodness, and beauty," and estimated the jade and labor would have come to about $1,500,000.[6]

For the third consecutive year a new high record was established, when the value of diamonds sold in 1952 totaled an estimated £72,000,000, an increase of about 6 percent above 1951. Sales effected through the Central Selling Organization on behalf of South African and other producers amounted to £69,662,000, an increase of £4,604,000 over 1951. The remainder was divided principally between Brazil, Venezuela, and British Guiana. As in previous years, the United States was the principal world market for diamonds. There was no significant change in sales volume of diamond jewelry or diamond engagement rings between 1951 and 1952. Jewelers had no difficulty in obtaining enough diamonds, although some reported a short supply of certain sizes and qualities. Diamond engagement rings continued to produce as much revenue for the typical jeweler as all other diamond jewelry combined.

The outstanding feature of diamond sales in 1952 was the strong advance in industrial diamonds. Sales of industrial diamonds

---

[5] Blakemore, Jean, Treasure Hunting in Maine—Gems and Minerals: Smiling Cow Shop, Boothbay, Maine, 1st ed., 1952, 118 pp.
California Journal of Mines and Geology, Gem Stones: Vol. 48, No. 1, January 1952, pp. 111–112.
Dake, H. C., California Gem Trails: Mineralogist Pub. Co., Portland, Oreg., 1952, 80 pp.
Claringbull, G. F., and Hey, M. H., Sinhalite ($MgAlBO_4$), a New Mineral: Mineralogist Mag., (London), vol. 24, No. 217, June 1952, pp. 841–849.
Mihelcic, Lillian, Story of Amber: Mineralogist, vol. 20, No. 9, September 1952, pp. 333–334.
Mineralogist, California Obsidian Deposits: Vol. 20, No. 2, February 1952, pp. 85–90.
Nininger, H. H., Out of the Sky: Univ. of Denver Press, Denver, Colo., 1952, 336 pp.
Patchick, P. F., Mineral Collecting at Crestmore, Calif.: Rocks and Minerals, vol. 27, No. 3–4, March–April 1952, pp. 130–135.
Paugh, F. H., A Short Course in Gemology: Jewelers' Circular—Keystone, vol. 122, No. 7, April 1952, pp. 126, 144–148; No. 8, May 1952, pp. 116, 142–146; No. 9, June 1952, pp. 92, 108–109; No. 10, July 1952, pp. 100, 102, 126–127; No. 11, August 1952, pp. 118, 153; and No. 12, September 1952, pp. 122, 161–162; vol. 123, No. 1, October 1952, pp. 132, 148–151; and No. 2, November 1952, pp. 118, 164–168.
Roots, Robert D., Thunder Eggs: Rocks and Minerals, vol. 27, No. 5–6, May–June 1952, pp. 234–236.
Smith, G. F. H., Gem Stones: Methuen & Co., Ltd., London, 12th ed., 1952, 537 pp.
Sohon, J. A., Connecticut Minerals, Their Properties and Occurrence: Connecticut State Geological and Natural History Survey, Bull. 77, 1952, 133 pp.
Walton, James, Physical Gemology: Sir Isaac Pitman & Sons, Ltd., London, 1952, 304 pp.
Wescott, I. P., Some Beryl-Family Gems: Mineralogist, vol. 20, No. 1, January 1952, pp. 3–7.

[6] Time, Jade in Church: Vol. 60, No. 14, Oct. 6. 1952, p. 76.

amounted to £23,892,000, an advance of more than £5,000,000 over 1951. Sales of gem diamonds amounted to £45,770,000 in 1952, about £1,000,000 less than in 1951.

Although the diamond industry was at a high level, diamond cutting was still troubled by shortage of rough material and some unemployment.

The announcement of the date for Queen Elizabeth's coronation had an impact on fashion at all levels. Precious jewelry responded conservatively with revivals of diamond-set crown brooches, small baskets of jeweled flowers, increased demand for amethyst (the royal purple) and the Tudor rose as a motif. Tiaras and crownlike ornaments of all kinds were heavily promoted.

In engagement rings, there was a revival of the use of cushion-cut diamonds mounted in platinum. In lower priced engagement rings baguette solitaires were used set with an extension rim to increase their apparent size. Eighty percent of diamond engagement rings sold were set with center stones of 55 points or less, and the price reported by the typical dealer for engagement rings sold in 1952 was $167, exclusive of Federal tax.

The so-called "baroque" jewelry, made by tumbling rough fragments of various gem stones to polish them while maintaining their irregular shape, continued to grow in popularity.

Conditions in the American synthetic corundum and spinel industry continued at low ebb as a result of recovery of the European industry. Sales of synthetic corundum boules manufactured in the United States were very small. There was some sale of synthetic star sapphires and rubies made in the United States, but even this market was impaired by imports of less expensive synthetic star stones made in Europe.

Sales of synthetic rutile remained essentially unchanged. There was no popular acceptance of this material, and it was not a serious threat to the diamond trade.

FOREIGN TRADE [7]

Imports of gem stones, exclusive of industrial diamonds, in 1952 totaled $124,807,761, compared with $128,953,866 in 1951, a decrease of 3 percent (table 1).

Imports of gem-quality diamonds into the United States in 1952 totaled $103,972,623, compared with $110,169,603 in 1951. A distribution of these figures into rough or uncut and cut but unset for the past 2 years is shown in table 2.

TECHNOLOGY

The expanding need for industrial diamonds and the present outlook for only a limited increase in production stimulated a great interest in the synthesis of diamonds. Several research programs concerned with this problem were underway, but no successful synthesis so far had been announced. A more than usual number of dubious claims were publicized, the one receiving the most press

[7] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 1.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1951–52

[U. S. Department of Commerce]

Commodity	1951		1952	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty-free	[1] 654, 235	[1] $48,256,746	725, 422	$52, 300, 980
Cut but unset, suitable for jewelry, dutiable	[1] 480, 602	[1] 61, 912, 857	438, 546	51, 671, 643
Emeralds:				
Rough or uncut, duty-free	2, 706	2, 698	8, 790	22, 213
Cut but not set, dutiable	20, 148	264, 527	11, 162	449, 726
Pearls and parts, not strung or set, dutiable:				
Natural		449, 379		465, 165
Cultured or cultivated		2, 747, 653		3, 373, 383
Other precious and semiprecious stones:				
Rough or uncut, duty-free		160, 609		226, 632
Cut but not set, dutiable		2, 686, 137		2, 125, 456
Imitation, except opaque, dutiable:				
Not cut or faceted		87, 162		97, 502
Cut or faceted:				
Synthetic		888, 629		536, 659
Other		[1] 11, 378, 844		13, 412, 914
Imitation, opaque, including imitation pearls, dutiable		26, 394		39, 142
Marcasites, dutiable:				
Real		88, 395		75, 285
Imitation		3, 836		11, 061
Total		[1] 128,953,866		124, 807, 761

[1] Revised figure.

notices being that of Herman Meincke and associates working under the auspices of the German Economic Ministry. The method of production, when carried out under the eyes of Government investigators, produced no diamonds.

Methods for producing synthetic sapphires, rubies, and emeralds were described, and distinguishing facts were emphasized.[8] The thermal conductivity of synthetic sapphire was investigated and found at 100° C. to be about 0.07 calorie per second per centimeter per °C.[9]

Experiments reportedly showed that no gem, either natural or synthetic, has more dispersion or fire than synthetic rutile.[10]

Procedures used in cutting a rough diamond into a finished gem and the stages of development of the brilliant cut since the 15th century were described during the year.[11] Details of the index of refraction, angle of total reflection, and inclination of main facets for diamond, zircon, corundum, topaz, and quartz were compiled in 1952.[12]

Various standard sizes and shapes for cabochons and methods of drilling holes in cabochons using hollow tubes and silicon carbide and diamond abrasives were described.[13]

[8] Webster, R., Synthetic Gem Stones: Gemologist, vol. 21, No. 249, 1952, pp. 66–70.
[9] Weeks, J. L., and Seifert, R. L., Thermal Conductivity of Synthetic Sapphire: Jour. Am. Ceram. Soc., vol. 35, No. 1, January 1952, p. 15.
[10] Field, D. S. M., Synthetic Rutile: Mineralogist, vol. 20, No. 10, October 1952, p. 378, 380.
[11] Jewelers' Circular—Keystone, How a Diamond Is Cut: Vol. 123, No. 2, November 1952, pp. 112, 114.
Dake, H. C., Development of the Brilliant Cut: Mineralogist, vol. 20, No. 10, October 1952, pp. 373–374, 376.
[12] Dake, H. C., Some Facet Cuts: Mineralogist, vol. 20, No. 11, November, 1952 pp. 421–422.
[13] Sinkankas, John, The Size and Shape of Cabochons: Rocks and Minerals, vol. 27, No. 5–6, May-June 1952, pp. 264–269.
Dake, H. C., Drilling Cabochons: Mineralogist, vol. 20, No. 1, January 1952, pp. 42, 44.

TABLE 2.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1951–52, by countries

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1951 [1]						
Australia	765	$97,086	$126.91	12	$1,200	$100.00
Belgian Congo	2,645	215,173	81.35			
Belgium-Luxembourg	4,582	409,071	89.28	[2] 251,703	[2] 31,331,704	[2] 124.48
Brazil	[2] 6,827	[2] 497,726	[2] 72.91	452	79,078	174.95
British Guiana	1,563	55,513	35.52	6	646	107.67
British Malaya				161	26,700	165.84
Canada	[2] 1,371	[2] 154,728	[2] 112.86	7	1,751	250.14
Ceylon				9	121	13.44
Czechoslovakia				10	1,150	115.00
Denmark				17	2,348	138.12
France	286	13,990	48.92	3,208	425,507	132.64
Germany				9,691	789,720	81.49
India				2	260	130.00
Iran				30	3,600	120.00
Israel and Palestine	207	1,656	8.00	104,194	[2] 9,169,614	[2] 88.01
Italy				62	12,372	199.55
Japan				50	5,670	113.40
Kuwait				1	800	800.00
Liberia	180	10,000	55.56			
Mexico				6	1,871	311.83
Netherlands	19,329	1,481,908	76.67	35,940	4,398,388	122.38
Switzerland	[2] 62,328	[2] 5,325,332	[2] 85.44	7,229	1,259,918	174.29
Union of South Africa	[2] 58,541	[2] 1,810,483	[2] 30.93	[2] 64,691	[2] 13,863,070	[2] 214.30
United Kingdom	[2] 470,598	[2] 37,461,206	[2] 79.60	3,120	536,944	172.10
Uruguay				1	425	425.00
Venezuela	[2] 25,013	[2] 722,874	[2] 28.90			
Total 1951	[2] 654,235	[2] 48,256,746	[2] 73.76	[2] 480,602	[2] 61,912,857	[2] 128.82
1952						
Australia				142	41,882	294.94
Belgium-Luxembourg	4,852	430,417	88.71	186,682	22,956,814	122.97
Bermuda	9,545	300,102	31.44			
Bolivia	71	2,119	29.85			
Brazil	9,719	479,114	49.30	2,056	242,763	118.08
British Guiana	1,061	53,855	50.76	22	3,349	152.23
British Malaya	1,723	115,367	66.96			
Canada	3,847	383,463	99.68	169	36,694	217.12
Denmark				15	2,528	168.53
France	50,490	1,075,560	21.30	784	321,310	409.83
French Equatorial Africa	13,976	396,924	28.40			
French Morocco				6	602	100.33
India				2,821	25,539	9.05
Indonesia				14	2,532	180.86
Israel and Palestine	1	47	47.00	128,206	10,017,374	78.13
Italy	359	60,808	169.38	187	29,641	158.51
Japan				5	1,250	250.00
Lebanon				7	1,573	224.71
Mexico				111	13,143	118.41
Netherlands	2,271	219,467	96.64	33,636	4,246,138	126.24
Portuguese Asia, n. e. s				1,021	7,476	7.32
Surinam	135	8,999	66.66			
Switzerland	103,447	7,050,320	68.15	3,319	582,130	175.39
Thailand	1,338	153,564	114.77	968	134,883	139.34
Union of South Africa	53,593	1,300,987	24.28	54,011	10,737,727	198.81
United Kingdom	442,068	39,418,835	89.17	6,706	902,044	134.51
Venezuela	26,926	851,032	31.61			
West Germany				17,658	1,364,251	77.26
Total 1952	725,422	52,300,980	72.10	438,546	51,671,643	117.82

[1] Changes in Minerals Yearbook 1951 are as follows: Bahrein and Southern British Africa revised to none.
[2] Revised figure.

Information on different abrasives and wheels used in polishing gem stones by lapidaries was given in an article.[14] A very high polish can be obtained on an onyx by using oxalic acid and tin oxide.[15]

A book on gem cutting was published in 1952.[16]

WORLD REVIEW

A new record was set for world production of diamonds in 1952, with a total of 18,694,000 metric carats, compared with 16,917,000 in 1951. Details are given in table 3. Belgian Congo was again the leading producer by weight, but 95 percent of the Belgian Congo production was industrial quality. South Africa, although producing less by weight, led in value owing to a higher percentage of gem stones.

Angola.—A comprehensive report on the diamond industry in Angola was published in 1952. Geology, tenor, character of the diamonds, reserves, production from 1916 to 1950, and other detailed information, were discussed.[17]

TABLE 3.—World production of diamonds, 1949–52, by countries, in metric carats

[Including industrial diamonds]

Country	1949	1950	1951	1952
Africa:				
Angola	769, 981	538, 867	[1] 734, 324	743, 302
Belgian Congo	9, 649, 896	10, 147, 471	10, 564, 667	11, 608, 763
French Equatorial Africa	122, 928	111, 407	[2] 136, 000	163, 400
French West Africa	94, 996	126, 346	101, 000	136, 080
Gold Coast	[3] 972, 976	[2] 950, 000	[1] 1, 752, 878	2, 189, 557
Sierra Leone	494, 119	655, 474	475, 759	451, 426
Southwest Africa	280, 134	488, 422	478, 075	541, 027
Tanganyika	191, 787	[1] 164, 996	108, 625	143, 023
Union of South Africa:				
Lode	964, 266	1, 516, 194	1, 967, 272	2, 093, 138
Alluvial	[4] 289, 756	[4] 231, 674	[4] 289, 063	[4] 282, 681
Brazil [2]	250, 000	200, 000	200, 000	200, 000
British Guiana	34, 790	37, 462	43, 260	38, 305
Venezuela	56, 362	60, 389	63, 226	98, 291
Other countries [2]	3, 000	3, 000	3, 000	5, 000
Total	14, 175, 000	15, 232, 000	16, 917, 000	18, 694, 000

[1] Revised.
[2] Estimate.
[3] Exports.
[4] Includes an estimated 100,000 carats for State Mines of Namaqualand.

Australia.—Australian opal production continued to diminish. The Lightning Ridge and White Cliffs fields were shut down, and only the Andamooka and Coober Pedy areas were supplying any opal. The number of miners working these deposits becomes smaller each year.

Some Australian sapphires were produced during the year, but they were not of fine quality and did not compete well with Ceylon stones in the world market.

Belgian Congo.—In addition to the productive area around Bakwanga and Tskikapa, Kasai Province, diamonds are known to occur in Katanga Province and along the Lomami, Ituri, Ubangi, and Uele

[14] Mineralogist, Lapidary Hints: Vol. 20, No. 6-8, June-August 1952, pp. 277-278.
[15] Mineralogist, Polishing Onyx: Vol. 20, No. 9, September 1952, p. 330.
[16] Willems, J. D., Gem Cutting: Chas. A. Bennett Co., Inc., Peoria, Ill., 1952, 224 pp.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 4, April 1952, pp. 32-46.

Rivers, but these localities are regarded to have no economic importance.[18] In Kivu Province, some small concentrations of rubies, white zircons, sapphires, and pink and green tourmalines are known to have been found. Garnets occur around Boma, in the Leopoldville Province, and in the District du Kibali-Ituri. Amethyst is known to occur in the Bas Congo of Leopoldville Province and in Kasai and Kivu Provinces. Agate has been found at Tshala on the Bushimaie River, and often in the alluvials along the rivers of Kasai, Kwango, and Moyen-Congo.[19]

Data on diamond production in the Belgian Congo by individual companies in 1951 was published during the year.[20]

Brazil.—Brazil continued to produce a large caratage of amethyst, aquamarine, citrine, topaz, and tourmaline, and smaller quantities of chrysoberyl, andalusite, euclase, and other gems.

Canada.—Properties and localities of gem stones, such as zircon, cat's-eye, tremolite, and scapolite, were discussed in an article.[21]

Gem-quality serpentine occurs at Kilmar, Quebec, associated with magnesite. The material ranges in color from dark green through pea green to citron yellow. Some of the stones have been made into ornamental objects, such as book ends.[22]

Ceylon.—Ceylon continued to be the principal world producer of ruby, sapphire, chrysoberyl, spinel, and zircon, and produced lesser quantities of garnet, topaz, and tourmaline. The gems came from the alluvial gravels of the Ratnapura district. Mining was done mostly by individuals, and no official production figures were available.[23]

Colombia.—Operations at the famous Chivor emerald mine, owned by Chivor Emerald Mines, Inc., were suspended. The Government-owned Muzo and Cosquez mines produced some emeralds, but output was erratic.[24]

French Equatorial Africa.—According to reports of Grivar Exploration Development Corp., the United States and France agreed to develop jointly a new diamond mine in this country. The mine is near the Ubangi River, about 220 miles southeast of Berberati.[25]

Madagascar.—Garnet was produced by Syndicat Minier Carlo Borsa near the village of Miary.[26] A small quantity of opaque black tourmaline for industrial uses was produced on the island.

Portuguese West Africa.—Harry Winston, Inc., a New York diamond dealer, was reported to have negotiated for distributor's rights for rough diamonds from Portuguese West Africa. The diamonds are mined by Angola Diamond Co.[27]

Tanganyika.—It was announced in 1952 that the diamond production from the Williamson mine at Mwadui, Shinyanga, would be sold

[18] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, p. 48.
[19] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, p. 50.
[20] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, pp. 31–37.
[21] Field, D. S. M., Miscellaneous Gem Stones in Canada: Canadian Min. Jour., vol. 73, No. 5, May 1952, pp. 78–80.
Field, D. S. M., More Canadian Gem Stones: Canadian Min. Jour., vol. 73, No. 11, November 1952, pp. 86–88.
[22] Canadian Mining Journal, vol. 73, No. 11, November 1952, p. 87.
[23] Seymour, John, Gem Mining in Ceylon: Mine and Quarry Eng. (London), vol. 18, No. 11, November 1952, p. 349.
[24] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 1, July 1952, p. 35. Mining World, vol. 14, No. 2, February 1952, p. 62.
[25] Mining World, vol. 14, No. 1, January 1952, p. 70.
[26] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 3, September 1952, p. 40.
[27] Mining World, vol. 14, No. 10, October 1952, p. 75.

on the open market. John T. Williamson stated he refused to agree to new terms to sell the diamonds through the Diamond Trading Corp. controlled by DeBeers diamond interests. Production from this mine has averaged about $8,400,000 per year.[28]

Venezuela.—The Minister of Mines and Hydrocarbons of Venezuela announced that the Government would grant a concession to the Compania Venezolana de Diamantes to exploit diamonds at Perantepuy. These deposits are in the southeastern part of the State of Bolivar near the Brazilian border.[29]

[28] Mining World, vol. 14, No. 2, February 1952, p. 56.
[29] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, October 1952, p. 29. Foreign Commerce Weekly, vol. 47, No. 12, June 23, 1952, p. 30.

Gold and Silver

By James E. Bell [1]

UNITED STATES mine production of recoverable gold and silver declined for the second successive year; the domestic output of gold was 4 percent less in 1952 than in 1951, and that of silver was 1 percent less. The production of both metals remained above postwar lows, however, but far below prewar averages. Most of the drop in gold production was ascribable to a decline in straight gold mining, both lode and placer, because of high costs and depletion of reserves workable under the fixed price of gold; on the other hand, straight underground gold mining gained in two important districts largely because of improvements in mining and treatment plants. The decreased silver output resulted in part from a drop in the prices of lead and zinc, which closed or curtailed operations at some mines producing these metals with silver as a byproduct.

South Dakota again was the leading State in gold production, followed in order by Utah and California, the same since 1950. These 3 States with Alaska supplied nearly 75 percent of the total domestic gold production in 1952. The South Dakota output was obtained almost entirely from gold ore produced at the Homestake mine in Lawrence County; Utah's gold was principally a byproduct from large mining operations of low-grade copper ore in the West Mountain (Bingham) district; California's production resulted mainly from straight gold mining, both lode and placer; and virtually all Alaska's output came from placer mining, mostly bucket-line dredging. Of the domestic gold production of 1952, 22 percent was recovered by placer mining, 36 percent by amalgamation and cyanidation, and 42 percent in smelting ores and concentrates.

Idaho was again the leading silver-producing State by a very large margin, followed, in order, by Utah, Montana, and Arizona, the same since 1943. These 4 States accounted for 84 percent of the total United States silver output of 1952. Nearly two-thirds of the Idaho production was obtained from dry ores mined principally for silver, but most of the remainder of the domestic silver yield was recovered as a byproduct of ores mined principally for base metals. Approximately 99 percent of the total domestic silver output was recovered in smelting ores and concentrates.

Gold production outside the United States increased 2 percent in 1952 compared with 1951, owing principally to higher output in the Union of South Africa and Australia. Silver production outside the United States rose 8 percent in 1952 over that of 1951, with Mexico and Peru supplying most of the gain. The world production rates of gold and silver in recent years have been far below prewar levels.

[1] Commodity-industry analyst.

TABLE 1.—Salient statistics of gold and silver in the United States,[1] 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Mine production, fine ounces:						
Gold	1,400,094	2,014,257	1,991,783	2,394,231	1,980,663	1,893,261
Silver	32,739,346	38,096,031	34,674,952	42,459,014	39,766,779	39,452,330
Ore (dry and siliceous) produced (short tons):						
Gold ore	2,602,870	3,261,194	3,376,139	3,584,360	2,606,202	2,339,160
Gold-silver ore	390,186	569,760	412,378	433,461	368,184	237,211
Silver ore	366,260	370,647	476,960	627,349	492,143	502,208
Percentage derived from—						
Dry and siliceous ores:						
Gold	36	39	45	43	39	40
Silver	24	27	24	33	32	31
Base-metal ores:						
Gold	39	31	28	31	36	38
Silver	76	73	76	67	68	69
Placers:						
Gold	25	30	27	26	25	22
Silver	(2)	(2)	(2)	(2)	(2)	(2)
Net consumption in industry and the arts:						
Gold	$99,034,594	$44,986,000	$108,842,471	$97,845,753	$69,476,979	$96,350,540
Silver, fine ounces	109,980,000	105,289,000	88,000,000	110,000,000	105,000,000	96,500,000
Imports:						
Gold	$584,379,466	$1,981,175,178	$771,390,261	$162,748,661	$81,258,502	$740,254,160
Silver	$40,854,525	$70,884,513	$73,535,694	$110,035,107	$103,468,510	$67,296,379
Exports:						
Gold	$325,351,778	$300,771,144	$84,935,678	$534,035,794	$630,381,566	$55,921,206
Silver	$63,129,015	$12,400,060	$23,281,043	$6,201,874	$8,590,185	$4,921,285
Monetary stocks (end of year):[3]						
Gold	----------	$24,244,000,000	$24,427,000,000	$22,706,000,000	$22,695,000,000	$23,186,000,000
Silver, fine ounces	----------	1,952,000,000	1,978,000,000	1,983,000,000	1,965,000,000	1,938,000,000
Price, average, per fine ounce:						
Gold [4]	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00
Silver [5]	$0.769+	$0.905+	$0.905+	$0.905+	$0.905+	$0.905+
World production, fine ounces (estimated):						
Gold	27,540,000	30,000,000	31,000,000	32,700,000	33,500,000	34,200,000
Silver	170,900,000	174,900,000	176,200,000	199,100,000	197,500,000	210,200,000

[1] Philippine Islands and Puerto Rico excluded.
[2] Less than 0.5 percent.
[3] Owned by Treasury Department; privately held coinage not included.
[4] Price under authority of Gold Reserve Act of Jan. 31, 1934.
[5] Treasury buying price for newly mined silver.

In the Union of South Africa a larger tonnage of ore of slightly higher average grade was milled in 1952 than in the preceding year, reflecting the initial contribution from several mines opened in the new Far West Rand and Orange Free State gold districts. Costs continued to rise in 1952, however, and operating profits were reduced; reportedly, less additional revenue from sales of gold at a premium over $35 per ounce was realized, also, because of declining prices for gold on the free market. Recovery of uranium as a byproduct of gold mining in the Rand began in October 1952, when the first of a series of plants for this purpose was placed in operation; the returns indicated that the uranium-recovery program will add substantially to working revenue for gold mines in the Union and probably will permit mining of lower grade ore.

The United States Treasury buying price for gold continued at $35 per fine troy ounce during 1952, and the Treasury price for silver mined domestically after July 1, 1946, was unchanged at $0.9050505+ per fine troy ounce. The New York market continued to dominate most transactions in silver throughout the world; trading in the London and Bombay silver markets was still subject to Government controls. The New York price for silver ranged from a high of $0.8800 per ounce to a low of $0.8275. World consumption of silver for coinage was up 15,000,000 ounces to approximately 104,000,000 ounces in 1952, of which over half was consumed in the United States.

There was a fairly steady net inflow of gold to the United States in 1952 from January through July and a steady outflow from August through December. The total inflow exceeded the total outflow, however, and resulted in a net gain in United States gold monetary stocks in 1952 of nearly $500,000,000, despite a net consumption in the arts and industry exceeding the output of domestic mines by 45 percent. Silver also continued to move generally to the United States during 1952, but the excess of imports over exports was 34 percent smaller in 1952 than in the preceding year.

Propaganda for increasing official national gold prices continued unabated throughout 1952. Since the United States Treasury is the only market strong enough to absorb sales of gold by all comers, the Treasury price as fixed by Congress ($35 per fine troy ounce) also determines the minimum world price. Postwar hardships of gold mining, due to rising costs and the fixed price of gold, have led to proposals by domestic gold producers for legislation by the Congress to increase the price of gold and to advancement of arguments by gold producers and organizations of foreign countries for such action. Among the arguments made were that revaluation of gold would help to restore currency convertibility, ease the world's dollar shortage, promote international trade, and relieve the United States of some of its foreign-aid burdens. The administration and much public opinion in the United States have remained opposed to raising the dollar price of gold. Secretary Snyder of the Treasury at the annual meeting of the International Monetary Fund in 1949 stated:

> I have said on many occasions, and I must say again, that I do not perceive any considerations of monetary policy which would justify me in proposing to my Government a change in the dollar price of gold.

The same views were reiterated by Snyder at the 1952 meeting of the fund. An example of the opinion held by commercial circles of the United States was the following extracted from a treatise issued in

November 1952, entitled "Dollar Sterling Alliance," by the American Chamber of Commerce in London:

> The Board of this Chamber is unalterably opposed to raising the dollar price of gold because in its judgment it would provide only a superficial and largely temporary alleviation in the sterling-dollar imbalance. It would not solve the fundamentals of the problem. Besides, it would damage confidence in the U. S. dollar. Further tinkering with the parity of our currency would not only destroy its integrity but would have thoroughly bad psychological and inflationary effects on our monetary system.

The National City Bank of New York in its monthly letter of January 1953 said:

> The U. S. Treasury's $35 an ounce price for gold has now been maintained unchanged for nearly twenty years. The dollar itself has become the cornerstone of postwar currency reconstruction. Confidence in its worth and stability is so vital to reestablishing faith in moneys generally, and the benefits of devaluation are so dubious and so transitory, that any course other than holding firmly to the present gold price and value of the dollar should be banished from our thought.

An article by Bratter on the dollar price of gold was published in 1952.[2]

LEGISLATION

War Production Board Limitation Order L-208, promulgated in October 1942 and rescinded in July 1945, had the avowed purpose of providing additional manpower and equipment for mines producing metals or minerals, mainly nonferrous metals, essential to the war effort.[3] The principal effect of the order was to restrict domestic gold mining to the extent that many gold mines, both lode and placer, were compelled to close or greatly curtail their operations. The gold-mining industry contended generally that Order L-208 was arbitrary, foredoomed to failure, accomplished little, and amounted to violation of constitutional rights. Furthermore, it contended that damages were suffered by mining properties because of loss of revenue, caving and flooding of unused mine workings, and deterioration of plant and equipment.

In June 1951, three gold-mining companies filed petitions in the United States Court of Claims for the right to seek compensation from the Government for damages resulting from the imposition of Order L-208. Although the Government took the position that the United States could never be required to pay compensations for damages caused by exercise of a regulatory power, in May 1952 the Court of Claims ruled that it would hold hearings to determine the liability of the Government in the matter of the enforced shutdowns. Encouraged by this decision, 13 additional companies filed similar petitions for the right to sue, acting before the expiration of the periods allowed under the statute of limitations. The majority of gold-mine owners or gold-mining companies had failed to file claims before the legal time limit, however, and to give them opportunity to do so, the Congress passed Public Law 532, S. 3195, quoted below, granting 1 year of additional time by waiving the statute of limitations; the bill was approved by the President on July 14, 1952.

---

[2] Bratter, Herbert, An American View of the Official Price of Gold: Optima, vol. 2, No. 4, December 1952, pp. 11-16.

[3] The provisions of Limitation Order L-208 are outlined in the Gold and Silver chapter of Minerals Yearbook 1942.

Public Law 532—82d Congress

An Act granting jurisdiction to the Court of Claims to hear, determine, and render judgment upon certain claims.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the United States Court of Claims be, and hereby is, given jurisdiction to hear, determine, and render judgment, nothwithstanding any statute of limitations, laches, or lapse of time, on the claim of any owner or operator of a gold mine or gold placer operation for losses incurred allegedly because of the closing or curtailment or prevention of operations of such mine or placer operation as a result of the restrictions imposed by War Production Board Limitation Order L–208 during the effective life thereof: Provided, That actions on such claims shall be brought within one year from the date this Act becomes effective.

Hearings by the United States Court of Claims were scheduled to begin in the fall of 1953.

PREMIUM PRICE OF GOLD

Developments in transactions in gold at premium prices and in private hoarding of gold have been reported in the chapters on Gold and Silver of Bureau of Mines Minerals Yearbooks for the past several years. Mounting pressure obliged the International Monetary Fund to announce in September 1951 relaxations in policy that permitted the member gold-producing countries to formulate their own regulations for disposal of their gold at premium prices.

As a result of the decision by the fund, greatly augmented supplies of newly mined gold became available for sale on the free market. It was estimated that around 10,000,000 ounces of the 1952 gold production were bought for private hoarding, mostly in France, the Near East, and the Far East. Prices quoted in the free market in Europe in 1952 ranged from around $39 per fine ounce at the beginning of the year to a low of $36.75 in November.

An interesting development in 1952 in the free gold market was the decision in August by the Swiss Federal Court (based on the international agreement of 1929) that private minting of gold coins of coinage withdrawn from circulation in countries of issue is not counterfeiting, provided the coins are of standard weight and fineness. The fact that gold in coin form generally commanded a substantially higher price on the free market than gold in bars, because of greater salability to hoarders, led to private coining of gold coins in Europe, beginning in 1950. With the legality thus accorded private minting by the court verdict referred to and greater availability of gold coins in consequence, the extra premium for gold in coin form declined.

A forecast of the free market demand for gold was as follows: [4]

The demand for gold in the free market remains strong and we see no reason to suppose that it will not easily absorb all that is likely to be offered.

So long as the world political situation remains as it is, and so long as the present economic situation maintains a system of currencies that are in part blocked, frozen, bilateral, and inconvertible, the twin spectres of war and devaluation will remain.

The only hedge known to most Europeans and all Asians against this dual calamity is the holding of gold, and at the present price it is reckoned a small insurance premium to pay.

---

[4] Samuel Montagu & Co., Ltd., Bankers and Bullion Merchants, London, Annual Bullion Review 1952.

Information available to the Bureau of Mines indicates that the quantity of "natural gold" absorbed by the open market in the United States (including Alaska) was much smaller in 1952 than in previous years, with total sales apparently amounting to less than 2,000 ounces. It was understood that the price received by sellers averaged around $39.50 per fine ounce, with the advantage of the premium largely offset by extra costs of handling.

DOMESTIC PRODUCTION

Production of gold and silver in the United States is measured at mines and refineries. Both measures are tabulated by States of origin, but there is a small annual variation between them, explained largely by time lag. Over a period of years the deviations are found to be negligible. Compared with the mine reports compiled by the Bureau of Mines, the refinery reports compiled by the Bureau of the Mint in cooperation with the Bureau of Mines for the 48 years, 1905–52 show a total excess of gold of 26,642 ounces (a difference of 0.02 percent) and a total excess of silver of 16,210,651 ounces (a difference of 0.63 percent).

TABLE 2.—Gold and silver produced in the United States,[1] 1905–52, in fine ounces, according to mine and mint returns, in terms of recoverable metals

Year	Mine		Mint	
	Gold	Silver	Gold	Silver
1905–47	147, 377, 397	2, 374, 700, 573	147, 620, 371	2, 389, 131, 012
1948	2, 014, 257	38, 096, 031	2, 025, 480	39, 228, 468
1949	1, 991, 783	34, 674, 952	1, 921, 949	34, 944, 554
1950	2, 394, 231	42, 459, 014	2, 288. 708	42, 308, 739
1951	1, 980, 663	39, 766, 779	1, 894, 726	39, 907, 257
1952	1, 893, 261	39, 452, 330	1, 927, 000	39, 840, 300
Total 1905–52	157, 651, 592	2, 569, 149, 679	157, 678, 234	2, 585, 360, 330

[1] Includes Alaska.

MINE PRODUCTION

The domestic mine output of recoverable gold declined in 1952 for the second successive year and was smaller than in any postwar year since 1946. The drop in 1952 was due mostly to lower production from dry gold ore and gold placers; it reflected the difficulties experienced by straight gold mining, both lode and placer, in recent years because of mounting costs for labor and supplies, depletion of workable reserves, and the fixed price of gold. Gold production from dry lode ore rose in 1952 in Colorado and South Dakota, however, owing largely to improvements in mining equipment and treatment plants. The domestic output of gold in 1952 amounted to only 39 percent of the all-time peak established in 1940.

The domestic mine output of recoverable silver also declined in 1952 for the second successive year. Lower prices for lead and zinc, which during the year closed some mines producing these metals with silver as a byproduct, caused part of the drop. A feature of the 1952 domestic silver output was the record recovery of byproduct silver from desilverizing bullion smelted from lead ores mined in the southeastern Missouri district. The current rate of silver production in the United States remains far below the prewar average.

TABLE 3.—Mine production of gold and silver in the United States,[1] in 1952, by months, in fine ounces

	Gold	Silver		Gold	Silver
January	131,399	3,424,057	August	186,364	3,156,010
February	126,562	3,422,040	September	181,995	3,065,660
March	134,598	3,510,024	October	181,165	3,333,899
April	136,097	3,456,777	November	171,393	3,049,697
May	151,203	3,574,781	December	160,825	3,157,676
June	154,035	3,253,309			
July	177,625	3,048,400	Total	1,893,261	39,452,330

[1] Includes Alaska.

All tonnage figures used in this report are short tons of 2,000 pounds "dry weight"; that is, they do not include moisture. Figures in cubic yards used in measuring material treated in placer operations are "bank measure"; that is, the material is measured in the ground before excavation. The weight unit for gold and silver is the troy ounce (480 grains). The totals are calculated upon the basis of recovered or recoverable fine gold and silver shown by assays to be contained in ore, bullion, and other material produced.

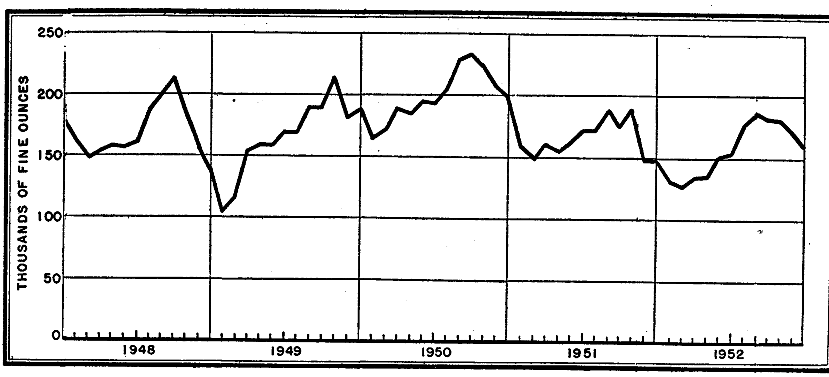

FIGURE 1.—Mine production of gold in the United States, 1948–52, by months, in terms of recoverable gold.

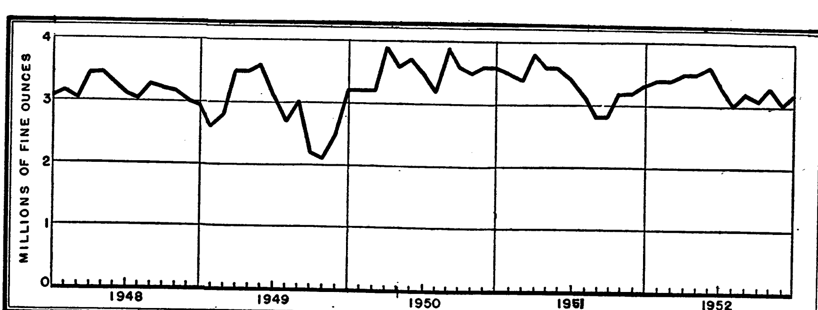

FIGURE 2.—Mine production of silver in the United States, 1948–52, by months, in terms of recoverable silver.

Mines are grouped in two main classes—placers and lodes. The placers are those in which gold and silver (and, in a few placers, platinum), are recovered from gravel as native metals or in natural alloy. Except for such small-scale hand methods as those utilizing the gold pan, the rocker, or the dry washer, all placer recovery methods employ sluice boxes; methods are distinguished by the means used for delivering the gravel to the sluices. Those methods where gravel is delivered mechanically include bucket-line dredging, dragline dredging, and treatment in nonfloating washing plants of gravel delivered by power shovel, dragline excavator, truck, slackline scraper, or other mechanical means. In the hydraulic method the gravel is mined from the bank by a powerful jet of water; in some small-scale hand methods the gravel is shoveled into sluices; and in drift operations the gravel is mined underground and delivered to sluices at the surface. The lode mines are those yielding gold and silver from ore (as distinguished from gravel), mainly from underground workings and, in addition to those worked chiefly for one or both of the precious metals, include those that yield ore mined chiefly for copper, lead, zinc, or other metals but contribute the precious metals as byproducts. As far as possible, the mine unit used is not the operator but the mining claim or group of claims.

PRINCIPAL MINING DISTRICTS AND LEADING MINES

Lawrence County (Lead), S. Dak., again was the leading gold-producing district in 1952, a position held since 1946. The West Mountain (Bingham), Utah, copper district, which held the lead from 1943 through 1945, has remained in second place since 1946. The Grass Valley-Nevada City gold-ore district in California, which ranked third from 1949 through 1951, was surpassed in 1952 by the Fairbanks district in Alaska. Nine of the 25 leading gold-producing mines were lode-gold mines, 6 were placers worked by bucket-line dredges, 3 were copper mines, 3 were lead-zinc mines, 1 was a zinc-copper mine, and 3 produced more than 1 type of ore. The 3 leading gold-producing mines supplied 52 percent of the country's total in 1952, and the leading 25 furnished 82 percent.

For many years the leading silver-producing districts have included many noted more for their base-metal production than for silver output, and this situation remained unchanged in 1952. The three leading silver-producing districts yielded 62 percent of the United States total in 1952. The leading 9 mines, each producing over 1,000,000 ounces of silver in 1952, supplied 56 percent of the United States total, and the leading 25 mines supplied 75 percent. As several mining companies each worked more than one of the leading silver mines in addition to smaller properties, the output by mining companies was substantially more concentrated than by mines.

TABLE 4.—Mine production of recoverable gold in the United States, 1943–47 (average) and 1948–52, by districts that produced 10,000 fine ounces or more during any year (1948–52), in fine ounces [1]

District or region	State	1943–47 (average)	1948	1949	1950	1951	1952
Lawrence County	South Dakota	178, 690	377, 836	464, 650	567, 996	458, 040	482, 511
West Mountain (Bingham)	Utah	286, 052	332, 588	286, 155	428, 313	407, 196	417, 607
Grass Valley-Nevada City	California	(2)	94, 398	(2)	(2)	(2)	(2)
American River (Folsom)	do	53, 709	104, 196	98, 435	91, 260	86, 867	73, 354
Robinson	Nevada	47, 246	37, 453	38, 703	49, 878	60, 055	59, 521
Chelan County [3]	Washington	30, 649	41, 826	(2)	(2)	46, 458	54, 135
Yuba River	California	(2)	(2)	(2)	(2)	(2)	(2)
Cripple Creek	Colorado	42, 063	53, 569	13, 460	5, 779	27, 699	48, 527
Ajo	Arizona	32, 492	38, 647	38, 455	37, 632	33, 805	36, 372
Upper San Miguel	Colorado	23, 866	38, 188	35, 217	52, 567	34, 030	34, 822
Warren (Bisbee)	Arizona	27, 423	19, 083	11, 837	13, 695	25, 338	26, 697
Battle Mountain	Nevada	(2)	7, 982	(2)	(2)	(2)	(2)
California (Leadville)	Colorado	(2)	(2)	(2)	(2)	(2)	18, 405
Bullion	Nevada	7, 493	16, 676	16, 791	20, 405	(2)	17, 824
Yellow Pine	Idaho	11, 989	27, 158	53, 576	48, 472	19, 605	17, 638
Big Bug	Arizona	7, 803	11, 058	14, 035	19, 328	19, 724	17, 317
Summit Valley (Butte)	Montana	13, 834	19, 163	15, 742	23, 092	15, 674	16, 918
Park City Region	Utah	16, 508	19, 087	19, 443	24, 125	18, 476	13, 827
Round Mountain	Nevada	(2)	----	----	(2)	(2)	(2)
Pioneer (Superior)	Arizona	7, 475	10, 054	12, 839	14, 392	12, 207	11, 664
Alleghany	California	(2)	(2)	(2)	14, 314	10, 776	9, 683
Animas	Colorado	21, 182	13, 428	10, 658	12, 874	9, 407	9, 657
Mother Lode	California	8, 995	(2)	21, 948	24, 513	(2)	7, 127
Verde (Jerome)	Arizona	10, 080	11, 374	10, 790	9, 421	7, 325	4, 328
Oroville	California	13, 818	20, 800	22, 701	(2)	(2)	2, 946
Tintic	Utah	16, 321	11, 007	5, 133	3, 277	4, 982	2, 942
Fairplay	Colorado	(2)	8, 489	(2)	(2)	(2)	2, 019
Merced River (Snelling)	California	(2)	(2)	(2)	(2)	4, 768	(2)
Cosumnes River	do	(2)	13, 956	(2)	(2)	(2)	(2)
Boise Basin	Idaho	3, 659	11, 732	4, 789	4, 942	5, 009	60
Tuolumne River (La Grange)	California	(2)	(2)	(2)	(2)	(2)	30
Comstock	Nevada	4, 003	11, 591	18, 540	9, 691	267	10
Scott River	California	(2)	(2)	(2)	12, 289	3, 919	6
Potosi	Nevada	(2)	--------	(2)	(2)	--------	--------

[1] Exclusive of Alaska.
[2] Figure withheld to avoid disclosure of individual company operations.
[3] Combined in 1952 with Ferry County to avoid disclosure of individual output.

TABLE 5.—Mine production of recoverable silver in the United States, 1943–47 (average) and 1948–52, by districts and regions that produced 200,000 fine ounces or more during any year (1948–52), in fine ounces

District or region	State	1943–47 (average)	1948	1949	1950	1951	1952
Coeur d'Alene Region	Idaho	8, 195, 687	10, 598, 338	9, 146, 146	15, 056, 131	13, 639, 808	13, 752, 081
Summit Valley (Butte)	Montana	5, 009, 204	6, 099, 790	5, 635, 101	6, 121, 264	5, 950, 647	5, 514, 330
West Mountain (Bingham)	Utah	4, 110, 173	4, 694, 674	4, 316, 378	4, 963, 586	4, 923, 249	5, 338, 291
Warren (Bisbee)	Arizona	1, 401, 926	1, 432, 172	1, 166, 210	1, 079, 311	1, 292, 719	1, 242, 935
Park City Region	Utah	1, 365, 441	1, 703, 864	1, 061, 902	952, 632	1, 131, 360	861, 563
Upper San Miguel	Colorado	280, 623	526, 742	579, 498	730, 860	621, 257	764, 478
Coso	California	586, 286	393, 761	352, 482	600, 440	570, 595	(1)
Tintic	Utah	1, 081, 618	1, 123, 460	914, 150	924, 722	944, 818	666, 345
Warm Springs	Idaho	528, 044	266, 226	468, 302	502, 973	506, 363	630, 886
Pioneer (Superior)	Arizona	334, 407	308, 448	401, 202	529, 186	581, 952	606, 553
Big Bug	do	303, 751	425, 079	581, 351	701, 973	636, 812	581, 699
Southeastern	Missouri	92, 270	114, 187	123, 413	236, 273	184, 424	517, 432
Ajo	Arizona	365, 503	455, 411	471, 134	473, 020	437, 675	450, 303
Pioche	Nevada	406, 575	684, 321	708, 216	608, 710	415, 622	425, 475
Copper Mountain (Morenci)	Arizona	325, 529	605, 153	606, 111	754, 591	612, 336	402, 593
Red Cliff	Colorado	130, 040	416, 032	216, 580	669, 461	412, 788	348, 090
California (Leadville)	do	(1)	(1)	(1)	(1)	272, 352	322, 034
Animas	do	311, 131	417, 887	539, 402	564, 321	415, 876	321, 308
Central	New Mexico	(1)	(1)	(1)	(1)	236, 484	306, 236
Grand Island	Colorado	3, 217	15, 364	53, 188	58, 262	109, 206	274, 104
Chelan County [2]	Washington	101, 999	137, 242	(1)	(1)	113, 155	241, 935
Verde (Jerome)	Arizona	577, 476	408, 669	509, 828	456, 254	408, 891	233, 946
Flint Creek	Montana	177, 364	31, 858	15, 040	22, 528	82, 033	233, 799
Mineral Creek (Ray)	Arizona	40, 431	30, 985	34, 514	130, 669	172, 765	214, 030
Rush Valley	Utah	(1)	(1)	(1)	95, 324	189, 110	179, 401
Harshaw	Arizona	160, 031	210, 533	140, 011	147, 258	152, 366	176, 778
Creede	Colorado	451, 022	297, 926	263, 867	345, 247	236, 652	174, 219
Ash Peak	Arizona	74, 201	135, 356	147, 958	227, 342	193, 419	136, 072
Pima (Sierritas, Papago, Twin Buttes).	do	121, 863	162, 224	252, 334	182, 540	145, 941	128, 847
Resting Springs	California	(1)	(1)	(1)	(1)	(1)	(1)
Virginia City	Montana	87, 528	225, 784	84, 918	66, 267	32, 427	35, 547
Ten Mile	Colorado	67, 649	271, 944	254, 294	68, 289	811	671
Comstock	Nevada	58, 312	176, 882	233, 705	108, 944	3, 512	8
Sand Springs	do	---------	164, 413	174, 718	200, 217	111, 529	---------

[1] Figure withheld to avoid disclosure of individual company operations.
[2] Combined in 1952 with Ferry County to avoid disclosure of individual output.

TABLE 6.—Twenty-five leading gold-producing mines in the United States in 1952, in order of output

Rank	Mine	District	State	Operator	Source of gold
1	Homestake	Whitewood	South Dakota	Homestake Mining Co	Gold ore.
2	Utah Copper	West Mountain (Bingham)	Utah	Kennecott Copper Corp	Copper ore.
3	Fairbanks Unit	Fairbanks	Alaska	U. S. Smelting, Refining & Mining Co	Dredge.
4	Natomas	American River (Folsom)	California	Natomas Co	Do.
5	Yuba Unit	Yuba River	do	Yuba Consolidated Gold Fields	Do.
6	Brunswick	Grass Valley-Nevada City	do	Idaho Maryland Mines Corp	Gold ore.
7	New Cornelia	Ajo	Arizona	Phelps Dodge Corp	Copper ore.
8	Nome Unit	Nome	Alaska	U. S. Smelting, Refining & Mining Co	Dredge.
9	Ruth Pit	Robinson	Nevada	Kennecott Copper Corp	Copper ore.
10	Empire Star Group	Grass Valley-Nevada City	California	Empire Star Mines, Ltd	Gold ore.
11	Copper Queen	Warren (Bisbee)	Arizona	Phelps Dodge Corp	Zinc-lead, copper ores.
12	Ajax Group	Cripple Creek	Colorado	Golden Cycle Corp	Gold ore.
13	Knob Hill	Republic	Washington	Knob Hill Mines, Inc	Do.
14	Treasury Tunnel, etc	Upper San Miguel	Colorado	Idarado Mining Co	Copper-lead-zinc ore.
15	Greenan Placers	Battle Mountain	Nevada	Natomas Co	Dredge.
16	Holden Group	Chelan Lake	Washington	Howe Sound Co	Zinc-copper ore.
17	Goldacres	Bullion	Nevada	London Extension Mining Co	Gold ore.
18	Yellow Pine	Yellow Pine	Idaho	Bradley Mining Co	Do.
19	Iron King	Big Bug	Arizona	Shattuck Denn Mining Corp	Zinc-lead ore.
20	Resurrection Group	California	Colorado	Resurrection Mining Co	Lead-zinc ore.
21	Portland, Dakota, Clinton	Portland, Bald Mountain	South Dakota	Bald Mountain Mining Co	Gold ore.
22	Smuggler Union, etc	Upper San Miguel	Colorado	Telluride Mines, Inc	Lead-zinc ore.
23	Gold King	Wenatchee River	Washington	Lovitt Mining Co	Gold ore.
24	New York—Alaska Gold Dredging Corp.	Aniak	Alaska	New York—Alaska Gold Dredging Corp	Dredge.
25	United States and Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co	Zinc-lead, lead, copper, gold-silver ores.

TABLE 7.—Twenty-five leading silver-producing mines in the United States in 1952, in order of output

Rank	Mine	District	State	Operator	Source of silver
1	Butte Hill mines	Summit Valley (Butte)	Montana	Anaconda Copper Mining Co	Copper, zinc-lead ores.
2	Sunshine	Evolution	Idaho	Sunshine Mining Co	Silver ore.
3	Utah Copper	West Mountain (Bingham)	Utah	Kennecott Copper Corp	Copper ore.
4	Polaris	Evolution	Idaho	Sunshine Mining Co	Silver ore.
5	Bunker Hill	Yreka	do	Bunker Hill & Sullivan Mining & Concentrating Co.	Zinc-lead ore.
6	United States and Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co	Zinc-lead, copper, lead, gold-silver ores.
7	Silver Summit	Evolution	Idaho	Polaris Mining Co	Silver ore.
8	St. Germaine, Purim	do	do	Sunshine Mining Co	Do.
9	Copper Queen	Warren (Bisbee)	Arizona	Phelps Dodge Corp	Zinc-lead, copper ores.
10	Darwin group	Coso	California	Anaconda Copper Mining Co	Zinc-lead, lead ores.
11	Treasury Tunnel, etc	Upper San Miguel	Colorado	Idarado Mining Co	Copper-lead-zinc ore.
12	Triumph, North Star	Warm Springs	Idaho	Triumph Mining Co	Zinc-lead ore.
13	Magma	Pioneer (Superior)	Arizona	Magma Copper Co	Zinc-copper, copper ores.
14	Iron King	Big Bug	do	Shattuck Denn Mining Corp	Zinc-lead ore.
15	Chief No. 1	Tintic	Utah	Chief Consolidated Mining Co	Zinc-lead, silver, lead ores.
16	New Cornelia	Ajo	Arizona	Phelps Dodge Corp	Copper ore.
17	Page	Yreka	Idaho	Federal Mining & Smelting Co	Zinc-lead ore.
18	Pioche group	Pioche	Nevada	Combined Metals Reduction Co	Do.
19	Morenci	Copper Mountain (Morenci)	Arizona	Phelps Dodge Corp	Copper ore.
20	Lucky Friday	Hunter	Idaho	Lucky Friday Silver-Lead Mines	Zinc-lead ore.
21	Silver Syndicate	Evolution	do	Sunshine Mining Co	Silver ore.
22	Eagle group	Red Cliff	Colorado	Empire Zinc Division, New Jersey Zinc Co	Silver-zinc ore.
23	Butterfield	West Mountain (Bingham)	Utah	Combined Metals Reduction Co	Zinc-lead, silver, gold-silver ores.
24	Park Galena and Mayflower	Park City Region	do	New Park Mining Co	Zinc-lead ore.
25	Kelley Shaft	Summit Valley	Montana	Anaconda Copper Mining Co	Copper ore.

TABLE 8.—Mine production of recoverable gold in the United States, 1942–52, with production of maximum year, and cumulative production from earliest record to end of 1952, by States, in fine ounces

	Maximum production [1]		Production by years											Total production from earliest record to end of 1952
	Year	Quantity	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	
Western States and Alaska:														
Alaska	1906	1, 066, 030	487, 621	99, 583	49, 296	68, 117	226, 781	279, 988	248, 395	229, 416	289. 272	239, 637	240, 557	27, 610, 693
Arizona	1937	332, 694	253, 651	171, 810	112, 162	77, 223	79, 024	95, 860	109, 487	108, 993	118, 313	116, 093	112, 355	11, 529, 260
California	1852	3, 932, 631	847, 997	148, 328	117, 373	147, 938	356, 824	431, 415	421, 473	417, 231	412, 118	339, 732	258, 176	104, 161, 364
Colorado	1900	1, 391. 364	268, 627	137, 558	111, 455	100, 935	142, 613	168, 279	154, 802	102, 618	130, 390	116, 503	124, 594	39, 855, 129
Idaho	1871	212, 850	95, 020	30, 808	25, 008	17, 780	42, 975	64, 982	58, 454	77, 829	79, 652	45, 064	32, 997	8, 199, 727
Montana	1865	870, 750	146, 892	59, 586	50, 021	44, 597	70, 507	90, 124	73, 091	52, 724	51, 764	30, 502	24, 161	17, 374, 487
Nevada	1910	913, 265	295, 112	144, 442	119, 056	92, 265	90, 680	89, 063	111, 532	130, 399	178, 447	121, 036	117, 203	26, 264, 681
New Mexico	1915	70, 681	11, 961	5, 563	6, 918	5, 604	4, 009	3, 146	3, 414	3, 249	3, 414	3, 959	2, 949	2, 202, 966
Oregon	1940	113, 402	46, 233	1, 097	1, 369	4, 467	17, 598	18, 979	14, 611	16, 226	11, 058	7, 927	5, 509	5, 765, 862
South Dakota	1939	618, 536	522, 098	106, 444	11, 621	55, 948	312, 247	407, 194	377, 850	464, 650	567, 996	458, 101	482, 534	23, 804, 626
Texas	1929	1, 279	236	4	-----	-----	9	45	57	40	49	32	39	8, 552
Utah	1950	457, 551	391, 544	390, 470	344, 223	279, 979	178. 533	421, 662	368, 422	314, 058	457, 551	432, 216	435, 507	13, 072, 394
Washington	1950	92, 117	75, 396	65, 244	47, 277	57, 860	51, 168	34, 965	70, 075	71, 994	92, 117	67, 405	54, 776	2, 570, 002
Wyoming	1869	7, 498	23	-----	20	2	105	1, 486	115	389	-----	9	1	80. 041
Total	-----	-----	3, 442, 411	1, 360, 937	995, 799	952, 715	1, 573, 073	2, 107, 188	2, 011, 778	1, 989, 816	2, 392, 141	1, 978, 216	1, 891, 358	282, 499, 784
West Central States: Missouri	1900	33	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	33
States east of the Mississippi:														
Alabama	1936	4, 726	1	-----	-----	5	1	-----	-----	-----	-----	-----	-----	49, 495
Georgia	1882	12, 094	30	12	5	-----	21	73	19	18	-----	3	-----	870, 663
Indiana	(2)	(2)	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	(3)
Maryland	1937	1, 040	-----	-----	-----	-----	-----	-----	-----	-----	20	1	-----	6, 123
Michigan	1890	4, 354	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----	33, 297
North Carolina	1887	10, 884	4, 077	131	21	-----	-----	-----	-----	13	-----	-----	-----	1, 164, 601
Pennsylvania	1942	2, 499	2, 499	2, 218	2, 115	1, 588	1, 150	1, 518	2, 200	1, 645	1, 764	2, 179	1, 500	[4] 36, 090
South Carolina	1941	15, 508	7, 824	147	-----	-----	-----	-----	-----	-----	-----	-----	-----	318, 801
Tennessee	1930	696	159	303	222	148	95	303	156	171	160	108	241	22, 104
Vermont	1946	165	-----	17	100	104	165	100	104	120	146	156	162	[5] 1, 207
Virginia	1938	2, 943	109	50	132	12	-----	-----	-----	-----	-----	-----	-----	167, 558
Total	-----	-----	14, 699	2, 878	2, 595	1, 857	1, 432	1, 997	2, 479	1, 967	2, 090	2, 447	1, 903	2, 669, 939
Grand total	-----	-----	3, 457, 110	1, 363, 815	998, 394	954, 572	1, 574, 505	2, 109, 185	2, 014, 257	1, 991, 783	2, 394, 231	1, 980, 663	1, 893, 261	285, 169, 756

[1] For Central and Eastern States figures are peaks since 1880, except Pennsylvania and Vermont, for which the figures are peaks since 1905. For Alaska, Nevada, and Oregon figures are likewise peaks since 1880 only.
[2] Figure not available.
[3] Small, figure not available.
[4] 1908–52 only.
[5] 1905–52 only.

TABLE 9.—Mine production of recoverable silver in the United States, 1942–52, with production of maximum year, and cumulative production from earliest record to end of 1952, by States, in fine ounces

	Maximum production [1]		Production by years											Total production from earliest record to end of 1952
	Year	Quantity	1942	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952	
Western States and Alaska:														
Alaska	1916	1,379,171	119,704	42,788	13,362	9,983	41,793	66,150	67,341	36,056	52,638	32,870	32,986	20,078,339
Arizona	1937	9,422,552	7,064,467	5,713,889	4,394,039	3,558,216	3,268,765	4,569,084	4,837,740	4,970,736	5,325,441	5,120,985	4,701,330	322,212,730
California	1921	3,629,223	1,450,440	609,075	778,936	986,798	1,342,651	1,597,442	724,771	783,880	1,071,917	1,145,219	1,099,658	114,622,975
Colorado	1893	25,838,600	3,096,211	2,664,142	2,248,830	2,226,780	2,240,151	2,557,653	3,011,011	2,894,886	3,492,278	2,787,882	2,813,643	747,984,031
Idaho	1937	19,587,766	14,644,890	11,700,180	9,931,614	8,142,667	6,491,104	10,345,779	11,448,875	10,049,257	16,095,019	14,753,023	14,923,165	598,100,530
Montana	1892	19,038,800	11,188,118	8,450,370	7,093,215	5,942,070	3,273,140	6,326,190	6,930,716	6,327,025	6,590,747	6,393,768	6,138,185	787,856,454
Nevada	1913	16,090,083	3,723,435	1,620,280	1,259,636	1,043,380	1,250,651	1,377,579	1,790,020	1,800,209	1,537,217	981,669	941,195	598,031,601
New Mexico	1885	2,343,800	676,170	463,583	535,275	465,127	338,000	515,833	537,674	380,855	338,581	443,267	479,318	70,450,259
Oregon	1941	276,158	87,376	10,523	20,243	10,461	6,927	30,379	13,596	12,195	13,565	6,218	4,037	5,305,302
South Dakota	1900	536,200	186,937	35,886	5,445	26,564	86,901	111,684	94,693	109,383	142,065	139,590	132,102	10,417,526
Texas	1938	1,433,008	672,781	10,284	5,355	23,265	42,922	20,547	3,065	2,691	2,454	1,381	4,672	33,303,173
Utah	1925	21,276,689	10,574,955	9,479,340	7,593,075	6,106,545	4,118,453	7,780,032	8,045,329	6,724,880	7,083,808	7,310,665	7,194,109	763,311,342
Washington	1902	721,450	369,038	370,440	321,608	281,444	264,453	293,736	375,831	357,853	363,656	334,948	315,645	14,871,542
Wyoming	1901	21,400	52	----------	3	31	26	95	11	21	----------	2	----------	74,821
Total	-------	----------	53,854,574	41,170,780	34,200,636	28,823,331	22,765,937	35,592,183	37,880,673	34,449,927	42,109,386	39,451,487	38,780,045	4,086,620,625
West Central States: Missouri	1952	517,432	69,106	111,285	92,243	94,822	69,401	93,600	114,187	123,413	236,273	184,424	517,432	5,431,326
States east of the Mississippi:														
Alabama	1936	869	----------	----------	----------	1	----------	----------	----------	----------	----------	----------	----------	5,239
Georgia	1904	1,500	7	----------	----------	----------	----------	13	3	----------	----------	----------	----------	10,963
Illinois	1924	8,891	104	2,153	2,437	2,198	2,302	1,790	4,047	3,128	2,001	3,465	3,781	155,554
Maryland	1917	1,092	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------	2,595
Michigan	1916	716,640	61,674	48,479	54,218	21,863	----------	3,089	----------	----------	----------	----------	----------	10,256,112
New York	1951	47,568	40,012	38,004	25,238	14,271	15,786	22,409	18,788	18,378	32,628	47,568	38,895	567,788
North Carolina	1906	30,769	8,259	7,169	1,461	----------	----------	----------	----------	----------	----------	----------	----------	357,223
Pennsylvania	1942	15,501	15,501	13,095	13,545	10,434	7,887	9,863	13,731	10,827	10,563	13,575	9,247	249,360
South Carolina	1940	8,047	5,064	135	----------	----------	----------	----------	----------	----------	----------	----------	----------	35,325
Tennessee	1920	110,719	34,671	52,058	45,907	35,391	18,016	79,147	39,692	41,833	39,958	24,960	57,569	3,321,509
Vermont	1952	45,361	----------	2,721	18,862	20,586	35,275	21,469	24,910	27,446	28,205	41,300	45,361	[2] 292,743
Virginia	1944	18,993	1,793	14,947	18,993	1,300	----------	----------	----------	----------	----------	----------	----------	79,389
Total	-------	----------	167,085	178,761	180,661	106,044	79,266	137,780	101,171	101,612	113,355	130,868	154,853	15,333,800
Grand total	-------	----------	54,090,765	41,460,826	34,473,540	29,024,197	22,914,604	35,823,563	38,096,031	34,674,952	42,459,014	39,766,779	39,452,330	4,107,385,751

[1] States east of the Mississippi figures are peaks since 1896, except New York and Pennsylvania which are peaks since 1905. The Illinois figure is the peak since 1907. Alaska, California, Nevada, and Oregon are peaks since 1880.

[2] Includes a small quantity for New Hampshire.

ORE PRODUCTION, CLASSIFICATION, METAL YIELD, AND METHODS OF RECOVERY

Tables 10 to 15 give details of classes of ore, metal yield in fine ounces of gold and silver to the ton, and gold and silver output by classes of ore and by methods of recovery, embracing all ores that yielded gold and silver in the United States in 1952. These tables were compiled from the individual State chapters in volume III, in which more detailed data are presented.

TABLE 10.—Ore, old tailings, etc., yielding gold and silver, produced in the United States and average recoverable content, in fine ounces, of gold and silver per ton in 1952 [1]

State	Gold ore			Gold-silver ore			Silver ore		
	Short tons	Average ounces per ton		Short tons	Average ounces per ton		Short tons	Average ounces per ton	
		Gold	Silver		Gold	Silver		Gold	Silver
Western States and Alaska:									
Alaska	11,457	[2] 0.111	[2] 0.020	------	------	------	------	------	------
Arizona	8,091	.137	.337	9,528	0.086	1.745	14,982	0.034	9.575
California	232,665	.479	.269	775	.283	15.498	19	.421	150.684
Colorado	156,119	.316	.073	184,840	.041	1.672	28,444	.064	16.704
Idaho	322,027	.064	.224	6,995	.497	8.311	283,597	.003	34.568
Montana	33,935	.131	.325	9,981	.215	17.262	46,338	.013	4.295
Nevada	155,482	.123	.027	601	.213	6.804	3,057	.043	[3] 18.096
New Mexico	568	.229	.081	17	.353	22.471	219	------	4.429
Oregon	842	.629	3.076	------	------	------	------	------	------
South Dakota	1,324,789	.364	.099	------	------	------	------	------	------
Texas	------	------	------	------	------	------	------	------	------
Utah	1	33.000	22.000	24,474	.040	2.896	125,459	.021	4.415
Washington	93,184	.384	1.754	------	------	------	93	------	.753
Total	2,339,160	.311	.198	237,211	.065	2.713	502,208	.013	22.369
States east of the Mississippi	------	------	------	------	------	------	------	------	------
Total	2,339,160	.311	.198	237,211	.065	2.713	502,208	.013	22.369

State	Copper ore			Lead ore			Lead-copper ore		
	Short tons	Average ounces per ton		Short tons	Average ounces per ton		Short tons	Average ounces per ton	
		Gold	Silver		Gold	Silver		Gold	Silver
Western States and Alaska:									
Alaska	------	------	------	2	------	116.500	------	------	------
Arizona	44,539,353	0.002	0.065	5,635	0.159	4.679	4	0.500	31.000
California	2,152	[3,4] .172	[3,4] 5.589	27,885	.066	8.171	6	.500	19.667
Colorado	73	.014	3.438	27,286	.031	3.992	8	.250	13.875
Idaho	100,800	.007	.078	158,965	.002	3.130	46,488	------	1.621
Montana	2,154,657	.002	.715	27,367	.033	3.432	------	------	------
Nevada	6,850,825	.009	.025	19,477	.065	7.670	114	.009	17.035
New Mexico	8,421,983	------	.010	42,831	.001	.251	------	------	------
Oregon	89	.933	4.067	------	------	------	------	------	------
South Dakota	------	------	------	28	------	11.964	------	------	------
Texas	111	.207	1.856	751	------	4.856	408	.039	2.007
Utah	32,038,719	.013	.103	15,609	.048	4.741	39	.051	12.718
Washington	126	.016	.294	16,175	------	1.535	------	------	------
Total	94,108,888	.006	.085	342,011	.020	3.561	47,067	.001	1.678
States east of the Mississippi	4,130,883	------	.011	------	------	------	------	------	------
Total	98,239,771	.006	.082	342,011	.020	3.561	47,067	.001	1.678

TABLE 10.—Ore, old tailings, etc., yielding gold and silver produced in the United States and average recoverable content, in fine ounces, of gold and silver per ton in 1952 [1]—Continued

State	Zinc ore			Zinc-lead, zinc-copper, and zinc-lead-copper ores			Total ore		
	Short tons	Average ounces per ton		Short tons	Average ounces per ton		Short tons	Average ounces per ton	
		Gold	Silver		Gold	Silver		Gold	Silver
Western States and Alaska:									
Alaska							11,459	0.111	0.040
Arizona	5,646	0.009	2.179	802,088	0.031	1.983	45,385,327	.002	.104
California	40,722	.031	3.469	120,560	.006	5.246	424,784	[3 4].273	[3 4]2.569
Colorado	292,240	.007	.692	859,805	.071	1.984	1,548,815	.079	1.816
Idaho	[5]58,806		.639	2,030,552	.001	2.152	[5]3,008,230	.010	4.960
Montana	[6]34,270	.002	1.621	2,319,202	.005	1.753	[6]4,625,750	.005	1.327
Nevada	[7]11,292	[7].003	[7]1.511	272,849	.015	1.920	7,313,697	.012	[3].127
New Mexico	636,294	.001	.477	42,312	.005	1.853	9,144,224		.052
Oregon							931	.658	3.171
South Dakota							1,324,817	.364	.100
Texas							1,270	.031	3.679
Utah	[8]10,142	.004	.674	660,591	.042	4.840	[8]32,875,034	.013	.219
Washington	31,052		.031	1,261,842	.015	.100	1,402,472	.039	.225
Total	1,120,464	.004	.694	8,369,801	.018	1.946	107,066,810	.014	.362
States east of the Mississippi	2,440,931			2,467,855		.041	[9]9,039,669	(9)	[9].016
Total	3,561,395	.001	.218	10,837,656	.014	1.512	116,106,479	.013	.335

1 Missouri excluded.
2 Includes 195 ounces of gold and 51 ounces of silver recovered from mill cleanup at 3 inactive properties.
3 Includes metal recovered from tungsten ore or tungsten tailings.
4 Includes metal recovered from pyritic ore (residue).
5 Includes 58,482 tons of old zinc slag.
6 Includes 30,243 tons of old zinc slag.
7 Includes 8,346 tons of ore and contained recoverable metal from the former Metals Reserve Company stockpile at Jean, Nev.
8 Includes 7,142 tons of old zinc slag.
9 Excludes magnetite-pyrite ore and gold and silver therefrom.

The classification originally adopted in 1905 on the basis of smelter terminology, smelter settlement contracts, and metal recovery has been used continuously in succeeding years, except for modifications necessitated by the improvement in metallurgy and the lowering of the grade of complex ores treated. The copper ores include those smelting ores that contain 2.5 percent dry assay or more of copper (or less than this percentage if no other metal is present); or those ores concentrated chiefly for their copper content. The lead ores are those that contain 5 percent dry assay (minimum lead-smelting charge requires 7.5 to 8.5 percent wet assay) or more of lead, irrespective of precious-metal content; and ore that carries any grade of lead exclusively is called a lead ore. Zinc-smelting ores (chiefly oxides) had ranged from 16 to 45 percent zinc; but, with the development of slag fuming, which permits some oxidized ore in the charge, and with high zinc prices, the minimum has declined to as low as 5 percent recoverable zinc. Zinc concentrating ores include any grade of zinc ore that makes marketable zinc concentrate, irrespective of precious-metal content. The mixed ores are combinations of those enumerated.

Gold, gold-silver, and silver ores containing too little copper, lead, or zinc to be classified as copper, lead, zinc, or mixed base-metal ores are called dry ores, regardless of the ratio of concentration, except low-grade ore milled chiefly for its copper content and having very little or no precious-metal content (chiefly the porphyry coppers) and ores from which separate products of lead concentrates and zinc concentrates are made. The crude ore into the mill in these two exceptional instances thus takes its name from its products—a name that is also justified by the mineralogical content and final recovery of metals. The dry ores thus are ores, chiefly siliceous, valuable for their gold and silver content and, in some instances, for their fluxing properties, regardless of method of treatment. Dry gold ores are those that by inspection are overwhelmingly of gold content; a similar qualification applies to silver ores; decision as to gold-silver ore is made on a basis of value, using the rule that the bimetal classification is not used unless the metal of lower value equals or exceeds one-quarter of the combined value of the gold and silver.

The lead, zinc, and zinc-lead ores in most districts in the States east of the Rocky Mountains carry no appreciable quantity of gold or silver; such ores are excluded from this report unless otherwise indicated.

TABLE 11.—Mine production of gold and silver in the United States,[1] 1943–47 (average) and 1948–52, by percent from sources and in total fine ounces

Year	Percent from—						Total fine ounces
	Placers	Dry ore	Copper ore	Lead ore	Zinc ore	Zinc-lead, zinc-copper, lead-copper, and zinc-lead-copper ores	
GOLD							
1943–47 (average)	24.8	36.3	30.1	0.6	0.5	7.7	1,400,094
1948	29.8	39.5	22.4	.5	.2	7.6	2,014,257
1949	26.8	44.8	19.8	.6	.2	7.8	1,991,783
1950	25.5	43.1	23.1	.7	.1	7.5	2,394,231
1951	24.8	38.9	27.5	.5	.2	8.1	1,980,663
1952	22.5	39.5	29.4	.4	.2	8.0	1,893,261
SILVER							
1943–47 (average)	0.1	23.5	29.8	8.1	2.0	36.5	32,739,346
1948	.2	26.6	20.7	5.9	1.5	45.1	38,096,031
1949	.2	23.5	20.0	7.8	1.5	47.0	34,674,952
1950	.2	32.8	19.6	5.1	1.0	41.3	42,459,014
1951	.2	31.9	20.8	4.2	1.8	41.1	39,766,779
1952	.1	31.3	20.6	4.4	2.0	41.6	39,452,330

[1] Includes Alaska.

TABLE 12.—Mine production of gold and silver in the United States in 1952, by States and sources, in fine ounces of recoverable metal

State	Placers	Dry ore	Copper ore	Lead ore	Lead-copper ore	Zinc ore	Zinc-lead, zinc-copper, and zinc-lead-copper ores	Total
GOLD								
Alaska	239,290	[1] 1,267	-	-	-	-	-	240,557
Arizona	70	2,433	84,439	894	2	52	24,465	112,355
California	142,343	111,648	[2 3] 371	1,850	3	1,256	705	[2] 258,176
Colorado	2,180	58,807	1	844	2	1,938	60,822	124,594
Idaho	4,321	24,957	729	394	14	1	2,581	32,997
Montana	78	7,171	3,745	893	-	68	12,206	24,161
Nevada	33,079	19,414	59,295	1,272	1	[4] 32	4,110	117,203
New Mexico	2	136	1,608	48	-	941	214	2,949
Oregon	4,896	530	83	-	-	-	-	5,509
Pennsylvania	-	-	[5] 1,500	-	-	-	-	1,500
South Dakota	-	482,534	-	-	-	-	-	482,534
Tennessee	-	-	241	-	-	-	-	241
Texas	-	-	23	-	16	-	-	39
Utah	-	3,626	403,321	755	2	40	27,763	435,507
Vermont	-	-	162	-	-	-	-	162
Washington	3	35,818	2	-	-	6	18,947	54,776
Wyoming	1	-	-	-	-	-	-	1
Total	426,263	748,341	555,520	6,950	40	4,334	151,813	1,893,261
SILVER								
Alaska	32,528	[1] 225	-	233	-	-	-	32,986
Arizona	10	162,804	2,909,567	26,365	124	12,301	1,590,159	4,701,330
California	8,474	77,422	[2 3] 12,027	227,842	118	141,278	632,497	[2] 1,099,658
Colorado	345	795,546	251	108,919	111	202,354	1,706,117	2,813,643
Idaho	1,587	9,933,633	7,816	497,555	75,345	37,563	4,369,666	14,923,165
Illinois	-	-	-	-	-	-	3,781	3,781
Missouri	-	-	-	[6] 517,432	([6])	-	-	517,432
Montana	6	382,349	1,541,348	93,922	-	55,539	4,065,021	6,138,185
Nevada	11,011	[1] 63,645	174,357	149,383	1,942	[4] 17,058	523,799	941,195
New Mexico	-	1,398	85,335	10,733	-	303,467	78,385	479,318
New York	-	-	-	-	-	-	38,895	38,895
Oregon	1,085	2,590	362	-	-	-	-	4,037
Pennsylvania	-	-	[5] 9,247	-	-	-	-	9,247
South Dakota	-	131,767	-	335	-	-	-	132,102
Tennessee	-	-	57,569	-	-	-	-	57,569
Texas	-	-	206	3,647	819	-	-	4,672
Utah	-	624,849	3,290,788	74,007	496	6,832	3,197,137	7,194,109
Vermont	-	-	45,361	-	-	-	-	45,361
Washington	-	163,472	37	24,835	-	962	126,339	315,645
Wyoming	-	-	-	-	-	-	-	-
Total	55,046	12,339,700	8,134,271	1,735,208	78,955	777,354	16,331,796	39,452,330

[1] Includes 195 ounces of gold and 51 ounces of silver recovered from mill cleanup at 3 inactive properties.
[2] Includes metal recovered from tungsten ore or tungsten tailings.
[3] Includes metal recovered from pyritic ore (residue).
[4] Includes 8,346 tons of ore and contained recoverable metal from the former Metals Reserve Company stockpile at Jean, Nev.
[5] From magnetite-pyrite ore.
[6] A little silver recovered from lead-copper ore from one mine included with that from lead ore.

TABLE 13.—Gold and silver produced in the United States from ore and old tailings, in 1952, by States and methods of recovery, in terms of recoverable metals [1]

State	Total ore, old tailings, etc., treated (short tons)	Ore and old tailings to mills						Crude ore to smelters		
		Short tons	Recoverable in bullion		Concentrates smelted and recoverable metal			Short tons	Gold (fine ounces)	Silver (fine ounces)
			Gold (fine ounces)	Silver (fine ounces)	Concentrates (short tons)	Gold (fine ounces)	Silver (fine ounces)			
Western States and Alaska:										
Alaska	11,459	11,457	1,186	195	7	81	30	2	----------	233
Arizona	[2] 41,649,554	[2] 41,002,438	386	136	1,363,172	86,879	3,421,122	647,116	25,020	1,280,062
California	424,784	401,050	101,033	40,994	36,412	7,915	810,040	23,734	6,885	240,150
Colorado	1,548,815	1,526,124	66,435	17,411	177,657	54,162	2,550,667	22,691	1,817	245,220
Idaho	[3] 3,008,230	2,934,210	4,946	2,245	275,002	23,055	14,720,616	74,020	675	198,717
Montana	[4] 4,625,750	4,504,448	254	11	521,847	19,035	5,707,910	121,302	4,794	430,258
Nevada	[5] 7,313,697	7,203,100	18,733	3,697	265,012	62,769	782,143	110,597	2,622	144,344
New Mexico	9,144,224	8,978,040	116	20	367,430	1,789	432,122	166,184	1,042	47,176
Oregon	931	842	57	10	175	473	2,580	89	83	362
South Dakota	1,324,817	1,324,789	482,534	131,767	----------	----------	----------	28	----------	335
Texas	1,270	----------	----------	----------	----------	----------	----------	1,270	39	4,672
Utah	[6] 32,875,034	32,699,373	----------	----------	1,090,607	430,792	6,474,234	175,661	4,715	719,875
Washington	1,402,472	1,362,769	3,194	32,046	74,360	36,322	263,222	39,703	15,257	20,377
Wyoming	----------	----------	----------	----------	----------	----------	----------	----------	----------	----------
Total	103,331,037	101,948,640	678,874	228,532	4,171,681	723,272	35,164,686	1,382,397	62,949	3,331,781
States east of the Mississippi	[7] 9,039,669	[7] 9,039,669	----------	----------	631,144	1,903	154,853	----------	----------	----------
Total	112,370,706	110,988,309	678,874	228,532	4,802,825	725,175	35,319,539	1,382,397	62,949	3,331,781

[1] Missouri excluded.
[2] Excludes 3,735,773 tons of ore leached from which no gold or silver was recovered.
[3] Includes 58,482 tons of old zinc slag.
[4] Includes 30,243 tons of old zinc slag.
[5] Excludes tungsten ore.
[6] Includes 7,142 tons of old zinc slag.
[7] Excludes magnetite-pyrite ore from Pennsylvania. Includes material classified as fluorspar ore mined in Illinois and Kentucky.

TABLE 14.—Gold and silver produced at amalgamation and cyanidation mills in the United States and percentage of gold and silver recoverable from all sources, 1943–47 (average) and 1948–52 [1]

Year	Bullion and precipitates recoverable (fine ounces)				Percent of gold and silver from all sources [1]							
	Amalgamation		Cyanidation		Amalgamation		Cyanidation		Smelting [2]		Placers	
	Gold	Silver	Gold	Silver	Gold	Silver	Gold	Silver	Gold	Silver	Gold	Silver
1943–47 (average)	197,013	42,843	161,957	217,239	14.1	0.1	11.6	0.7	49.5	99.1	24.8	0.1
1948	378,590	104,598	278,237	481,406	18.8	.3	13.8	1.3	37.6	98.2	29.8	.2
1949	450,618	119,443	290,938	555,859	22.6	.3	14.6	1.6	36.0	97.9	26.8	.2
1950	547,118	153,806	300,783	449,699	22.9	.4	12.6	1.0	39.0	98.4	25.5	.2
1951	445,466	93,958	224,968	274,974	22.5	.2	11.3	.7	41.4	98.9	24.8	.2
1952	422,087	87,589	256,787	140,943	22.3	.2	13.6	.4	41.6	99.3	22.5	.1

[1] Includes Alaska. Illinois, Michigan, and Missouri excluded, 1943–47; Missouri excluded 1948–52.
[2] Both crude ores and concentrates.

TABLE 15.—Gold and silver produced at amalgamation and cyanidation mills in the United States in 1952, by States

State	Amalgamation		Cyanidation		Percent of gold and silver from all sources in State			
	Bullion recoverable (fine ounces)		Bullion and precipitates recoverable (fine ounces)		Amalgamation		Cyanidation	
	Gold	Silver	Gold	Silver	Gold	Silver	Gold	Silver
Western States and Alaska:								
Alaska	635	116	551	79	0.26	0.35	0.23	0.24
Arizona	386	136	---	---	.34	(1)	---	---
California	70,749	12,147	30,284	28,847	27.40	1.10	11.73	2.62
Colorado	17,907	8,278	48,528	9,133	14.37	.29	38.95	.32
Idaho	2,675	2,108	2,271	137	8.11	.01	6.88	(1)
Montana	254	11	---	---	1.05	(1)	---	---
Nevada	378	144	18,355	3,553	.32	.02	15.66	.38
New Mexico	116	20	---	---	3.93	(1)	---	---
Oregon	57	10	---	---	1.03	.25	---	---
South Dakota	328,844	64,584	153,690	67,183	68.15	48.89	31.85	50.86
Washington	86	35	3,108	32,011	.16	.01	5.67	10.14
Wyoming	---	---	---	---	---	---	---	---
Total	422,087	87,589	256,787	140,943	22.32	.22	13.58	.36
States east of the Mississippi	---	---	---	---	---	---	---	---
Grand total	422,087	87,589	256,787	140,943	22.29	.22	13.56	.36

[1] Less than 0.01 percent.

PLACERS

The domestic output of gold by placer mining declined 13 percent to 426,263 ounces in 1952; it corresponded to 22 percent of the United States total in 1952 compared with 25 percent in 1951. The drop in production was general to all the various methods of gold placer mining.

Of the total placer gold of 1952, 358,492 ounces (84 percent) was recovered by bucket-line dredges. The quantity of gold recovered by this method since the inception of the industry as a commercial factor in 1896 to the end of 1952 is recorded as 22,581,798 ounces, originating by States as follows: California, 13,317,851; Alaska, 6,492,184 (including the production from single-dipper dredges and some gold by hydraulicking); Montana, 785,419; Idaho, 697,200; and other States, 1,289,144.

The second most important gold-placer-mining method was nonfloating washing plants, with mechanical earth-moving equipment for gravel delivery. Production by this method was upward from 1944 through 1950 but declined progressively in 1951 and 1952. Production by dragline dredging remained in third place, and production by small-scale hand methods regained fourth place in 1952 over that of hydraulic mining.

TABLE 16.—Gold production at placer mines in the United States, by class of mine and method of recovery, 1943–47 (average) and 1948–52 [1]

Class and method	Mines producing	Washing plants (dredges)	Material treated (cubic yards)	Gold recoverable: Fine ounces	Gold recoverable: Value	Gold recoverable: Average value per cubic yard
Surface placers:						
Gravel mechanically handled:						
Bucket-line dredges:						
1943–47 (average)	38	49	63,888,980	270,773	$9,477,041	$0.148
1948	57	78	120,062,532	475,228	16,632,980	.139
1949	52	74	110,897,581	425,863	14,905,205	.134
1950	43	63	108,250,189	492,939	17,252,865	.159
1951	36	56	93,214,943	404,305	14,150,675	.152
1952	37	56	69,940,758	358,492	12,547,220	.179
Dragline dredges:						
1943–47 (average)	[1] 30	28	[2] 4,536,491	[1] 23,391	[1] 818,664	.180
1948	42	41	5,224,260	31,446	1,100,610	.211
1949	35	31	4,583,055	22,789	797,615	.174
1950	23	21	4,623,474	21,032	736,120	.159
1951	25	23	2,342,647	8,820	308,700	.132
1952	16	16	1,936,587	8,517	298,095	.154
Becker-Hopkins dredges:						
1943–47 (average)	-----	-----	1,000	6	224	.224
1948–52	-----	-----	-----	-----	-----	-----
Suction dredges:						
1943–47 (average)	3	3	23,498	171	5,985	.255
1948	8	9	84,200	473	16,555	.197
1949	12	13	278,765	1,418	49,630	.178
1950	17	14	263,800	1,422	49,770	.189
1951	13	9	180,500	717	25,095	.139
1952	9	9	74,100	305	10,675	.144
Nonfloating washing plants:						
1943–47 (average)	[1] 62	[1] 61	[2] 1,987,514	[1] 23,007	[1] 805,238	.405
1948	153	152	5,985,070	65,856	2,304,960	.385
1949	183	183	4,995,465	70,974	2,484,090	.497
1950	185	183	8,510,139	85,932	3,007,620	.353
1951	117	115	7,049,566	69,592	2,435,720	.346
1952	103	102	4,795,100	54,866	1,920,310	.400
Gravel hydraulically handled:						
1943–47 (average)	[1] 112	-----	[2] 1,578,022	[1] 19,438	[1] 680,323	.431
1948	137	-----	1,708,650	16,976	594,160	.348
1949	81	-----	779,800	7,107	248,745	.319
1950	88	-----	639,585	4,342	151,970	.238
1951	51	-----	257,800	3,460	121,100	.470
1952	33	-----	130,401	1,326	46,410	.356
Small-scale hand methods:						
Wet:						
1943–47 (average)	[1] 190	-----	[2] 371,217	[1] 5,156	[1] 180,460	.486
1948	275	-----	296,776	9,800	343,000	1.156
1949	279	-----	248,076	4,234	148,190	.597
1950	250	-----	261,562	4,856	169,960	.650
1951	148	-----	99,804	3,106	108,710	1.089
1952	119	-----	101,152	2,598	90,930	.899
Dry:						
1943–47 (average)	10	-----	2,498	114	3,997	1.600
1948	10	-----	3,900	170	5,950	1.526
1949	13	-----	2,870	144	5,040	1.756
1950	7	-----	2,200	88	3,080	1.400
1951	4	-----	550	27	945	1.718
1952	-----	-----	-----	-----	-----	-----
Underground placers (drift):						
1943–47 (average)	[1] 22	-----	[2] 7,701	[1] 701	[1] 24,542	3.186
1948	42	-----	20,105	551	19,285	.959
1949	26	-----	3,717	206	7,210	1.940
1950	34	-----	12,790	802	28,070	2.195
1951	19	-----	4,275	498	17,430	4.077
1952	14	-----	4,370	159	5,565	1.273
Unclassified placers:						
1943–47 (average)	50	-----	(3)	4,403	154,112	(3)
1948–52	-----	-----	-----	-----	-----	-----
Grand total placers:						
1943–47 (average)	[4] 516	-----	[2] 72,396,921	347,160	12,150,586	.168
1948	724	-----	133,385,493	600,500	21,017,500	.158
1949	[4] 680	-----	121,789,329	532,735	18,645,725	.153
1950	647	-----	122,563,739	611,413	21,399,455	.175
1951	413	-----	103,150,085	490,525	17,168,375	.166
1952	331	-----	76,982,468	426,263	14,919,205	.194

[1] Data for Alaska not separately available; included with "Unclassified placers" for 1943 and/or 1944.
[2] Data for Alaska not available and not included for years 1943 and/or 1944.
[3] Data not available for years 1943–44.
[4] A mine using more than 1 method of recovery is counted but once in arriving at total for all methods.

Alaska produced 56 percent of the domestic placer gold in 1952, followed by California with 33 percent and Nevada with 8. Other States with a considerable yield of placer gold were, in order of output, Oregon, Idaho, and Colorado. Alaska led in production by bucket-line dredges, nonfloating washing plants and hydraulicking; and California by dragline dredging, suction dredging, small-scale hand methods, and underground placer mining. No production by dry placer mining was recorded in 1952.

Table 16 shows the placer gold produced in the United States, classified by mining methods, from 1943–47 (average) and 1948 to 1952. Additional information on placer mining may be found in the State reviews of volume III.

REFINERY PRODUCTION

Table 17 contains official estimates of production of gold and silver in the United States, made by the Bureau of the Mint, based upon arrivals at United States mints and assay offices and at privately owned refineries. The mints and assay offices determine the State source of all newly mined unrefined material when deposits are received. The State source of material received by privately owned refineries is determined from information submitted by them and by intervening smelters, mills, etc., involved in the reduction processes.

TABLE 17.—Gold and silver refined in the United States, 1943–47 (average) and 1948–52, and approximate distribution by source (State), in 1952, in fine ounces

[U. S. Bureau of the Mint]

State or Territory	Gold	Silver	State or Territory	Gold	Silver
1943–47 (average)	1,394,665	33,060,953	1952 (cont.):		
1948	2,025,480	39,228,468	Nevada	125,500	1,000,000
1949	1,921,949	34,944,554	New Mexico	3,000	500,000
1950	2,288,708	42,308,739	New York		58,700
1951	1,894,726	39,907,257	Oregon	6,000	4,000
			Pennsylvania	1,500	9,200
1952:			South Dakota	471,900	130,000
Alaska	249,800	34,600	Tennessee	200	57,600
Arizona	113,000	4,615,000	Texas	39	5,000
California	263,000	1,176,000	Utah	450,000	7,500,000
Colorado	125,000	3,000,000	Vermont	160	46,200
Idaho	34,000	14,500,000	Washington	54,000	300,000
Illinois		4,000	Wyoming	1	
Missouri		400,000			
Montana	29,900	6,500,000	Total	1,927,000	39,840,300

CONSUMPTION AND USES IN INDUSTRY AND THE ARTS

Monetary use has claimed by far the largest part of the gold and silver output through the years, but this use to a large extent takes the form of stockpiling in Government and private hoards that can be made available to industry and the arts without smelter or refinery preparation. In contrast, the gold and silver that enter industry and the arts are consumed much as are other metals, any return as secondary metal requiring the usual channels of collection, smelting, and refining. The consumption of gold and silver in the arts antedates written history, but industrial use of these two metals is a comparatively recent development. A process has been developed for plating small mechanical parts with gold or silver to meet rigid specifications as to thickness and adhesion.[5]

[5] Du Mond, T. C., Silver and Gold Plated Parts Meet Tough Specifications: Mat. and Meth., vol. 36, No. 5, November 1952, pp. 114–115.

TABLE 18.—Gold and silver produced in the United States, 1792–1952 [1]

Period	Gold		Silver	
	Fine ounces	Value [2]	Fine ounces	Value [3]
1792–1847	1,187,170	$24,537,000	309,500	$404,500
1848–73	60,021,278	1,240,750,000	146,218,600	193,631,500
1874–1952	226,989,723	5,542,180,080	4,000,406,230	3,026,052,881
Total	288,198,171	6,807,467,080	4,146,934,330	3,220,088,881

[1] Includes Alaska. From Report of the Director of the Mint. The estimates for 1792–1873 are by R. W. Raymond, Commissioner of Mining Statistics, Treasury Department, and since then, by the Director of the Mint.
[2] Gold valued in 1934 and thereafter at $35 per fine ounce; prior thereto, at $20.67+ per fine ounce.
[3] Silver valued in 1934 and thereafter at Government's average buying price for domestic product.

Gold.—The arts require a much larger quantity of gold than does industry, but the metal's corrosion resistance and other properties have resulted in some industrial demand. Consumption in the arts increased rapidly during the war. A high marriage rate and widespread prosperity have increased the sale of jewelry, watches, and many luxury items made of gold. Comparison of 1952 gold figures with those for 1951 shows a 13-percent decrease in the return from industrial use, a 21-percent increase in issue for industrial use, and a 39-percent increase in net consumption. The net absorption by industry and the arts exceeded the total new gold produced from domestic mines during 1952 by 45 percent.

TABLE 19.—Net industrial [1] consumption of gold and silver in the United States, 1943–47 (average) and 1948–52

[U. S. Bureau of the Mint]

Year	Gold (dollars)			Silver (fine ounces)		
	Issued for industrial use	Returned from industrial use	Net industrial consumption	Issued for industrial use	Returned from industrial use	Net industrial consumption
1943–47 (average)	131,518,846	32,484,252	99,034,594	154,615,252	44,635,252	109,980,000
1948	90,128,764	45,142,764	44,986,000	129,186,173	23,897,173	105,289,000
1949	148,975,571	40,133,100	108,842,471	110,660,459	22,660,459	88,000,000
1950	134,587,773	36,742,020	97,845,753	155,257,340	45,257,340	110,000,000
1951	105,012,094	35,535,115	69,476,979	151,650,905	46,650,905	105,000,000
1952	127,189,489	30,838,949	96,350,540	121,538,076	25,038,076	96,500,000

[1] Including the arts.

Silver.—Although 8 percent smaller than in 1951, the net consumption of silver in the United States continued at a high rate in 1952 and again exceeded any annual output ever achieved by domestic mines.

Silver has many properties that make it valuable in the arts and industries. It is beautiful in color and will take a fine finish. It is highly malleable and ductile and ranks first among metals in conductivity of electricity and heat. It resists corrosion, especially by weak acids and organic compounds.

For many years the principal consumer of silver has been the silverware industry, mostly in the fabrication of tableware in sterling silver. Pure silver is too soft for most uses and is alloyed with 7.5 percent copper to form sterling silver of standard grade. Jewelry, insignia, and many novelties are also made of sterling silver.

Second in rank in silver consumption is the photographic industry, followed by the electroplating industry and the manufacture of silver-clad equipment for the chemical industry.

Of growing importance are the silver solders and brazing alloys, which are made in a wide variety of types containing from 10 to 80 percent silver, with the remainder consisting of copper, zinc, or other metals. Silver-bearing alloys are widely used in joining pipes, making electrical connections, and forming mechanical assemblies. Silver alloyed with about 10 percent copper is often used in electrical contacts; small additions of silver to copper impart hardness to commutator bars. Soft lead-silver solder containing about 2.5 percent silver has advantages over soft lead-tin solders or babbitt metal for some uses.

Compounds of silver are used for caustic, astringent, and antiseptic purposes in medicine. Silver has considerable use in dentistry as dental fillings, and in surgery for suture wires and plates.

MONETARY STOCKS

According to the Federal Reserve Bulletin, gold holdings of the United States Treasury rose from $22,695,000,000 on January 1, 1952, to $23,186,000,000 on January 1, 1953. The high for 1952 was reached in July when Treasury reserves had climbed to $23,350,000,000, corresponding to a gain of $655,000,000 from January. Gold flowed away from the United States steadily from August through December, however, with the result that the net gain for 1952 was $491,000,000. Largely as a consequence of credits extended under the Marshall Plan, gold had moved regularly from the United States from September 1949 to July 1951, with an overall decline in Treasury holdings in this period of $2,852,000,000. Gold moved to the United States during the last 6 months of 1951, however, with a gain in this period of $939,000,000. Total world reserves are not positively known, since reports from some countries are not received. However, the Federal Reserve estimated that world monetary reserves of gold rose $260,000,000 in 1952 to $36,210,000,000, exclusive of holdings of the Soviet Union.

Silver holdings of the United States Treasury decreased 27,000,000 fine ounces during 1952 to 1,938,000,000 ounces. The holdings do not include 410,553,000 ounces released by the United States during World War II under lend-lease agreements that provide for the return of this silver. By countries, the quantities loaned under these agreements were as follows: Australia 11,773,093 ounces; Fiji Islands 196,000; United Kingdom 88,074,000; India 226,000,000; Ethiopia 5,425,000; Netherlands 56,737,000; Saudi Arabia 22,348,000. The consummation of the Japanese Peace Treaty on April 28, 1952, set the date within 5 years afterward of which all lend-lease silver was to be returned to the United States. A complication was introduced by the political separation of India and Pakistan in 1947, and in May 1952 a statement was made by Indian officials that the total loan of silver to undivided India would be repaid by India and Pakistan in a ratio of 82½ and 17½, respectively. It was stated further that India would repay its share from surplus stocks of silver and silver coins withdrawn from circulation.

Coinage requirements of silver by governments were 104,100,000 ounces in 1952, compared with 89,000,000 ounces in 1951. Of the total used, the United States accounted for 57,300,000 ounces, Saudi Arabia 23,000,000, Western Germany 8,800,000, Mexico 8,300,000, Canada 4,200,000, Cuba 2,100,000, and others 400,000.

PRICES

Since January 1934, the price of gold at the United States Mint has been $35 per fine troy ounce. The Treasury buying price for silver domestically mined after July 1, 1939, was fixed at $0.711+ per ounce on July 6, 1939; on July 31, 1946, the President approved an act (Public Law 579, 79th Cong.) that provided that the seigniorage to be deducted for silver mined after July 1, 1946, and delivered to the Treasury be reduced from 45 percent to 30 percent. The effect was to raise the price of domestically mined silver to 90.50505+ cents an ounce; there has been no price change since.

The New York price of silver, per ounce, 0.999 fine, opened in 1952 at $0.8800, where it remained until early in May. Four drops in May set the low for the year of $0.8275 on May 28. This price continued to late in July when it recovered to $0.8325, where it held for the balance of 1952. The average price of pound-sterling exchange in New York (buying rates for cable transfers, as certified by the Federal Exchange Bank of New York) was $2.7926 in 1952. The London price of silver, per ounce, 0.999 fine, ranged in 1952 from a high of 77d. to a low of 72½d. (equivalent in United States currency to $0.8983 and $0.8458).

FOREIGN TRADE [6]

The excess of exports over imports of gold that prevailed in 1950 and 1951 was replaced by an excess of imports over exports in 1952. The gain from imports plus domestic output far exceeded consumption in the arts and industries, and gold monetary stocks thus increased. As has been normal for many years, imports of silver exceeded exports by a wide margin.

TABLE 20.—Value of gold and silver imported into and exported from the United States, 1948–52

[U. S. Department of Commerce]

	Imports	Exports	Excess of imports over exports [1]
Gold:			
1948	$1,981,175,178	$300,771,144	$1,680,404,034
1949	771,390,261	84,935,678	686,454,583
1950	162,748,661	534,035,794	−371,287,133
1951	81,258,502	630,381,566	−549,123,064
1952	740,254,160	55,921,206	684,332,954
Silver:			
1948	70,884,513	12,400,060	58,484,453
1949	73,535,694	23,281,043	50,254,651
1950	110,035,107	6,201,874	103,833,233
1951	103,468,510	8,590,185	94,878,325
1952	67,296,379	4,921,285	62,375,094

[1] Excess of exports over imports indicated by minus sign.

[6] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 21.—Gold imported into the United States in 1952, by countries of origin

[U. S. Department of Commerce]

Country of origin	Ore and base bullion		Bullion, refined		United States coin (value)	Foreign coin (value)
	Troy ounces	Value	Troy ounces	Value		
Australia	13,808	$482,544				
Austria	14	507				
Belgium-Luxembourg	1,957	68,489	114	$4,001		
Bermuda	35	1,200				
Bolivia	964	33,608				
Brazil	10,406	364,198				
British Guiana	8,775	312,349				
Canada	142,123	4,961,935	17,736,317	620,771,217		$471
Chile	25,326	886,539				
Colombia	537	18,775				
Cuba	881	30,766				
Dominican Republic	332	11,616				
Ecuador	19,476	677,691				
El Salvador	23,125	808,719				
French Guiana	13	450				
Germany, West	10	349	18,524	648,345		87,487
Guatemala	4	136				
Honduras	20,284	710,597				
Iran	2	68				
Israel					$400	
Italy	174	5,934				
Japan			288,539	10,098,880		
Korea, Republic of	1	34				
Liberia	761	26,576				
Malta, Gozo, and Cyprus	2,323	81,102				
Mexico	96,839	3,374,000				
Nicaragua	79,435	2,773,667				
Northern Rhodesia	243	8,508				
Panama	629	21,922				
Peru	21,495	750,536				
Philippines	128,294	4,724,648	15,478	624,524		
Portugal	15,762	551,347				
Southern Rhodesia	1,795	62,821				
Turkey	1,856	64,836				
Union of South Africa	558	19,568	2,440,227	85,407,975		
United Kingdom	2,056	71,299	9,674	338,566		251
Venezuela	471	16,442				
Yugoslavia	9,950	348,267				
Total	630,714	22,272,043	20,508,873	717,893,508	400	88,209

TABLE 22.—Gold exported from the United States in 1952, by countries of destination

[U. S. Department of Commerce]

Country of destination	Ore and base bullion		Bullion, refined		Foreign coin (value)
	Troy ounces	Value	Troy ounces	Value	
Argentina					$12,419,533
Bahamas			2	$108	
Belgium-Luxembourg			256	9,829	
Bolivia			249	11,236	
Brazil			757	29,689	
Canada			92,768	3,403,347	
Chile			2,126	74,996	
Cuba			539	18,788	
Dominican Republic			1,251	56,476	
Ecuador			3	110	
Egypt			13,936	510,268	
El Salvador			8,070	283,551	
France			9,337	341,757	
Germany, West			142,696	5,055,646	
Greece					14,400,384
Guatemala			63	2,857	
Haiti			716	28,536	
Honduras			75	3,896	
Iran			4,133	157,875	
Italy			320	11,796	
Kuwait			128,935	4,757,446	
Lebanon			88,001	3,080,034	
Mexico			127	6,809	
Netherlands			45,900	1,622,161	
Netherlands Antilles			45	1,882	
Nicaragua			3	242	
Norway			37	1,376	
Panama			1,207	44,366	
Paraguay			6	204	
Peru			1,022	36,032	
Philippines			57,165	2,989,030	
Portugal			50,306	1,783,670	
Saudi Arabia			189	9,879	
Syria			59,995	2,099,818	
Tangier			11,350	397,285	
United Kingdom	1,835	$64,000			
Uruguay			9,513	352,561	
Venezuela			51,428	1,853,733	
Total	1,835	64,000	782,526	29,037,289	26,819,917

TABLE 23.—Silver imported into the United States in 1952, by countries of origin

[U. S. Department of Commerce]

Country o origin	Ore and base bullion		Bullion, refined		United States coin (value)	Foreign coin (value)
	Troy ounces	Value	Troy ounces	Value		
Argentina	692	$595				
Australia	1,151,859	991,101				
Austria						$230
Belgium-Luxembourg	595,151	506,162	343,509	$288,875		
Bolivia	3,791,666	3,242,046				
Brazil	3,995	3,434				
Canada	5,768,762	4,932,626	13,273,962	11,358,777	$721,701	60
Ceylon	49	42				
Chile	748,006	640,430				
Colombia	1,500	1,314				
Cuba	163,211	139,511				
Denmark			13,017	11,141		
Dominican Republic					10,533	
Ecuador	74,373	63,767				
El Salvador	333,277	283,090				
France			450,563	385,318		
Germany, West	8,194	6,985	6,400	5,361	2,961	630
Greece						616
Guatemala	118,276	101,323				
Honduras	3,578,324	3,039,888			1,806,450	
Indonesia			99,848	84,254		14,912
Iran	5,485	4,633				
Italy	16,400	14,247	109,653	96,169		
Japan	103,970	85,983	6,728,549	5,816,723		
Korea, Republic of	2,921	2,476				
Lebanon	71,376	62,245				
Malta, Gozo, and Cyprus	19,020	16,859				
Mexico	6,075,193	5,154,912	10,089,478	8,508,792	37,805	
Netherlands	182,513	154,939	1,086,541	924,712		
Nicaragua	137,309	117,927				
Nigeria	1,812	1,504				
Northern Rhodesia	62,063	54,128				
Panama	163	141				
Peru	5,566,796	4,778,950	8,851,717	7,573,897		150,815
Philippines	429,115	372,777	24,598	21,508		
Poland-Danzig						119
Portugal	58,802	51,261				
Southern Rhodesia	2,057	1,760				
Sweden			22,779	19,276	392	
Switzerland					185	8,384
Syria						310
Taiwan			31,115	26,992		
Turkey	36,016	30,204				
Union of South Africa	382,182	324,411				
U. S. S. R.					9,702	
United Kingdom	628,278	538,817	2,990,396	2,610,893		362
Venezuela	148,513	123,716	615,684	519,143		
Yugoslavia	511,818	434,177				
Total	30,779,137	26,278,381	44,737,809	38,251,831	2,589,729	176,438

TABLE 24.—Silver exported from the United States in 1952, by countries of destination

[U. S. Department of Commerce]

Country of destination	Bullion, refined		United States coin (value)	Foreign coin (value)
	Troy ounces	Value		
Bahamas			$5,000	
Canada	167,359	$141,171	54,850	$1,580,894
Colombia	119,607	102,606		
Cuba	4,312	3,782		1,250,000
Ecuador	20	17		
El Salvador			250,000	
France	465,628	409,656		
Germany, West	278	245		
Haiti			3,000	
Italy	18	15		
Liberia			10,000	
New Zealand				216
Norway	341	299		
Portugal	50,064	41,678		
Saudi Arabia			34,500	
Switzerland	400,053	336,829		
Turkey	480	428		
Union of South Africa	400,166	353,146		
United Kingdom	386,504	333,954		
Venezuela	10,103	8,999		
Total	2,004,933	1,732,825	357,350	2,831,110

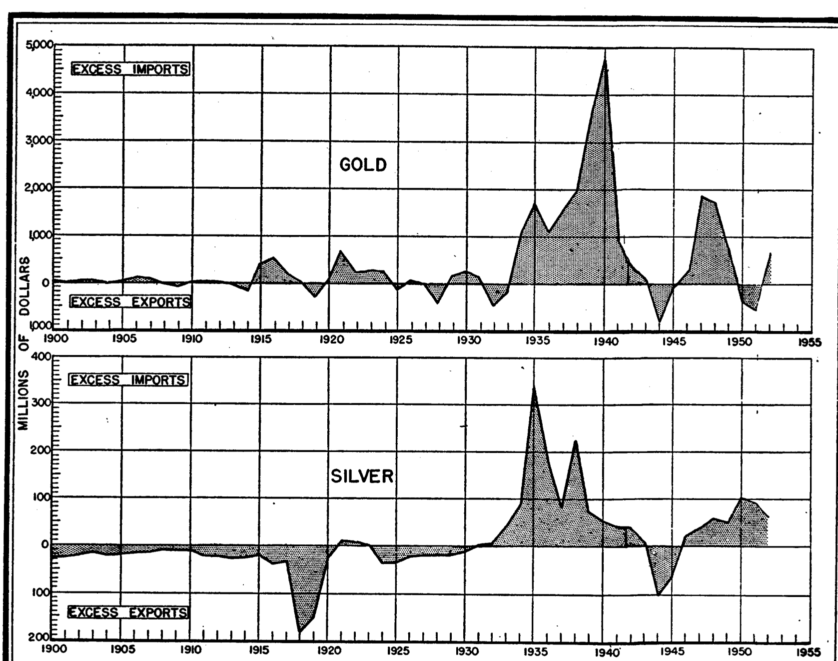

FIGURE 3.—Net imports or exports of gold and silver, 1900–52.

WORLD REVIEW

World output of gold rose 2 percent in 1952 compared with 1951, continuing the uptrend that began in 1946, but the 1952 total was well below the annual quantities produced before World War II. World silver production rose 6 percent in 1952 over 1951, owing mostly to gains in Mexico and Peru.

According to the Bureau of the Mint, the world output of gold and silver from 1493 to 1952 is 1,751,208,100 fine ounces of gold valued at $45,071,610,800 and 19,590,263,100 fine ounces of silver valued at $16,896,487,900.

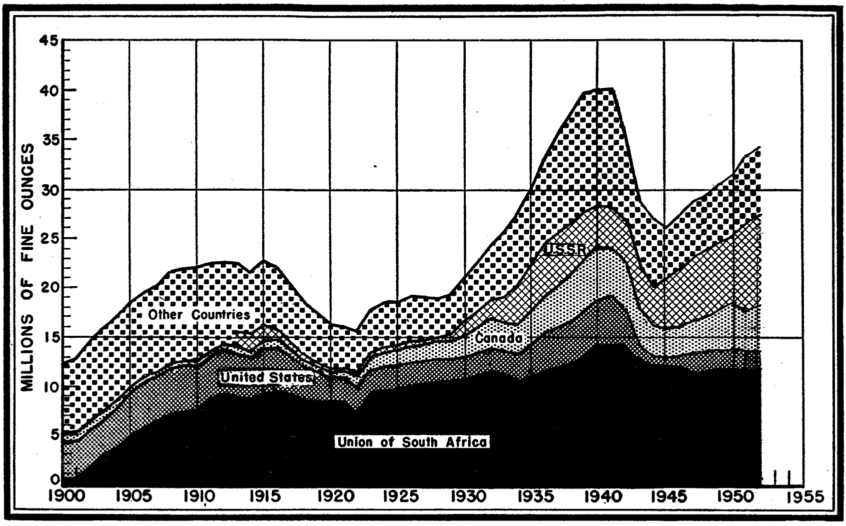

FIGURE 4.—World production of gold, 1900–52.

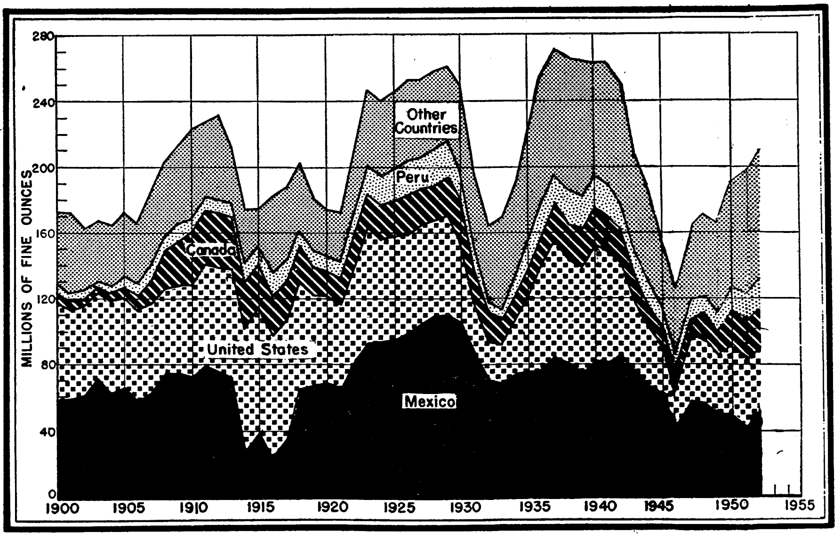

FIGURE 5.—World production of silver, 1900–52.

TABLE 25.—World production of gold, 1948–52, by countries,[1] in fine ounces [2]

[Compiled by Pauline Roberts and Berenice B. Mitchell]

Country [1]	1948	1949	1950	1951	1952
North America:					
United States (including Alaska) [3]	2,025,480	1,921,949	2,288,708	1,894,726	1,927,000
Canada	3,529,608	4,123,518	4,441,227	4,392,751	4,419,570
Central America and West Indies:					
Costa Rica [4]	1,096	284	115	1	-----------
Cuba	334	[4] 5,692	[4] 6,915	[4] 835	[4] 881
Dominican Republic [4]	29	993	475	411	332
Guatemala [4]	16	5	397	7	4
Honduras	13,633	25,832	36,545	31,216	31,967
Nicaragua (exports)	218,019	219,139	229,206	251,160	254,675
Panama	1,000	[5] 9,657	1,118	2,897	-----------
Salvador (exports)	20,778	27,091	29,053	27,097	27,682
Mexico	367,612	405,550	408,122	394,007	459,370
Total	6,177,600	6,739,700	7,441,900	6,995,100	7,121,500
South America:					
Argentina (estimate)	8,000	8,000	8,000	8,000	8,000
Bolivia	6,687	33,533	7,716	[6] 3,200	[5] 9,034
Brazil (estimate)	156,900	183,500	195,500	200,000	180,000
British Guiana	16,518	19,368	11,800	13,485	[6] 21,000
Chile	165,062	179,144	190,172	173,646	176,025
Colombia	335,260	359,474	379,412	446,314	422,240
Ecuador	79,207	99,241	91,946	12,683	24,267
French Guiana	13,632	14,757	12,249	12,056	8,231
Peru	111,162	113,754	147,967	158,270	134,865
Surinam	4,177	3,794	4,546	6,494	6,134
Venezuela	49,730	61,378	34,462	2,861	4,797
Total	946,000	1,076,000	1,084,000	1,037,000	995,000
Europe:					
Finland	11,317	14,587	9,465	18,500	20,100
France	47,519	55,537	63,015	67,838	45,011
Germany, West	(7)	1,447	[6] 1,500	1,479	2,025
Italy	18,422	10,385	10,674	12,089	14,854
Portugal	11,799	10,385	19,900	18,350	19,000
Rumania	90,000	112,528	(7)	(7)	(7)
Spain	11,375	30,318	13,217	12,777	8,944
Sweden	71,889	80,280	78,866	70,957	(7)
U. S. S. R. (estimate) [8]	7,000,000	7,000,000	8,000,000	9,500,000	9,500,000
Yugoslavia	26,331	34,594	42,760	21,380	36,266
Total (estimate)	7,300,000	7,400,000	8,400,000	9,800,000	9,800,000
Asia:					
Burma	230	158	150	131	(7)
China	88,200	[6] 60,000	108,000	[6] 100,000	[6] 100,000
India	180,430	164,203	196,848	226,475	243,629
Indonesia (estimate)	32,000	35,000	42,000	(7)	(7)
Japan	69,060	84,492	135,033	177,472	201,392
Korea:					
Korea, Republic of	3,466	3,419	5,144	1,000	15,657
North Korea (estimate)	300,000	300,000	200,000	(7)	(7)
Malaya	10,212	13,617	18,436	17,018	19,806
Philippines	209,225	287,844	333,991	393,602	469,408
Sarawak	599	1,523	1,440	931	843
Saudi Arabia	74,000	66,835	66,202	73,104	69,394
Taiwan (Formosa)	17,668	16,607	18,232	30,500	33,178
U. S. S. R.	(8)	(8)	(8)	(8)	(8)
Total (estimate)	990,000	1,040,000	1,130,000	1,280,000	1,420,000
Africa:					
Angola	443	319	201	61	40
Bechuanaland	1,507	256	261	493	1,245
Belgian Congo [9]	299,774	333,853	339,415	352,308	368,769
Egypt	3,853	7,045	10,724	16,469	17,059
Eritrea	2,242	2,243	1,042	675	(7)
Ethiopia	41,595	45,102	43,524	32,937	27,291
French Cameroon	10,706	8,938	7,170	5,422	2,604
French Equatorial Africa	63,713	57,273	54,996	52,849	51,655
French Morocco	804	643	119	2,069	4,051
French West Africa [10]	100,000	47,000	96,000	5,700	1,500
Gold Coast	672,388	676,934	689,441	698,676	715,036
Kenya	23,429	20,072	22,945	19,765	10,210
Liberia	13,797	14,656	11,025	[5, 11] 9,806	[5, 11] 949
Madagascar	2,095	1,663	1,935	1,951	1,768
Mozambique	4,734	2,468	997	861	831
Nigeria	2,899	2,515	2,238	1,566	[6] 1,350
Northern Rhodesia	[12] 1,180	[12] 1,186	[12] 1,432	101	20

For footnotes, see end of table.

TABLE 25.—World production of gold, 1948–52, by countries,[1] in fine ounces [2]—Continued

Country [1]	1948	1949	1950	1951	1952
Sierra Leone	2,405	2,330	3,484	3,292	[6] 2,700
Southern Rhodesia	514,440	528,180	511,163	486,907	496,731
South-West Africa	455	32	32	(7)	(7)
Sudan	3,579	4,114	3,503	1,495	1,545
Swaziland	3,110	2,841	1,794	322	1
Tanganyika (exports)	57,557	68,989	65,127	65,224	64,693
Uganda (exports)	1,158	650	509	223	181
Union of South Africa	11,584,849	11,705,048	11,663,713	11,516,450	11,818,681
Total	13,415,000	13,535,000	13,535,000	13,275,000	13,590,000
Oceania:					
Australia:					
Commonwealth	885,507	889,057	867,837	895,536	980,435
New Guinea	86,556	93,045	80,099	94,085	122,431
Papua	163	450	788	248	149
Fiji	93,059	104,036	103,421	93,635	[6] 95,000
New Zealand	93,903	84,874	76,527	75,115	59,373
Total	1,159,188	1,171,462	1,128,672	1,158,619	1,257,000
World total (estimate)	30,000,000	31,000,000	32,700,000	33,500,000	34,200,000

[1] Figures used derived in part from American Bureau of Metal Statistics. For some countries accurate figures are not possible to obtain owing to clandestine trade in gold (as for example, French West Africa). Data not available for Austria, Bulgaria, Czechoslovakia, Hungary, and Thailand; estimates included in the total. In addition, production in Cyprus and Indonesia was negligible.
[2] This table incorporates a number of revisions of data published in previous gold chapters.
[3] Refinery production. Excludes production of the Philippines.
[4] Imports into United States.
[5] Exports.
[6] Estimate.
[7] Data not available; estimate included in total.
[8] Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.
[9] Includes Ruanda-Urundi.
[10] Estimate based on reported production.
[11] Year ended September 30 of year stated.
[12] Included is yield from Nkana mine refinery slimes accumulated during the war: 999 ounces in 1948; 972 in 1949; and 1,296 in 1950.

TABLE 26.—World production of silver, 1948–52, by countries,[1] in fine ounces [2]

[Compiled by Pauline Roberts and Berenice B. Mitchell]

Country	1948	1949	1950	1951	1952
North America:					
United States	39,228,468	34,944,554	42,308,739	39,907,257	39,840,300
Canada	16,109,982	17,641,493	23,221,431	23,125,825	24,375,853
Central America and West Indies:					
Costa Rica [3]	3,029	720	215	582	----------
Cuba	185,216	[3] 157,411	[3] 221,779	[3] 172,318	[3] 163,211
Guatemala	(4)	81,502	339,360	309,857	371,679
Honduras	3,170,871	3,431,614	3,514,556	3,182,254	3,703,912
Nicaragua [3]	216,802	191,082	133,282	141,764	137,309
Panama	400	(4)	1,940	5,788	----------
Salvador	[5] 216,342	280,309	462,973	352,102	368,448
Mexico	57,519,703	49,454,882	49,141,445	43,797,734	50,353,560
Total	116,651,000	106,184,000	119,346,000	110,996,000	119,314,000
South America:					
Argentina	1,201,900	1,249,421	1,150,000	1,253,879	962,948
Bolivia (exports)	7,555,424	6,655,204	6,558,751	7,137,465	7,065,608
Brazil	23,095	21,041	21,155	20,315	17,301
Chile	861,961	799,685	746,765	983,491	1,246,356
Colombia	109,188	106,590	115,711	129,773	123,175
Ecuador	205,800	264,300	273,200	33,600	82,297
Peru	9,288,703	10,609,648	13,367,807	17,379,148	19,179,525
Total	19,246,000	19,706,000	22,234,000	26,938,000	28,677,000

For footnotes, see end of table.

TABLE 26.—World production of silver, 1948–52, by countries,[1] in fine ounces [2]—Continued

Country	1948	1949	1950	1951	1952
Europe:					
Austria	(4)	7,427	8,681	5,466	3,858
Czechoslovakia	[6] 1,600,000	(4)	(4)	(4)	(4)
Finland	167,615	171,150	115,939	157,275	150,083
France	494,414	570,888	549,669	546,550	353,650
Germany, West	[7] 867,459	1,601,782	1,637,116	1,819,957	1,877,700
Greece	32,000			64,300	72,403
Italy	595,464	793,545	850,998	869,710	1,055,927
Norway	215,410	170,399	167,184	163,969	176,186
Portugal	35,366	31,958	68,288	65,427	67,697
Spain	339,396	514,283	823,831	735,908	553,128
Sweden	1,137,943	1,140,708	1,275,709	1,145,890	(4)
U. S. S. R. (estimate)	12,000,000	20,000,000	24,000,000	24,000,000	24,000,000
United Kingdom	15,942	13,996	18,153	26,777	(4)
Yugoslavia	1,504,237	1,917,792	2,386,839	3,032,008	2,577,043
Total (estimate)	19,500,000	29,000,000	34,000,000	35,000,000	35,000,000
Asia:					
Burma	450,000	[6] 250,000	1,800	280,720	242,307
China	(4)	160,000	320,000	320,000	[6] 400,000
India	12,797	11,275	15,676	17,180	(4)
Japan	2,185,672	2,887,265	3,964,572	4,609,924	5,288,707
Korea, Republic of	38,505	18,932	1,222	5,371	6,130
Philippines	150,760	218,419	216,034	274,602	693,751
Saudi Arabia	67,819	81,295	124,287	109,912	111,945
Taiwan (Formosa)	14,133	17,148	20,603	26,388	(4)
Total (estimate)	3,000,000	3,700,000	4,700,000	5,700,000	6,800,000
Africa:					
Algeria	29,739	32,472	32,000	9,600	(4)
Bechuanaland	233	27	39	70	281
Belgian Congo	3,805,715	4,549,330	4,459,951	3,795,266	4,727,252
French Morocco	487,598	736,220	1,007,900	1,569,000	(4)
Gold Coast (exports)	45,553	40,051	43,317	52,542	44,116
Kenya	3,184	2,279	2,586	2,150	17,315
Mozambique	616	244	71	96	(4)
Nigeria	4,270	484	325	200	270
Northern Rhodesia [8]	145,865	134,920	173,304	100,702	312,940
Southern Rhodesia	81,404	84,495	85,549	79,731	81,356
South-West Africa	323,647	642,500	843,737	1,030,066	1,064,335
Swaziland	124	120	60	18	
Tanganyika (exports)	25,010	27,631	31,014	35,697	35,900
Tunisia	16,011	67,517	73,947	61,119	[6] 62,000
Uganda (exports)	56	42	35	14	(4)
Union of South Africa	1,170,951	1,159,375	1,119,135	1,162,588	1,176,433
Total	6,140,000	7,478,000	7,873,000	7,899,000	9,032,000
Oceania:					
Australia:					
Commonwealth	10,057,519	9,849,213	10,677,456	10,792,032	11,256,742
New Guinea [9]	31,739	31,786	30,399	33,603	(4)
Fiji	29,187	29,755	37,736	24,869	(4)
New Zealand	232,563	232,599	199,701	133,291	(4)
Total	10,351,000	10,143,000	10,945,000	10,984,000	11,362,000
World total (estimate) [1]	174,900,000	176,200,000	199,100,000	197,500,000	210,200,000

[1] Silver is also produced in Bulgaria, Cyprus, Hong Kong, Hungary, Federation of Malaya, Indonesia, North Korea, Poland, Rumania, Sarawak, Sierra Leone, and Turkey; production data are not available, but estimates are included in total.
[2] This table incorporates a number of revisions of data published in previous silver chapters.
[3] Imports into the United States. Scrap is included in this figure in many instances, most notably in the case of Cuba.
[4] Data not available; estimate included in total.
[5] Exports.
[6] Estimate.
[7] American and British Zones only.
[8] Recovered from an accumulation of refinery slimes.
[9] Year ended May 31 of year following that stated.

Australia.—Gold production in Australia increased in 1952 to 980,435 ounces, corresponding to an advance of nearly 9 percent over the 1951 output. The gain was due mainly to greater activity in gold mining in Western Australia; in most areas the industry was handicapped by shortages of labor. The premium from sales of gold on the free market was helpful in meeting rising costs, but the additional revenue realized was not up to expectations. Silver production in Australia rose 4 percent in 1952 to 11,256,742 ounces.

Canada.—In comparison with the preceding year, the gold yield in Canada rose 1 percent to 4,419,570 ounces in 1952. Of the minerals produced in Canada, gold continued to lead in output value, closely followed by nickel. Gold mining was handicapped by rising costs for labor and supplies and by lower return realized for gold because of the over-par exchange value of the Canadian dollar in relation to the United States dollar. On the other hand, many producers were aided by sale of their gold at premium prices on the free market, or through subsidy allowed by the Canadian Government under the Emergency Gold Mining Assistance Act. Marginal operations were still hard pressed, however, and a more liberal formula for assistance was authorized for 1953.

By Provinces or Territories the gold output in 1951 and 1952 was as follows, in fine troy ounces:

Province or Territory:	*1951*	*1952*
Alberta	97	88
British Columbia	289, 992	285, 545
Manitoba	163, 914	142, 003
Newfoundland	8, 515	8, 030
Northwest Territories	212, 211	246, 245
Nova Scotia	17	1, 564
Ontario	2, 462, 979	2, 458, 359
Quebec	1, 067, 306	1, 109, 677
Saskatchewan	110, 216	89, 190
Yukon	77, 504	78, 869
Total	4, 392, 751	4, 419, 570

Of the total output, 2 percent was obtained by placer gold mining, 13 percent as a byproduct of base-metal mining, and 85 percent from straight lode gold mining.

Silver production in Canada rose 5 percent in 1952, reaching 24,375,853 ounces; most of the output was recovered as a byproduct or coproduct of base-metal mining.

Colombia.—Colombia leads all other countries in South America in gold production by a wide margin. The output in 1952 dropped 5 percent to 422,240 ounces. The gold-mining industry in Colombia has been beset by rising labor costs, largely those resulting from social legislation; consequently, the subsidy allowed by the Government of Colombia to gold miners for newly mined gold was increased from 12 pesos per ounce to 30 pesos. Nearly 80 percent of the 1952 production was obtained by placer mining, as against 20 percent from gold lode mines. Silver production in Colombia declined 5 percent to 123,175 ounces in 1952; the entire output of silver is recovered as a byproduct of gold mining.

Honduras.—Normal operations were continued at the San Juancito and El Mochito mines of the New York & Honduras Rosario Mining Co., enabling Honduras to maintain its rank of sixth in silver production among countries of the Western Hemisphere. Development on deep levels at the El Mochito mine gave favorable results, and ore reserves increased.

India.—The Government of India began constructing a silver refinery near Calcutta to recover silver from quartenary coins introduced during World War II, which are being replaced by nickel coins. The coinage withdrawn contains around 300,000,000 ounces of silver; recovery of this silver will enable repayment of lend-lease silver acquired during the war.

Mexico.—Stimulated by favorable prices, silver production in Mexico in 1952 rose 15 percent to 50,353,560 ounces, and once again Mexico maintained its rank as the leading silver producer. Gold output in Mexico showed a gain in 1952 paralleling that of silver.

Nicaragua.—With an output of 254,675 ounces (measured by exports), Nicaragua continued to be the leading gold-producing country of Central America in 1952. Most of the gold and silver of this country are produced from five mines.

Philippines.—Despite many difficulties, gold-mining companies in the Philippines increased their total output of gold in 1952 substantially (19 percent) to 469,408 ounces. Fifteen prewar producers were in active production in 1952, compared with 11 in the preceding year. Mining operations were hard pressed to meet mounting costs arising from import controls, high taxes, labor demands, and the 4-peso minimum wage law; and, according to the Philippine Gold Producers Association, the gold-mining industry experienced an overall net loss of nearly ₱900,000 during 1952. Remedial measures proposed by mining companies to the Philippine Congress were endorsed by the Philippine Bureau of Mines.

Silver production in the Philippines gained 153 percent to 693,751 ounces in 1952, due largely to new base-metal mining operations yielding silver as a byproduct.

Union of South Africa.—Reflecting initial production operations at several mines in the new Far West Rand and Orange Free State gold fields, the tonnage of gold ore milled and the gold output of the Union of South Africa was 3 percent greater in 1952 than in 1951. Reversing a downtrend that began in 1949, the average recovery of gold per ton was up slightly. Average working costs per ton of ore rose 2s. 4d. (32⅔ cents), and working profits declined 12 percent. However, disposal of some gold at premium prices on the free market supported the overall revenue received from sales of gold. The first of a series of plants to recover uranium as a byproduct from the gold ores of South Africa was completed, and others were under construction. In common with other industries, gold mining was handicapped by shortages of electric power and labor.

The new gold field in the Orange Free State centers around Odendaalsrus; diamond drilling and underground development have shown that gold ores of workable grade extend over an area at least 30 miles long and 10 miles across at the widest point. The gold occurs in conglomerate beds or reefs generally similar in character to the gold-bearing formations mined on the Rand. Two mines completed their first year of production operations in 1952, with 4 additional properties scheduled to reach the production stage in 1953. It has been estimated that the field has a potential annual output of around 8,000,000 ounces.

TABLE 27.—Salient statistics of gold mining in the Union of South Africa, 1943–47 (average) and 1948–52

[Transvaal Chamber of Mines]

	1943–47 (average)	1948	1949	1950	1951	1952
Ore milled (tons)	57, 598, 940	55, 285, 700	56, 881, 550	59, 515, 200	58, 645, 800	60, 500, 000
Gold recovered (fine ounces)	12, 081, 269	11, 574, 871	11, 708, 013	11, 663, 713	11, 516, 450	11, 818, 681
Gold recovered (dwt. per ton)	4. 028	4. 012	3. 942	3. 759	3. 756	3. 767
Working revenue	£99, 409, 087	£96, 179, 355	£110, 617, 476	£139, 491, 029	£137, 494, 860	£141, 271, 319
Working revenue per ton	34s. 6d.	34s. 9d.	38s. 11d.	46s. 11d.	46s. 11d.	47s. 1d.
Working cost	£69, 305, 860	£72, 383, 938	£76, 667, 643	£87, 956, 643	£93, 494, 860	£102, 525, 003
Working cost per ton of ore	24s. 2d.	26s. 2d.	27s. 0d.	29s. 7d.	31s. 10d.	34s. 2d.
Working cost per ounce of metal	119s. 10d.	130s. 7d.	136s. 9d.	157s. 3d.	169s. 6d.	181s. 6d.
Working profit	£30, 103, 227	£23, 790, 417	£33, 949, 793	£51, 534, 386	£44, 157, 054	£38, 746, 307
Working profit per ton	10s. 5d.	8s. 7d.	11s. 11d.	17s. 4d.	15s. 1d.	12s. 11d.
Dividends	£13, 449, 699	£13, 419, 443	£17, 394, 046	£24, 699, 544	£22, 787, 806	£19, 804, 928

Graphite

By Frank D. Lamb[1] and Eleanor V. Blankenbaker[2]

ESTIMATED world production of natural graphite in 1952 was 190,000 metric tons. This equaled estimated production in 1951, the highest annual output since 1943, the peak year of World War II, when an estimated 272,000 metric tons was produced. Production of flake graphite in Madagascar continued to increase, reaching a new high during 1952, and consumers had no difficulty such as they experienced in 1950 and early in 1951 in obtaining adequate supplies of Madagascar crucible flake graphite. Production of amorphous lump graphite in Ceylon, particularly the 97–98 percent carbon grades, was below normal in 1952, and shortages of this variety of graphite existed at times during the year. Supplies of Mexican amorphous graphite were adequate, although 1952 production was 25 percent below that of 1951. Shortage of labor at the mines in Sonora, Mexico, was largely responsible for the decrease in production.

A report[3] published in 1952 described work by the Bureau of Standards on determining the relative merits of crucibles manufactured entirely from Alabama, Pennsylvania, and Madagascar graphite. The report indicated that domestic graphite of equivalent flake size and carbon content may be substituted entirely for Madagascar graphite without impairing the life of the crucible.

Work toward rehabilitating the Government-owned Benjamin Franklin mine and mill at Chester Springs, Pa., was begun by the F. M. Equipment Co. for the National Industrial Reserve Division of the General Services Administration. The mine and mill were to be operated on an experimental basis to demonstrate the quantity and quality of graphite that may be produced.

DOMESTIC PRODUCTION

Production of natural graphite in the United States continued to come from 3 mines—1 each in Alabama, Texas, and Rhode Island. Production in Alabama and Texas was crystalline flake graphite, largely in fine sizes, while that produced in Rhode Island was amorphous material. The quantity of crystalline and amorphous graphite produced from domestic mines in 1952 decreased 21 percent from 1951 production. Shipments decreased 25 percent in quantity and 23 percent in value. The manufacture of artificial or electric-furnace graphite continued at Niagara Falls, N. Y., by the Acheson Graphite Division of the National Carbon Co., Inc., and the Great Lakes Carbon Corp., with plants at Niagara Falls, N. Y., and Morganton, N. C., and by the International Graphite & Electrode Corp. in a plant at St. Marys, Pa.

The Bureau of Mines is not at liberty to publish separate statistics on natural crystalline and amorphous graphite but combined figures for 1943–47 (average) and 1948–52 are shown in table 2.

[1] Metallurgist.
[2] Statistical clerk.
[3] Heindl, R. A., Effects of Graphite and Bonding Agents, Foundry Crucible Life: Am. Foundryman September 1952, pp. 40–43.

TABLE 1.—Salient statistics of the graphite industry in the United States, 1951–52

	1951		1952	
	Short tons	Value	Short tons	Value
Natural graphite:				
Production	7,135	(1)	5,606	(1)
Sales	6,808	$771,434	5,081	$594,618
Consumption [2]	38,318	5,083,527	26,911	4,048,787
Imports:				
Crystalline flake	10,227	1,412,787	7,654	1,259,541
Lump, chip, or dust	336	29,096	67	10,733
Amorphous (natural)	43,830	1,561,494	34,725	1,569,949
Artificial	90	7,420	337	18,502
Total imports	54,483	3,010,797	42,783	2,858,725
Exports:				
Crystalline flake, lump, or chip	213	56,345	158	57,068
Amorphous (natural)	612	75,964	1,501	139,020
Other natural graphite	679	63,639	127	15,037
Total exports	1,504	195,948	1,786	211,125

[1] Figure not available.
[2] Minimum quantities as reported by consumers to the Bureau of Mines.

TABLE 2.—Production and shipments of natural graphite in the United States, 1943–47 (average) and 1948–52

Year	Production (short tons)	Shipments		Year	Production (short tons)	Shipments	
		Short tons	Value			Short tons	Value
1943–47 (average)	6,039	6,150	$403,166	1950	5,102	5,605	$427,908
1948	9,949	9,871	450,759	1951	7,135	6,808	771,434
1949	6,102	5,213	475,264	1952	5,606	5,081	594,618

CONSUMPTION

The Bureau of Mines did not obtain data on graphite consumption from many small consumers in 1952, and a strict accounting of the uses for which available graphite was consumed was not possible. One difficulty encountered was the duplication resulting from reporting of the same material as "processed for resale" by one establishment and as "used" by another. The inability of consumers, in some instances, to identify the types and varieties of graphite used reduced the accuracy of the canvass data. However, the coverage is substantially the same from year to year, and the totals obtained indicate at least the minimum quantities used in making various products. For the more strategic uses of graphite, the consumption data shown in table 3 are believed to be reasonably accurate, and the discrepancies in the canvass data relate largely to amorphous graphite used for foundry facings, paints, and other nonstrategic uses.

PRICES

Price quotations decreased during the year on Madagascar graphite but remained constant on graphite from other sources. At the year end, the trade-journal listings were as follows: Per pound, carlots, f. o. b. shipping point, crystalline flake, natural, 85–88 percent carbon, crucible grade, 13 cents; 96 percent carbon, special and dry usage, 22 cents; 94 percent carbon, normal and wire drawing, 19 cents;

TABLE 3.—Consumption of natural graphite in the United States in 1952, by uses

Use	Short tons	Value	Use	Short tons	Value
Foundry facings	11,098	$1,227,719	Packings	754	$248,348
Crucibles, retorts, stoppers, sleeves, and nozzles	3,275	785,994	Paints and polishes	552	61,988
Lubricants	2,494	287,124	Oilless bearings	80	41,383
Dry cell batteries	2,372	164,053	Other [1]	3,665	474,031
Lead pencils	1,816	464,046	Total	26,911	4,048,787
Carbon brushes	805	294,101			

[1] Includes brake linings, roofing granules, recarburizing steel, etc.

98 percent carbon, special for brushes, etc., 26½ cents. Amorphous, natural, for foundry facings, etc., up to 85 percent carbon, 10 cents. Madagascar, c. i. f. New York, "standard grades, 85–87 percent carbon," $200 per ton; special mesh $230–$260; special grade 99 percent carbon, nominal. Amorphous graphite, Mexican, f. o. b. point of shipment (Mexico), per metric ton, $9 to $16, depending on grade.

FOREIGN TRADE [4]

Imports of all types of graphite decreased during 1952 from the unusually high quantities imported during 1951, when consumers were replenishing stocks used in 1949 and 1950. Imports of crystalline flake graphite from Madagascar in 1952 decreased 27 percent in quantity and 10 percent in value from the 1951 figures. Imports from Ceylon in 1952 decreased 43 percent in quantity and 11 percent in value. Mexican amorphous graphite imports also decreased substantially, resulting in a decrease of 21 percent in quantity and 5 percent in value for all types of graphite as shown in table 4.

Production of crystalline graphite in Madagascar during 1952 amounted to 14,385 metric tons of flake and 4,093 tons of fines Exports from the island were 13,074 metric tons of flake and 4,311 tons of fines.[5] The United States received 43 percent of the total exports from Madagascar. Exports from Ceylon amounted to 7,782 metric tons of which the United States received 38 percent.

Production of graphite in Europe was reported in 8 countries, usually for local consumption, and only 2 countries, West Germany and Norway, exported appreciable quantities to the United States. During 1952 West Germany exported 5,086 metric tons, of which only 12 percent went to the United States. Norway, which previously produced only about 2,500 metric tons of graphite a year, increased the capacity of its only producer in the fall of 1952 to about 5,000 tons a year. The consumption of graphite in Norway remained small, and most of the production was exported to other European countries. The United States imported 28 percent of the graphite produced in Norway in 1952.

The United States tariff rates on graphite, effective January 1, 1948, were still in force during 1952. They are: Amorphous, natural and artificial, 5 percent ad valorem; crystalline flake, 15 percent ad valorem, with a specific minimum of 0.4125 cent per pound and a specific maximum of 0.825 cent per pound; crucible flake and dust and other crystalline lump and chip, 7½ percent ad valorem.

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.
[5] Bureau of Mines, Mineral Trade Notes, vol. 36, No. 5, May 1953, p. 37.

TABLE 4.—Graphite (natural and artificial) imported for consumption in the United States, 1948–52

[U. S. Department of Commerce]

	Crystalline				Amorphous				Total	
	Flake		Lump, chip, or dust		Natural		Artificial			
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948	3, 496	$429, 557	554	$83, 226	48, 150	$1, 529, 312	117	$4, 153	52, 317	$2, 046, 248
1949	2, 228	277, 368	235	27, 313	29, 298	954, 388	44	1, 398	31, 805	1, 260, 467
1950	6, 130	725, 172	100	7, 514	37, 255	1, 335, 142	184	12, 518	43, 669	2, 080, 346
1951										
Canada	172	57, 626			1, 069	96, 445	74	6, 806	1, 315	160, 877
Ceylon			280	24, 841	5, 496	716, 896			5, 776	741, 737
British East Africa					28	1, 254			28	1, 254
France	100	41, 878	(1)	309					100	42, 187
Germany	419	71, 496			55	7, 704	16	614	490	79, 814
India	(1)	24							(1)	24
Madagascar	9, 536	1, 241, 763	56	3, 946	173	18, 718			9, 765	1, 264, 427
Mexico					35, 337	582, 257			35, 337	582, 257
Mozambique					167	10, 938			167	10, 938
Norway					1, 447	114, 654			1, 447	114, 654
United Kingdom					58	12, 628			58	12, 628
Total	10, 227	1, 412, 787	336	29, 096	43, 830	1, 561, 494	90	7, 420	54, 483	3, 010, 797
1952										
Canada	181	53, 695			1, 326	128, 320	334	17, 441	1, 841	199, 456
Ceylon			56	9, 664	3, 229	648, 863			3, 285	658, 527
France	30	13, 228							30	13, 228
Germany, West	457	79, 569			221	21, 758			678	101, 327
India					28	3, 875			28	3, 875
Madagascar	6, 986	1, 113, 049			1, 223	213, 975			8, 209	1, 327, 024
Mexico					27, 321	447, 248			27, 321	447, 248
Mozambique					100	4, 914			100	4, 914
Norway			11	1, 014	1, 277	100, 963			1, 288	101, 977
Switzerland							3	1, 061	3	1, 061
United Kingdom			(1)	55	(1)	33			(1)	88
Total	7, 654	1, 259, 541	67	10, 733	34, 725	1, 569, 949	337	18, 502	42, 783	2, 858, 725

[1] Less than 1 ton.

Exports of natural graphite, 1948–50, were: 1948, 1,047 tons, $127,931; 1949, 1,352 tons, $158,694; 1950, 1,397 tons, $173,700. Data for 1951 and 1952 are shown in table 5.

TECHNOLOGY

A report describing the corrosion-resistance properties of carbon and graphite and impervious carbon and graphite products, with data on physical properties, forms available, and applications was published.[6] The report describes the carbon and graphite materials available for use as construction materials in the chemical industry.

The work of the Bureau of Standards toward demonstrating the effects of using graphite from various sources and various bonding agents on the life of foundry crucibles was described.[7] This investigation compared the relative merits of crucibles manufactured from Alabama, Pennsylvania, and Madagascar graphite. The crucibles made from each variety of graphite were manufactured according to the formulas ordinarily used for the regular production of crucibles for use in brass-melting foundries. Six foundries were selected for making the tests, and the crucibles were employed in the regular melting

[6] Oliver, J. P., Carbon and Graphite: Chem. Eng., vol. 59, No. 9, September 1952, pp. 276–284.
[7] See footnote 3.

TABLE 5.—Graphite exported from the United States, 1951–52, by countries of destination

[U. S. Department of Commerce]

Country	Amorphous		Crystalline flake, lump, or chip		Natural, n. e. s.	
	Short tons	Value	Short tons	Value	Short tons	Value
1951						
Australia			90	$9,800		
Austria	1	$187	1	278		
Belgium-Luxembourg	4	694				
Bolivia	1	226	1	144		
Brazil	5	2,173			1	$140
Canada	238	20,734	18	6,600	575	46,406
Chile	8	1,600	4	1,542	5	1,290
Colombia	4	518	8	2,345		
Cuba	18	2,174	32	8,709	77	9,602
Denmark	23	3,982				
Dominican Republic			1	156		
El Salvador			(1)	126		
France	40	5,759				
Germany	32	4,136				
Guatemala			(1)	125		
India	23	3,813	21	9,767		
Israel and Palestine			1	364	1	547
Italy	11	1,990				
Japan	17	2,022				
Mexico	17	2,328	24	9,468	15	4,663
Netherlands			(1)	244		
Peru	2	387	2	961		
Philippines	64	9,355	6	1,898	3	631
Sweden	29	4,547				
Taiwan			1	1,458		
United Kingdom	73	9,003	(1)	525		
Uruguay			1	692		
Venezuela	2	336	2	1,143	2	360
Total 1951	612	75,964	213	56,345	679	63,639
1952						
Argentina	4	1,935	14	8,050		
Australia			11	1,163		
Austria	9	1,825				
Belgium-Luxembourg	4	502				
Canada	1,152	88,578	11	8,997	121	12,865
Canal Zone					(1)	116
Chile	17	2,897	16	4,554		
Colombia			2	1,877		
Cuba	16	1,922	35	8,160	1	104
Denmark	6	840	(1)	224		
Dominican Republic			3	492	(1)	223
Ecuador			1	291		
France	24	4,466				
Germany, West	74	9,753				
Guatemala			(1)	158		
India	19	2,160	3	1,556		
Israel and Palestine	6	1,074	6	1,215		
Italy	1	369				
Japan	5	847				
Mexico	5	812	24	9,159	2	528
Netherlands			1	1,130		
Netherlands Antilles			1	576		
Nicaragua					1	120
Peru	1	106	1	842	(1)	593
Philippines	8	1,168	21	4,274	1	189
Saudi Arabia					1	164
Turkey			4	2,766		
Union of South Africa	1	568				
United Kingdom	143	18,204				
Venezuela	6	994	4	1,584	(1)	135
Total 1952	1,501	139,020	158	57,068	127	15,037

(1) Less than 1 ton.

operations at the foundries. Conclusions stated in the report are that crucibles made from Madagascar graphite gave no more heats than crucibles manufactured with either Alabama or Pennsylvania graphite; carbon-bonded crucibles gave approximately twice as many heats as clay-bonded crucibles; and the use of finer flake sizes than ordinarily used by some manufacturers of carbon-bonded crucibles was not detrimental.

The American Society for Testing Materials, Committee D-2, Research Division XII, instigated a program to develop a graphite abrasion tester that may be used as a standard device to measure the abrasive properties of graphite used for lubricating purposes. A "ball-bearing tester" was designed and constructed which gave measurable results that could be reproduced without difficulty. It is believed that, with further development, this device will fill a need that has long been felt for a standard abrasion tester.

WORLD REVIEW

Available statistics on world production of graphite for 1948–52 are shown in table 6. Comparable figures for 1915–39 were published in Minerals Yearbook, Review of 1940 (p. 1414), for 1938–46 in Minerals Yearbook, 1946 (p. 1287), and for 1944–50 in Minerals Yearbook, 1950 (p. 1346).

World production of natural graphite in 1952 was estimated to be the same as in 1951. Decreases in production in Mexico and Korea, ordinarily the two largest producers, and Ceylon were offset by increases in Austria, West Germany, Norway, Madagascar, and other countries.

TABLE 6.—World production of natural graphite, by countries,[1] 1948–52 in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
North America:					
Canada	2,303	1,948	3,253	1,467	1,842
Mexico	35,261	23,812	24,626	32,286	24,152
United States (amorphous and crystalline)	9,026	5,536	4,628	6,473	5,086
South America: Brazil	8,124	556	471	700	(3)
Europe:					
Austria	11,300	14,400	14,685	18,227	19,701
Czechoslovakia	15,000	(3)	(3)	(3)	(3)
Germany, West	5,757	5,097	6,563	(3)	8,963
Italy	7,251	4,639	4,521	4,486	4,010
Norway	1,083	2,257	2,465	3,453	4,120
Spain	241	256	310	274	612
Sweden	64	109			(3)
Yugoslavia					687
Asia:					
Ceylon (exports)	14,221	12,437	13,030	12,824	7,782
India	1,675	988	1,611	1,603	(3)
Japan	9,132	5,664	4,008	4,872	4,068
Korea, Republic of	15,958	45,219	19,049	20,380	15,820
Taiwan (Formosa)	(3)	(3)	(3)	(3)	700
Africa:					
Egypt	50				(3)
French Morocco	290	72	74	131	21
Kenya					35
Madagascar	7,684	9,141	14,013	18,338	18,478
Mozambique	90	110		240	
South-West Africa	1,627	2,264	1,380	2,626	1,184
Spanish Morocco	25	15	3		
Union of South Africa	172	107	244	328	353
Australia	235	126	147	135	(3)
Total (estimate)	170,000	180,000	165,000	190,000	190,000

[1] In addition to countries listed, graphite has been produced in Argentina, China, and U. S. S. R., but production data are not available, estimates by senior author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous graphite chapters.
[3] Data not available; estimate by senior author of chapter included in total.

Gypsum

By Oliver S. North[1] and Nan C. Jensen[2]

ACTIVITY in the gypsum industry was generally lower in 1952 than in 1951, as is illustrated by a 3-percent decrease in the quantity of domestic crude gypsum mined and a decline of 8 percent in the tonnage of calcined gypsum produced. However, many of the year's losses were principally concentrated in the first quarter, when housing starts were at a low point, even on a seasonal basis. Some improvement was noted in the second and third quarters, and by the last 3 months of the year several gypsum products were being sold in record quantities.

New nonfarm housing starts in 1952 were about 40,000 above the 1951 total, and public construction and private industrial building continued on a high level. The welfare of the gypsum industry depends on building construction, which annually consumes over 90 percent of the total value of all gypsum products sold or used in the country.

The demand for wallboard continued high, and a new sales record was established for that commodity. Record quantities of agricultural gypsum and sanded plaster also were sold. The principal gain for agricultural gypsum (and gypsite) was made in California. The increase in sanded plaster was accounted for by the inclusion of perlite premixed plaster in the statistics of that category.

TABLE 1.—Salient statistics of the gypsum industry in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Active establishments [1]	82	95	88	87	85	89
Crude gypsum: [2]						
Mined ... short tons	4,657,622	7,254,535	6,608,118	8,192,625	8,665,534	8,415,300
Imported ... do	939,347	2,859,209	2,593,329	3,219,299	[3] 3,436,927	3,067,905
Apparent supply ... do	5,596,969	10,113,744	9,201,447	11,411,924	[3] 12,102,461	11,483,205
Calcined gypsum produced:						
Short tons	[4] 3,317,309	6,243,392	5,767,163	7,341,024	7,454,916	6,874,432
Value	[4] $22,213,183	$48,144,806	$45,455,419	$60,479,573	$65,761,032	$59,696,410
Gypsum products sold: [5]						
Uncalcined uses:						
Short tons	1,405,852	2,226,026	1,989,893	2,218,286	2,530,379	2,705,727
Value	$4,323,795	$7,927,266	$7,127,497	$7,911,988	$9,413,098	$9,616,780
Industrial uses:						
Short tons	187,235	219,472	211,635	266,192	288,713	252,216
Value	$2,745,400	$3,731,489	$3,562,017	$4,530,159	$5,467,803	$4,999,779
Building uses:						
Value	$73,041,882	$165,175,523	$148,056,853	$193,734,651	$222,166,148	$212,465,516
Total value	$80,111,077	$176,834,278	$158,746,367	$206,176,798	$237,047,049	$227,082,075
Gypsum and gypsum products:						
Imported for consumption	$1,120,896	$3,114,762	$2,851,289	$3,584,152	[3] $3,813,892	$3,694,975
Exported	$988,239	$1,317,042	$1,936,148	$1,046,458	$1,584,488	$1,216,294

[1] Each mine, plant, or combination mine and plant is counted as 1 establishment.
[2] Excludes byproduct gypsum.
[3] Revised figure.
[4] Includes production from small quantity of byproduct gypsum in 1943–46.
[5] Made from domestic, imported, and byproduct crude gypsum.

[1] Commodity-industry analyst.
[2] Statistical assistant.

At the end of the year the outlook for the gypsum industry in 1953 was considered good by many forecasters. Estimates placed the probable amount of new construction at about $1 billion more than 1952. Little change was anticipated in building costs; hence, the physical volume of work done was expected to be higher, with housing starts again exceeding 1,100,000 units. Sales of the uncalcined products and industrial plasters also were expected to reach at least their 1952 levels.

DOMESTIC PRODUCTION

Crude.—For the third successive year the output of crude gypsum from mines in the United States exceeded 8 million short tons, although the production in 1952 was 3 percent lower than in 1951, the record year. Compared to 1951, increased tonnages were mined in California and in the Arizona-Arkansas-Kansas-Louisiana group of States, while all other separately recorded States and State groupings showed declines. A total of 56 mines, located in 19 States, reported production during the year; of these, 40 were open-pit operations, 13 were underground mines, and 3 were combination pit-underground mines.

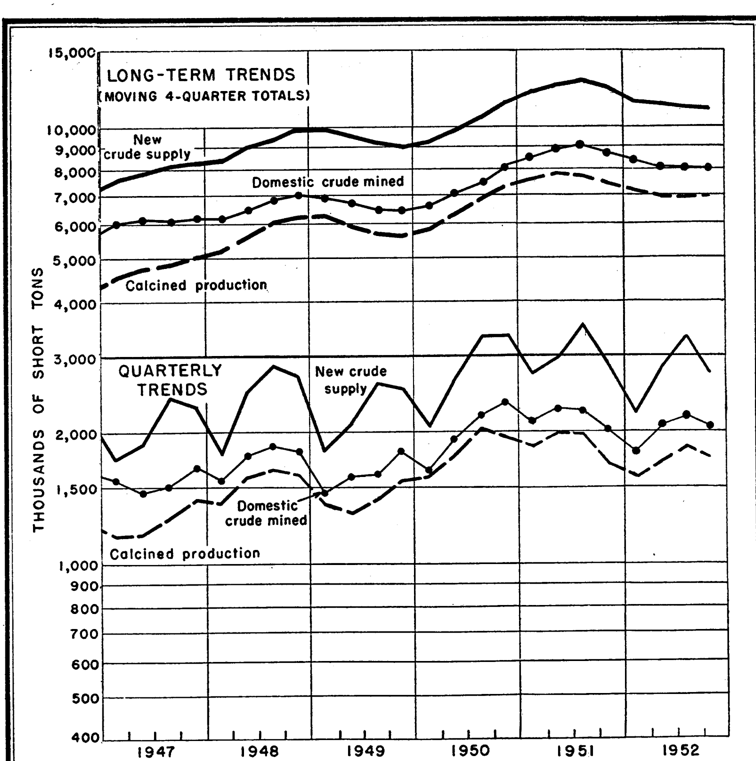

FIGURE 1.—Trends of new crude supply, domestic crude mined, and production of calcined gypsum, 1947–52, by quarters.

Calcined.—Fifty plants, with 224 pieces of calcining equipment, were in operation. The quantity of calcined gypsum produced in 1952 was 8 percent lower than in the previous year. Production of calcined gypsum, the form in which most gypsum is utilized, is considered the most accurate overall measure of the industry, as it includes both domestic and imported raw material.

TABLE 2.—Crude gypsum mined in the United States, 1950–52, by States [1]

State	Active mines			1950		1951		1952	
	1950	1951	1952	Short tons	Value	Short tons	Value	Short tons	Value
California	11	10	13	962,373	$2,462,604	1,092,883	$2,602,758	1,236,430	$2,721,134
Iowa	5	5	4	981,647	2,507,651	1,127,705	2,881,150	1,122,409	2,797,704
Michigan	4	4	4	1,474,210	4,090,777	1,566,276	4,402,725	1,487,642	4,200,418
Nevada	4	5	4	604,604	1,614,107	643,637	1,811,757	608,284	1,666,938
New York	6	5	5	1,280,100	3,876,176	1,259,484	4,010,766	1,143,920	3,816,148
Texas	5	5	5	1,076,251	2,771,812	1,136,824	2,987,890	1,021,161	2,682,019
Other:									
Arizona	2	1	1						
Arkansas	1	1	1	333,228	706,451	392,863	717,133	446,705	777,975
Kansas	2	2	2						
Louisiana	1	1	1						
Colorado	4	3	3						
Idaho		1	1						
Montana	2	2	2	197,443	594,844	173,341	559,191	170,457	546,373
Washington	1	1	1						
Wyoming	1	1	1						
Ohio	2	2	2						
Oklahoma	2	2	3	1,282,769	4,110,146	1,272,521	4,050,731	1,178,292	3,687,342
Utah	3	3	2						
Virginia	1	1	1						
Total	57	55	56	8,192,625	22,734,568	8,665,534	24,024,101	8,415,300	22,896,051

[1] Production of some States is not shown separately, in order not to disclose individual company operations.

Mine and Calcining-Plant Developments.—Large quantities of agricultural gypsum or gypsite were being mined and sold in California, particularly in the San Joaquin Valley, where it was used to condition soils and aid in alleviating black alkali conditions. Much of the material was produced by relatively small operations from deposits on public lands leased by the Bureau of Land Management to private operators on a bid basis.[3] The quickened interest in gypsum in California was indicated by several other items in the press describing newly discovered deposits of the mineral and the filing of new gypsum claims by prospectors.[4]

Production was reported to have been begun at the gypsum mine of Suwanee Gypsum Products Co. 30 miles west of Albuquerque, N. Mex. The material was to be used to condition the soils of that area.[5]

The only gypsum-processing plant in operation in Washington was that of Columbia Gypsum Products, Inc., at Spokane. Gypsum rock used at these facilities was obtained from company-owned deposits in British Columbia. A full line of gypsum products except board and lath was being manufactured at the plant.[6]

[3] Bureau of Land Management, Our Public Lands: Vol. 2, No. 4, October 1952, p. 5.
[4] California Department of Natural Resources, Division of Mines, Mineral Information Service, Clark Mountain Area Gypsum: Vol. 5, No. 6, June 1, 1952, p. 9; California Journal of Mines and Geology, Gypsum: Vol. 48, No. 1, January 1952, p. 116; Engineering and Mining Journal, vol. 153, No. 3, March 1952, p. 126; vol. 153, No. 7, July 1952, p. 131.
[5] Engineering and Mining Journal, vol. 153, No. 9, September 1952, pp. 169–170.
[6] Utley, H. F., Columbia Gypsum Products Uses Kettle of Unusual Design: Pit and Quarry, vol. 44, No. 8, February 1952, pp. 93, 107.

CONSUMPTION AND USES

Expenditures for new construction in the United States totaled approximately $32.3 billion in 1952 compared with $29.9 billion in 1951 and $27.9 billion in 1950. About 1,130,000 new nonfarm dwellings were started during the year—4 percent more than in 1951 and second only to the record 1,390,000 starts of 1950.

The continuing activity in housing construction kept the demand for gypsum building products, particularly sanded plaster and wallboard, at a high level, although perhaps not as high as would have been anticipated from the number of starts. This may have been due partly to the fact that the number of starts in the last 3 months was considerably higher on a seasonally adjusted basis than in the earlier months; many of these starts had not yet reached by year end the stage of construction at which most gypsum products are used.

Most of the major plant-expansion programs had been completed by members of the industry before the end of the year, and producers apparently had no difficulty in meeting the demand for gypsum products.

Gypsum producers were reported to be taking increasing note of developments of new methods of construction and fireproofing practices that make use of lightweight-aggregate plasters and of special construction systems based on gypsum products.[7] Premixed perlite-gypsum plaster was being manufactured and sold by at least 6 large gypsum producing companies.

TABLE 3.—Calcined gypsum produced in the United States, 1951–52, by districts

District	1951		1952	
	Short tons	Value	Short tons	Value
New Hampshire, Massachusetts, and Connecticut	269,595	$2,527,020	247,835	$2,308,999
Eastern New York, New Jersey, Pennsylvania, Georgia, and Florida	1,384,516	13,335,707	1,285,101	12,134,418
Ohio, Virginia, Indiana, and Maryland	1,106,338	11,296,735	1,045,248	10,507,203
Western New York	820,416	6,159,060	640,956	5,145,257
Michigan	671,178	5,560,711	606,406	4,974,226
Iowa	766,370	6,028,271	721,953	5,382,295
Kansas and Oklahoma	425,378	3,302,367	453,901	3,333,289
Texas	793,562	6,509,550	707,654	5,960,375
Colorado, Montana, and Utah	277,258	2,766,854	243,365	2,336,283
California and Nevada	940,305	8,274,757	922,013	7,614,065
Total	7,454,916	65,761,032	6,874,432	59,696,410

Gypsum-Products Plant Developments.—The Redwood City, Calif., plant of Kaiser Gypsum Division, Henry J. Kaiser Co., was reportedly one of the two gypsum-products plants in the United States that do not calcine raw gypsum in kettles. At Redwood City the 4-inch lump material obtained from San Marcos Island, in the Gulf of California, was simultaneously pulverized and calcined in special oil-fired hammer mills. Most of the calcined material produced at this plant was used in the manufacture of plasterboard, punched lath, and exterior sheathing.[8]

[7] Rock Products, Gypsum Association Report: Vol. 55, No. 6, June 1952, p. 118.
[8] Utley, H. F., Kaiser Expands Gypsum-Board Plant at Redwood City, Acquired in 1949: Pit and Quarry, vol. 45, No. 1, July 1952, pp. 82–83, 90.

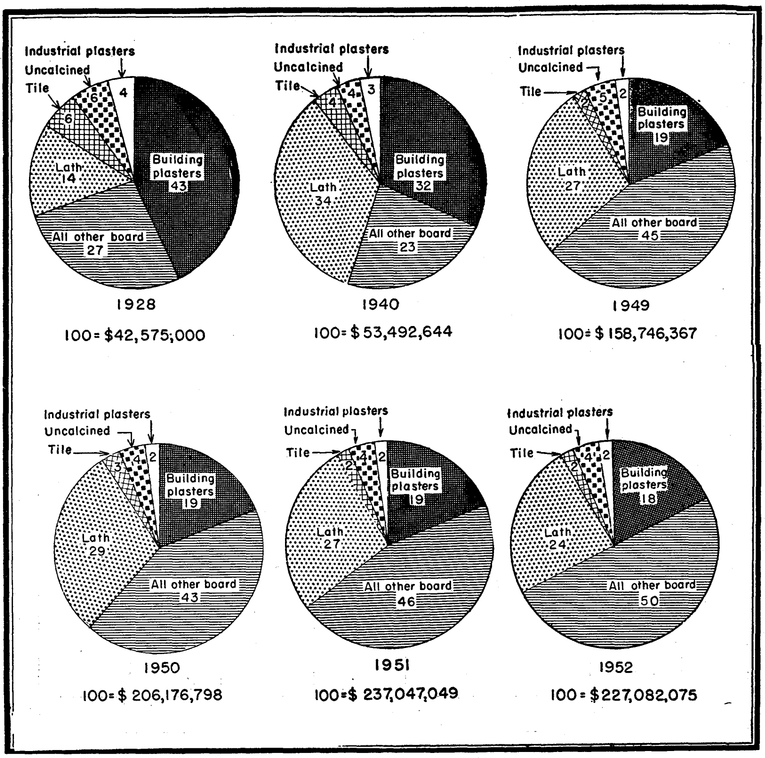

FIGURE 2.—Percentage distribution of total sales value, f. o. b. plant, of gypsum products in 1928, 1940, and 1949–52, by groups of products.

TABLE 4.—Active calcining plants and equipment in the United States, 1950–52, by States

State	1950			1951			1952		
	Calcining plants	Equipment		Calcining plants	Equipment		Calcining plants	Equipment	
		Kettles	Other calciners [1]		Kettles	Other calciners [1]		Kettles	Other calciners [1]
California	5	10	8	5	11	8	5	11	8
Iowa	5	22	4	5	24	4	5	24	4
Michigan	4	20	1	4	20	1	4	20	1
New York	7	22	6	7	22	6	7	22	6
Texas	4	30	1	4	31	1	4	30	1
Other States [2]	26	74	23	25	74	23	25	74	23
Total	51	178	43	50	182	43	50	181	43

[1] Includes rotary and beehive kilns, grinding-calcining units, and hydrocal cylinders.
[2] Comprises calcining plants in 1950–52 as follows: 1 each in Arizona (none in 1951–52), Connecticut, Florida, Georgia, Indiana, Maryland, Massachusetts, New Hampshire, New Jersey, Oklahoma, and Pennsylvania; 2 each in Colorado, Kansas, Montana, Nevada, Ohio, and Virginia; 3 in Utah.

National Gypsum Co., Buffalo, N. Y., revealed details of a $25 million loan, about one-fourth of which was to be invested in expansion programs at several company plants and in a research center in Buffalo. Plans included technological improvements and the manufacture of new products.[9] During the year National Gypsum Co.

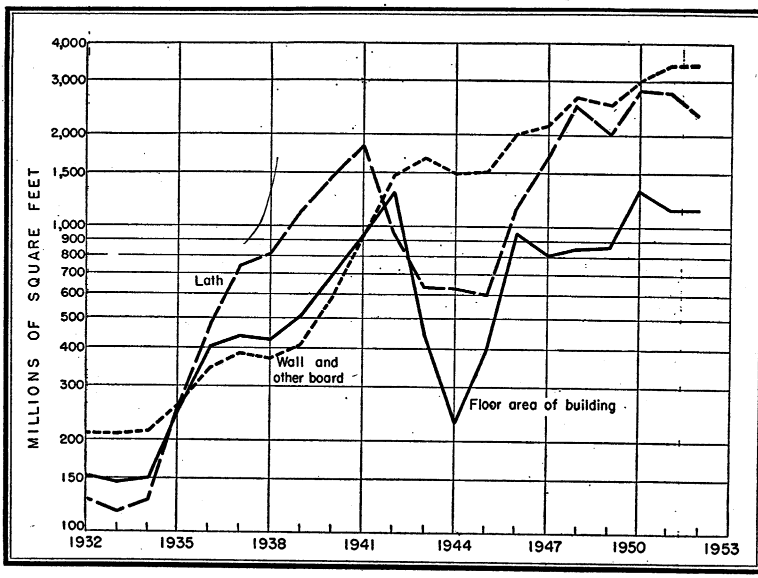

FIGURE 3.—Trends in sales of gypsum lath and wallboard and other boards (includes wallboard, laminated board in terms of component board, and sheathing), compared with Dodge Corp. figures on combined floor area of residential and nonresidential building, 1932–52.

continued diversification of its interests by acquiring the eight plants of Wesco Waterpaints, Inc.[10]

Certain-teed Products Corp., Ardmore, Pa., completed in Paoli, Pa., a research building in which product development and testing will be centered.[11]

---

[9] Pit and Quarry, National Gypsum Co. To Use $25,000,000 Loan in Expansion Program: Vol. 45, No. 5, November 1952, p. 81.
[10] Chemical and Engineering News, vol. 30, No. 15, April 14, 1952, p. 1542.
[11] Rock Products, Gypsum Research Building: Vol. 55, No. 12, December 1952, p. 79.

TABLE 5.—Gypsum products (made from domestic, imported, and byproduct crude gypsum) sold or used in the United States, 1951–52, by uses

Use	1951			1952			Percent of change in—	
	Short tons	Value		Short tons	Value			
		Total	Average		Total	Average	Tonnage	Average value
Uncalcined:								
Portland-cement retarder	1,808,766	$6,291,190	$3.48	1,815,489	$6,232,230	$3.43	(1)	−1
Agricultural gypsum	687,620	2,741,158	3.99	866,005	3,072,419	3.55	+26	−11
Other uses [2]	33,993	380,750	11.20	24,233	312,131	12.88	−29	+15
Total uncalcined uses	2,530,379	9,413,098	3.72	2,705,727	9,616,780	3.55	+7	−5
Industrial:								
Plate-glass and terra-cotta plasters	63,371	813,020	12.83	48,587	626,771	12.90	−23	+1
Pottery plasters	48,365	882,987	18.26	43,991	811,609	18.45	−9	+1
Orthopedic and dental plasters	11,297	397,476	35.18	11,017	390,347	35.43	−2	+1
Other industrial uses [3]	165,680	3,374,320	20.37	148,621	3,171,052	21.34	−10	+5
Total industrial uses	288,713	5,467,803	18.94	252,216	4,999,779	19.82	−13	+5
Building:								
Cementitious:								
Plasters:								
Base-coat	2,170,299	30,166,130	13.90	1,907,871	26,596,087	13.94	−12	(1)
Sanded	124,504	2,149,533	17.26	177,679	3,331,533	18.75	+43	+9
To mixing plants	16,345	189,698	11.61	11,703	126,243	10.79	−28	−7
Gaging and molding	208,422	3,310,641	15.88	176,957	2,943,304	16.63	−15	+5
Prepared finishes	18,323	1,030,955	56.27	16,000	935,670	58.48	−13	+4
Other [4]	246,124	5,456,166	22.17	220,997	6,082,843	27.52	−10	+24
Keene's cement	54,031	1,227,768	22.72	52,591	1,158,703	22.03	−3	−3
Total cementitious	2,838,048	43,530,891	15.34	2,563,798	41,174,383	16.06	−10	+5
Prefabricated:								
Lath	2,113,804	64,551,960	[5] 23.42	1,757,771	54,402,346	[5] 23.48	[6] −16	(1)
Wallboard and laminated board	2,842,537	105,128,204	[7] 32.39	2,964,381	108,974,618	[7] 32.88	[6] +2	+2
Sheathing board	122,907	4,240,084	[5] 36.49	123,310	4,281,772	[5] 36.57	[6] +1	(1)
Tile	218,603	4,715,009	[8] 77.79	157,451	3,632,397	[8] 78.54	[6] −29	+1
Total prefabricated	5,297,851	178,635,257	33.72	5,002,913	171,291,133	34.24	[6] −6	+2
Total building uses	----------	222,166,148	-------	----------	212,465,516	-------	------	-----
Grand total value	----------	237,047,049	-------	----------	227,082,075	-------	------	-----

1 Less than 1 percent.
2 Includes uncalcined gypsum sold for use as filler and rock dust, in brewer's fixe, in color manufacture, and for unspecified uses.
3 Includes statuary, industrial casting and molding plasters, dead-burned filler, granite polishing, and miscellaneous uses.
4 Includes insulating and roof-deck, joint filler, patching and painter's plaster, and unclassified building plasters.
5 Average value per M square feet.
6 Percent of change in square footage.
7 Average value per M square feet of wallboard only.
8 Average value per M square feet of partition tile only.

TABLE 6.—Gypsum board and tile sold or used in the United States, 1943–47 (average) and 1948–52, by types

Year	Lath			Wallboard		
	M square feet	Value		M square feet	Value	
		Total	Average [1]		Total	Average [1]
1943–47 (average)	941,359	$14,948,401	$15.88	1,536,779	$35,924,005	$23.38
1948	2,504,733	53,596,957	21.40	[2] 2,531,865	[2] 72,071,432	[3] 28.40
1949	2,015,638	43,060,474	21.36	[2] 2,439,121	[2] 68,493,078	[3] 28.03
1950	2,793,620	60,621,179	21.70	[2] 2,901,947	[2] 84,693,753	[3] 29.16
1951	2,756,278	64,551,960	23.42	[2] 3,243,676	[2] 105,128,204	[3] 32.39
1952	2,317,191	54,402,346	23.48	[2] 3,312,543	[2] 108,974,618	[3] 32.88

Year	Sheathing			Laminated board			Tile [4]		
	M square feet	Value		M square feet [5]	Value		M square feet	Value	
		Total	Average [1]		Total	Average [1]		Total	Average [6]
1943–47 (average)	126,017	$2,968,797	$23.56	101,672	$3,032,475	$29.82	18,066	$1,790,823	$52.45
1948	129,632	4,431,544	34.19	(2)	(2)	(7)	27,181	3,091,547	72.40
1949	97,037	3,267,935	33.68	(2)	(2)	(7)	28,518	3,286,264	73.17
1950	113,785	3,850,763	33.84	(2)	(2)	(7)	45,032	4,992,467	75.26
1951	116,204	4,240,084	36.49	(2)	(2)	(7)	37,862	4,715,009	77.79
1952	117,080	4,281,772	36.57	(2)	(2)	(7)	27,044	3,632,397	78.54

1 Per M square feet, f. o. b. producing plant.
2 Laminated board included with wallboard.
3 Average value per M square feet of wallboard.
4 Includes partition, roof, floor, soffit, shoe, and all other gypsum tiles and planks.
5 Area of component board and not of finished product.
6 Per M square feet, f. o. b. producing plant, of partition tile only.
7 Figure withheld to avoid disclosure of individual company operations.

STOCKS

Producers reported stocks of crude gypsum totaling 1,688,757 short tons on hand December 31, 1952, compared to 1,547,005 tons on the same date of the preceding year and 1,496,105 tons at the end of 1950.

PRICES

According to reports from producers, the average value of crude gypsum mined was $2.72 per ton compared to $2.77 in 1951 and $2.78 in 1950. Among the uncalcined uses, average values of both cement retarder and agricultural gypsum were lower, but the average value of miscellaneous uncalcined gypsum products was markedly higher. Average values of the industrial plasters in 1952 closely approximated those of 1951. Among the building plasters, the average value of base-coat plaster was unchanged, while that of sanded (and perlited) plasters increased sharply. None of the prefabricated gypsum products showed any appreciable change in average value from the previous year.

FOREIGN TRADE [12]

Imports of crude gypsum into the United States in 1952 declined to 3,067,905 short tons—11 percent less than the 1951 total. Canada supplied 91 percent of the total quantity imported and approximately one-fourth of the apparent domestic supply. Imports declined from every foreign source except Jamaica, which exported to the United States approximately 60 percent more than in the preceding year. Imports from the Dominican Republic were lower, although there were indications that it would become an important supplier in the near future.

TABLE 7.—Gypsum and gypsum products imported for consumption in the United States, 1948–52

[U. S. Department of Commerce]

Year	Crude (including anhydrite)		Ground		Calcined		Keene's cement		Alabaster manufactures [1] (value)	Other manufactures, n. e. s. (value)	Value
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value			
1948	2,859,209	$2,977,809	404	$13,960	11	$610	12	$728	$83,245	$38,410	$3,114,762
1949	2,593,329	2,693,824	613	14,209	209	8,036			55,569	79,651	2,851,289
1950	3,219,299	3,276,707	716	15,787	237	7,900	1	173	61,444	222,141	3,584,152
1951	[2] 3,436,927	[2] 3,535,747	576	16,929	301	12,308	3	441	97,858	150,609	[2] 3,813,892
1952	3,067,905	3,246,143	605	20,821	249	11,379	3	193	189,478	226,961	3,694,975

[1] Includes imports of jet manufactures, which are believed to be negligible.
[2] Revised figure.

TABLE 8.—Crude gypsum (including anhydrite) imported for consumption in the United States, 1950–52, by countries

[U. S. Department of Commerce]

Country	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Canada	2,979,131	$3,035,546	[1] 3,094,070	[1] $3,162,601	2,786,820	$2,917,999
China	2	449	1	160		
Dominican Republic			6,685	23,874	2,240	8,000
Italy	1	34				
Jamaica	9,296	27,275	22,563	65,471	35,784	102,963
Mexico	230,869	213,403	313,608	283,641	243,061	217,181
Total	3,219,299	3,276,707	[1] 3,436,927	[1] 3,535,747	3,067,905	3,246,143

[1] Revised figure.

[12] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 9.—Gypsum and gypsum products exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Crude, crushed, or calcined [1]		Plasterboard, wallboard, and tile		Other manufactures, n. e. s. (value)	Total value
	Short tons	Value	Square feet	Value		
1948	10,797	$259,728	16,506,127	$615,845	$441,469	$1,317,042
1949 [2]	17,567	423,478	53,313,138	1,336,269	176,401	1,936,148
1950 [2]	23,678	524,926	13,618,353	428,549	92,983	1,046,458
1951 [2]	25,045	608,940	25,556,712	848,777	126,771	1,584,488
1952 [2]	19,884	517,227	19,571,037	577,780	121,287	1,216,294

[1] Effective January 1, 1949, calcined gypsum not separable from crude, crushed, or calcined.
[2] Due to changes in items included in each classification, data are not strictly comparable with earlier years.

TECHNOLOGY

Two patents described methods of manufacturing gypsum board and tile from foamed gypsum slurries.[13] A series of patents covered methods for manufacturing building materials from natural rock anhydrite and synthetic anhydrite.[14]

The incorporation of certain percentages of residual fuel oil, alkali metal rosin soap, and a water-soluble alkali-earth salt in calcined gypsum was claimed to produce a water-repellent material from which wallboard and tile may be fabricated.[15] Other methods of producing water-resistive gypsum compositions were covered in subsequent patents.[16]

The process by which ammonium sulfate is manufactured from gypsum in a new plant at Sindri, India, was described in the trade press. The ammonium sulfate is produced by reaction of gypsum and ammonium carbonate under pressure. Plans have been made to utilize the residual calcium carbonate sludge for cement manufacture.[17]

The casting in gypsum-sand molds of light-metal forms for such uses as cylinder-head castings, radar parts, supercharger compressors, and the like was described.[18]

A study was made of the advantages that might be gained by grinding gypsum retarder separate from portland cement clinker and subsequently blending the ground material. The possibility of using the practice to minimize false set in the cement and to improve control of particle-size gradation in the finished product was explored.[19]

[13] Chappell, F. L., Jr. (assigned to Hercules Powder Co.), Foamed Gypsum Composition: U. S. Patent 2,593,008, April 15, 1952; Hart, W. H., Modified Starch Product: U. S. Patent 2,585,651, Feb. 12, 1952.

[14] Weber, H., Lightweight Porous Building Materials: U. S. Patent 2,606,126, Aug. 5, 1952. Lightweight Building Materials and Their Manufacture From Synthetic Anhydrous Calcium Sulfate: U. S. Patent 2,606,127, Aug. 5, 1952. Nonhydrating Setting and Binding Material: U. S. Patent 2,606,128, Aug. 5, 1952. Setting and Binding Material From Natural Mineral Anhydrite: U. S. Patent 2,606,129, Aug. 5, 1952.

[15] Riddell, W. C., and Kirk, G. B. (assigned to Henry J. Kaiser Co.), Water-Repellent Gypsum Product and Process of Making Same: U. S. Patent 2,597,901, May 27, 1952.

[16] Riddell, W. C., and Kirk, G. B. (assigned to Henry J. Kaiser Co.), Cementitious Composition: U. S. Patent 2,604,411, July 22, 1952. Water-Repellent Gypsum Product: U. S. Patent 2,610,130, Sept 9, 1952.

[17] Chemical Engineering, Shortage Glamorizes Gypsum: Vol. 59, No. 1, January 1952, pp. 250, 252; Chemical Engineering, Ammonium Sulfate From Gypsum: Vol. 59, No. 6, June 1952, pp. 242–245.

[18] Metal Progress, Light Metals Cast in Gypsum-Sand Molds: Vol. 61, No. 3, March 1952, pp. 51–52.

[19] Wadia, D. A., Grinding Gypsum Separate From Clinker: Rock Products, vol. 55, No. 5, May 1952, pp. 85–86.

Technologic and economic developments in the gypsum industry were discussed in an article that emphasized the advantages of high-cost, high-capacity gypsum-products plants strategically located with reference to sources of supply, and to market area.[20] Another report summarized the history of a large gypsum-producing company and listed, in chronological order, the important developments in the gypsum industry from 1903 to the present.[21]

The crystal chemistry of gypsum-plaster hydration was the subject of a study. During photomicrographic examination of crystallizing gypsum, the presence of swallowtail-twinned crystals were noted, a phenomenon that had not previously been described by other investigators.[22]

An article in a trade magazine discussed the chemistry involved in calcining gypsum and the mechanics of heat transference in gypsum kettles.[23]

Report of a study on gypsum-anhydrite cap rock was released. Subjects discussed included the process of gypsification, stress effects in the cap rock, process of recrystallization of anhydrite cap rock, and processes of formation of accompanying lesser minerals.[24]

A report on field investigations of a number of Idaho gypsum deposits was published. Economic factors involved in commercial exploitation were discussed.[25]

A published bulletin described in detail the occurrences and geology of the numerous California gypsum deposits. A section of the book is devoted to extensive descriptions of mining, processing, and marketing.[26]

A Bureau of Mines publication described a diamond-drill sampling program at a gypsum deposit on an island in southern Alaska.[27]

WORLD REVIEW

Belgian Congo.—Gypsum is mined in Katanga on a small scale for use as cement retarder and in the manufacture of plaster. Other deposits are found near Lake Edward and in Bas Congo.[28]

[20] Lenhart, W. B., Developments in Gypsum Manufacture: Rock Products, vol. 55, No. 1, January 1952, pp. 152–156.
[21] Rock Products, U. S. Gypsum's 50 Years of Progress: Vol. 55, No. 2, February 1952, pp. 94–99.
[22] Cunningham, W. A., Dunham, R. M., and Antes, L. L., Hydration of Gypsum Plaster: Ind. Eng. Chem.. vol. 44, No. 10, October 1952, pp. 2402–2408.
[23] Bauer, W. G., Fundamentals of Gypsum Calcination: Pit and Quarry, vol. 44, No. 10, April 1952, pp. 113–114, 118, 122–123.
[24] Goldman, M. I., Deformation, Metamorphism, and Mineralization of Gypsum-Anhydrite Cap Rock, Sulphur Salt Dome, Louisiana: Geol. Soc. America, Memoir 50, Mar. 25, 1952, 169 pp.
[25] McDivitt, J. F., Report on Gypsum Deposits in Washington County, Idaho: Idaho Bureau Min. and Geol., Pamph. 93, February 1952, 15 pp.
[26] ver Planck, W. E., Gypsum in California: California Dept. Nat. Resources, Div. of Min., Bull. 163, September 1952, 151 pp.
[27] Jermain, G. D., and Rutledge, F. A., Diamond Drilling Gypsum Camel Prospect, Iyoukeen Cove, Chicagof Island, Southeastern Alaska: Bureau of Mines Rept. of Investigations 4852, 1952, 6 pp.
[28] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, p. 49.

TABLE 10.—World production of gypsum, by countries,[1] 1947–52, in metric tons[2]

[Compiled by Helen L. Hunt]

Country [1]	1947	1948	1949	1950	1951	1952
North America:						
Canada	2,362,365	3,164,211	2,854,999	3,429,332	3,563,745	3,259,422
Cuba [3]	14,900	16,500	13,880	15,500	30,000	30,000
Dominican Republic	13,393	7,304	18,157	----	21,238	12,863
Jamaica	----	7,112	12,193	23,369	27,173	45,621
United States	5,631,969	6,581,169	5,994,752	7,432,186	7,861,199	7,634,192
South America:						
Brazil	(4)	(4)	50,857	[3] 51,000	(4)	(4)
Chile	83,928	31,440	60,304	65,509	68,938	(4)
Colombia	1,738	2,000	2,120	3,771	4,886	4,885
Ecuador	----	410	486	[3] 441	(4)	(4)
Peru	41,330	46,716	37,419	31,917	30,890	(4)
Venezuela [5]	3,451	2,406	3,042	2,050	1,404	(4)
Europe:						
Austria	15,096	26,376	36,189	42,300	39,520	187,540
Bulgaria [3]	5,000	5,000	5,000	5,000	5,000	(4)
Finland	(4)	1,711	(4)	(4)	----	----
France	2,229,940	2,254,181	2,143,163	2,100,000	[3] 2,000,000	(4)
Germany, West [6]	150,700	316,600	594,400	733,711	814,945	774,389
Greece	850	580	730	820	950	19,000
Ireland	36,415	62,693	67,268	82,668	[3] 100,000	(4)
Italy	298,224	371,787	447,647	488,794	578,205	(4)
Luxembourg	38,707	4,113	19,569	17,846	12,320	5,072
Poland	14,917	14,183	26,361	32,824	(4)	(4)
Portugal	33,868	42,842	43,060	36,034	29,993	(4)
Spain	1,337,662	[7] 1,423,728	1,293,552	2,251,831	1,821,676	(4)
Switzerland	165,000	[3] 165,000	[3] 80,000	[3] 80,000	120,000	(4)
United Kingdom:						
Great Britain	1,773,733	2,120,700	2,144,272	2,241,711	2,321,065	[3] 2,500,000
Northern Ireland	----	----	----	----	173	----
Yugoslavia	(4)	(4)	(4)	(4)	(4)	17,362
Asia:						
Ceylon	69	170	187	----	309	(4)
China	50,000	[3] 55,000	(4)	[3] 60,000	[3] 70,000	[3] 80,000
Cyprus (exports)	7,844	19,500	25,788	65,485	23,171	56,553
India	51,381	80,215	142,190	209,678	193,276	(4)
Iran	(4)	(4)	[3] [8] 378,000	[3] [8] 378,000	(4)	120,000
Iraq	(4)	(4)	(4)	250,000	(4)	(4)
Israel	(4)	(4)	(4)	23,623	1,700	20,000
Japan	61,555	113,754	117,123	114,505	200,640	196,788
Pakistan	16,121	6,361	15,896	16,927	22,791	29,663
Philippines	----	818	2,710	2,883	399	----
Syria [9]	4,500	[3] 1,000	1,400	2,000	8,170	5,500
Taiwan (Formosa)	1,983	3,889	2,939	1,968	2,055	1,800
Thailand (Siam)	71	200	154	336	79	----
Africa:						
Algeria	38,345	33,258	31,881	46,097	82,000	53,200
Anglo-Egyptian Sudan	350	3,045	1,496	----	183	1,451
Belgian Congo	----	----	----	[3] 7,190	3,955	3,955
Egypt	72,337	95,243	6,909	155,902	112,056	(4)
French Morocco	17,285	30,136	36,130	620	7,695	7,955
Kenya	659	1,016	181	610	83	1,619
Tanganyika	----	----	----	----	----	503
Tunisia	17,650	19,130	22,066	23,064	24,385	10,760
Union of South Africa (sales and exports)	80,166	83,936	88,232	103,707	124,979	148,911
Oceania:						
Australia	218,893	280,852	315,302	340,869	370,195	356,946
New Caledonia	2,705	779	17,119	15,200	15,777	(4)
Total (estimate)[1]	16,500,000	21,200,000	19,000,000	22,700,000	24,700,000	24,300,000

[1] In addition to the countries listed, gypsum is produced in Angola, Argentina, Mexico, Rumania, and U.S.S.R., but production data are not available. Estimates for these countries are included in the total.
[2] This table incorporates a number of revisions of data published in previous gypsum chapters.
[3] Estimate.
[4] Data not available; estimate by senior author of chapter included in total.
[5] Production in Government quarries only; beginning 1951 no longer under Government control.
[6] Crude production estimates based on the following calcined figures: 1947, 125,600; 1948, 263,822; 1949, 495,356; 1950, 611,426; 1951, 679,121; 1952, 645,324.
[7] Includes Spanish Moroccan production: 1948, 1,829.
[8] Year ended March 20 of year following that stated.
[9] Some pure, some 80 percent gypsum and 20 percent limestone.

Canada.—The new gypsum and wallboard plant at Humbermouth, Newfoundland, was reported to have begun operation late in 1952. Construction of the facilities is said to have been financed by the Provincial Government of Newfoundland.[29]

The Nova Scotia Legislature Assembly passed a bill assessing a tax of 6 cents per ton on those quarries producing over 20,000 tons of gypsum per year. The law went into effect May 1, 1952, and is to continue for 10 years.[30]

The Western Gypsum Products, Ltd., mine at Amaranth, Manitoba, is said to be the only gypsum body in western Canada now being worked from a shaft. In the mine area the gypsum bed is 43 feet thick at a depth of 133 feet. Output currently is 7,000 to 8,000 tons per month. Crude gypsum from this source is shipped to Winnipeg and Calgary to be calcined and manufactured into gypsum building products.[31]

Dominican Republic.—The gypsum-salt deposits 25 miles west of Barahona were being actively developed during the year, and some commercial production was recorded. Reserves of gypsum are said to be immense.[32] Although no gypsum was shipped from these deposits to the United States in 1952, several companies were said to have expressed interest in the possibility of importing from that source.[33]

India.—Eleven firms were reported to be producing gypsum in India.[34]

A development of considerable economic as well as technologic (see Technology section) interest was construction of a plant at Sindri, Bihar, India, for producing ammonium sulfate from gypsum. The ammonium sulfate is needed for local use as a fertilizer. When the plant reaches capacity, it is expected to utilize 1,800 tons of gypsum per day and manufacture 350,000 tons of ammonium sulfate per year.

New Caledonia.—As in the past several years, the only recorded production of gypsum in New Caledonia was that by La Société le Nickel for use in its nickel-smelting operations.[35]

---

[29] Rock Products, Cement and Gypsum Plants: Vol. 55, No. 8, August 1952, p. 100; Pit and Quarry, Cement and Gypsum Facilities Sponsored by Newfoundland: Vol. 45, No. 5, November 1952, p. 79.
[30] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 5, May 1952, pp. 35-36.
[31] California Mining Journal, Western Gypsum Products: Vol. 73, No. 11, November 1952, pp. 122-124.
[32] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 6, June 1952, pp. 45-46, 48-50.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 3, March 1953, pp. 33-34.
[34] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 4, April 1952, pp. 48-50; Chemical Age (London), Indian Newsletter: Vol. 67, No. 1738, p. 597; Mining World, vol. 14, No. 6, May 1952, p. 67.
[35] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 6, June 1952, p. 46.

Iodine

By Joseph C. Arundale [1] and Flora B. Mentch [2]

AN OUTSTANDING feature of the iodine industry has been the recent expanding output in Japan. This has been achieved through the development of brines rather than the seaweed that was formerly the major source of iodine in that country. Japan has now become an important exporter of iodine, and a substantial portion of its exportable surplus is shipped to the United States.

DOMESTIC PRODUCTION

Current domestic production of iodine is confined to California, where two firms—the Dow Chemical Co. at Seal Beach and Deepwater Chemical Co. at Compton—recover iodine from waste oil-well water. The output of these two firms constitutes a considerable portion of United States supply of iodine, but the Bureau of Mines is not at liberty to publish the data on quantity of domestic production. The last year for which data were published was 1937, when approximately 300,000 pounds was produced. Output in recent years has been substantially greater.

It was reported that Deepwater Chemical Co. had enlarged its capacity by minor changes in the flowsheet and revision of the method of recovering potassium iodide from the ferrous iodide solution.[3]

CONSUMPTION AND USES

The crude iodine of commerce usually is over 99 percent pure. However, little is consumed in this form; most is either resublimed to greater purity or converted to iodine compounds. Potassium iodide is the principal compound produced; but hundreds of other inorganic and organic compounds are made, and these have numerous and varied uses in industry, agriculture, and medicine. Outstanding applications of iodine include use in antiseptics, photographic film, stock-feed supplements, iodized salt, and titanium metallurgy.

TABLE 1.—Crude iodine consumed in the United States in 1951–52

Compound manufactured	1951			1952		
	Number of plants	Crude iodine consumed		Number of plants	Crude iodine consumed	
		Pounds	Percent of total		Pounds	Percent of total
Resublimed iodine	6	137,918	11	5	78,222	7
Potassium iodide	9	787,936	64	10	768,554	65
Sodium iodide	5	114,307	9	6	64,332	5
Other inorganic compounds	8	45,198	4	8	29,785	3
Organic compounds	16	152,563	12	13	232,981	20
Total	[1] 25	1,237,922	100	[1] 25	1,173,874	100

[1] A plant producing over 1 product is counted but once in arriving at total.

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.
[3] California Journal of Mines and Geology, vol. 48, No. 1, January 1952, p. 116.

The Chilean Iodine Educational Bureau, Stone House, Bishopsgate, London (with offices at 120 Broadway, New York, N. Y.), in 1952 issued a bulletin that contains a check list of iodine compounds and preparations used in human medicine. Several hundred iodine pharmaceuticals were described and their therapeutic applications listed.[4]

STOCKS

In additions to stocks of iodine maintained by domestic producers, large stocks normally are held in Chile and at Staten Island, N. Y., by Chilean Nitrate Sales Corp., and are replenished at irregular intervals as they are depleted.

PRICES

According to Oil, Paint and Drug Reporter, the prices quoted during 1952 for crude iodine in kegs was $1.84 to $2.04 per pound; resublimed U. S. P., bottles, jars, at $2.55 to $2.78; ammonium iodide N. F., jars, at $4.01 to $4.13 per pound; sodium iodide U. S. P., bottles, drums, at $2.69 per pound; potassium iodide in drums at $2.15 to $2.20 per pound.

FOREIGN TRADE[5]

Crude iodine is imported into the United States from only two countries—Chile and Japan.

TABLE 2.—Crude iodine imported for consumption in the United States by countries of origin, 1943–47 (average) and 1948–52

[U. S. Department of Commerce]

Year	Chile		Japan		Total	
	Pounds	Value	Pounds	Value	Pounds	Value
1943–47 (average)	1,463,369	$1,665,606			1,463,369	$1,665,606
1948	541,439	786,850	50,697	$60,902	592,136	847,752
1949	382,344	577,810	107,655	141,948	489,999	719,758
1950	582,562	854,236	142,296	201,710	724,858	1,055,946
1951	667,426	1,036,414	184,681	283,914	852,107	1,320,328
1952	471,077	858,092	320,131	504,817	791,208	1,362,909

TABLE 3.—Iodine, iodide, and iodates exported from the United States, 1943–47 (average) and 1948–52

[U. S. Department of Commerce]

Year	Pounds	Value	Year	Pounds	Value
1943–47 (average)	332,443	$552,640	1950	456,847	$784,578
1948	271,459	550,493	1951	320,165	612,556
1949	268,925	501,055	1952	120,789	264,952

TECHNOLOGY

Evidence of the extensive research that has been done on various aspects of iodine may be found in the comprehensive bibliographies on the subject appearing in Iodine Abstracts and Reviews, published regularly by the Chilean Iodine Educational Bureau, Inc., 120 Broadway, New York, N. Y.

[4] Chilean Iodine Educational Bureau, Iodine Pharmaceuticals: London, 1952, 78 pp.
[5] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

Many iodine compounds and radioactive isotopes are potentially useful for their physiological activity and as diagnostic tools.

The latest edition of the United States Pharmacopoeia describes tincture of iodine as consisting of 1.8–2.2 grams resublimed iodine and 2.1–2.6 grams sodium iodide dissolved in 100 cc. alcohol. However, previous editions specified 7 percent each of resublimed iodine and sodium iodide and still earlier editions 10 percent each. The reduction in the concentration of iodine was recommended because of the possibility of tissue damage with the higher concentrations. The use of iodine as a local antiseptic has been declining in favor of various antibiotics sprinkled into wounds. However, it has been claimed recently that new combinations of iodine with surface active agents enhance the halogen's germicidal activity and reduce its toxicity.[6]

A new compound containing about 67 percent by weight of iodine reportedly has given good results in making gall bladders visible in X-ray pictures. It was claimed that this material was 35 percent more opaque than other material used heretofore, with less nausea and other distress.[7]

The results of tests on the use of radioactive iodine compounds in localizing brain tumors was reported. The results obtained were said to be merely indicative of an area in the brain in which the tumor is located.[8]

The results of tests on the effectiveness of iodine as a germicide and its toxicity was outlined in a paper. Although it is an effective germicide, iodine has properties and characteristics that confine its scope of application. Among the principal limitations is the fact that iodine is both a strong primary irritant and sensitizer and it does not distinguish between bacterial and mammalian protein. The relatively high toxicity of iodine also limits its applications in certain fields. Furthermore, numerous organic and inorganic agents have been reported as being capable of neutralizing the effect of iodine. In combination with carriers, the properties of iodine are modified. A mixture of iodine and a carrier is sometimes called a "halophor" or "iodophor." The carrier is a compound that greatly increases the solubility and tends to improve its germicidal activity.[9]

A number of new processes involving iodine are being developed. For example, a new method for producing pure rare earths was described. The process involves reducing the anhydrous rare-earth chlorides with calcium in a refractory oxide-lined container. Iodine is added to the mixture and by its exothermic reaction with calcium raises the temperature and gives a well-fused mass of the product metal. The formation of calcium iodide gives a low-melting slag. Remelting in a vacuum removes all but a trace of calcium from the metal. Quantities of lanthanum, cerium, praseodymium, and neodymium have been produced in this manner, all with purities greater than 99.7 percent.[10]

A patent was issued on a method of converting titanium dioxide to titanium tetraiodide which comprises subjecting titanium dioxide to

---

[6] Chemical Week, Iodine Tamed: Vol. 69, No. 25, Dec. 22, 1951, pp. 19–20.
[7] Science News Letter, vol. 61, No. 12, Mar. 22, 1952, p. 184.
[8] Chou, Shelley N., Moore, George E., and Marvin, James F., Localization of Brain Tumors With Radio Iodide: Science, vol. 115, No. 2979, Feb. 1, 1952, pp. 119–120.
[9] Terry, Dr. D. H., and Shelansky, Dr. Herman, Iodine as a Germicide, Part I: Modern Sanitation, vol. 1, No. 1, January 1952, pp. 61–65: Part 2, vol. 4, No. 2, February 1952, pp. 61–64.
[10] Spedding, F. H.. Wilhelm, H. A., Keller, W. H., Ahmann, D. H., Doane, A. H., Hach, C. C., and Ericson, R. P., Production of Pure Rare-Earth Metals: Ind. Eng. Chem., vol. 44, No. 3, March 1952, pp. 553–556.

a reducing agent passing iodine vapor over the reduced oxide in a reaction zone maintained at a temperature of at least 500° C.; condensing the resulting titanium tetraiodide; and separating it from unreacted iodine vapor.[11]

The Commission on Atomic Weights of the International Union of Pure and Applied Chemistry at its meeting in New York in September 1951 adopted a change in the atomic weight of iodine. The previous value 126.92 was adopted in 1933 to replace 126.932. Recent measurements of iodine were said to yield 126.911 for the atomic weight of iodine, with an estimated uncertainty of 1 in the third decimal place. This and other evidence led the commission to accept 126.91 as the present best value.[12]

WORLD REVIEW

The growing importance of Japan as a supplier of iodine to the United States makes the following review of the Japanese iodine industry timely.[13]

Commercial production of iodine in Japan was begun in 1888, when a small company in Tokyo was organized to extract it from seaweed. By 1916 Japan was the leading producer and exporter of seaweed iodine; after World War I, however, Chile succeeded in capturing the world market and concluded an agreement with Japan in 1937 whereby the exports of iodine from the latter were restricted to 25 metric tons per year. In 1934 the Mikasa Shokai K.K. (now known as the Aioi Industrial Co., Ltd.) was established for the production of iodine from brine. The output of brine iodine increased steadily until the last half of World War II. Production of seaweed iodine virtually ceased until the advent of the war, inasmuch as it is a byproduct in the manufacture of potassium chloride from seaweed. Japanese producers of the latter could not compete successfully against foreign producers until shortly before the war, when the Government revived the industry by affording it special protection in the interest of national self-sufficiency.

Because of the urgent military and civilian need for resublimed iodine for medicine, total production of iodine rose to 150 metric tons in 1943 and 1944, and several new firms entered the field. In 1948 the importation of potassium chloride was resumed at prices substantially below the domestic price, with the result that local production of that chemical declined; consequently, seaweed iodine is no longer being produced in Japan. The output of brine iodine declined after 1943, mainly owing to a postwar decrease in domestic demand until 1948, when the first postwar exports of iodine were made. From 1948 to 1952 the total annual production of this commodity has increased 600 percent; production of brine iodine alone has risen over 800 percent. The estimated output for the Japanese fiscal year 1952 (ended March 31, 1953) is 300 metric tons, and the goal for 1953 is 400 metric tons. Only 6 firms produce iodine in significant quantities; their combined operable capacity is approximately 29 metric tons per month, of which 1 company, Aioi Industrial Co., Ltd., has about 60 percent.

[11] Reimert, Lawrence J. (assigned to the New Jersey Zinc Co.), Production of Titanium Tetraiodide: U. S. Patent 2,616,784, Nov. 4, 1952.
[12] Wichers, Edward, Report of the Committee on Atomic Weights of the American Chemical Society: Jour. Am. Chem. Soc., vol. 74, No. 10, May 24, 1952, pp. 2447–2448.
[13] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 4, April 1953, pp. 31–38.

TABLE 4.—Production and exports of iodine in Japan, 1930–52, in pounds

[Ministry of International Trade and Industry]

	Production			
	Brine iodine	Seaweed iodine	Total	Exports [1]
Calendar Year				
1930	----------	206,803	206,803	99,647
1931	----------	220,052	220,052	171,959
1932	----------	113,632	113,632	211,201
1933	----------	67,917	67,917	88,845
1934	----------	52,902	52,902	49,604
1935	32,540	44,279	76,819	16,094
1936	40,476	----------	40,476	9,985
1937	69,974	----------	69,974	6,422
1938	85,381	----------	85,381	(2)
1939	97,620	----------	97,620	(2)
1940	117,274	----------	117,274	(2)
1941	129,457	17,857	147,314	(2)
1942	160,054	58,179	218,233	(2)
1943	167,274	164,536	331,810	----------
1944	132,038	208,313	340,351	----------
1945	79,584	107,496	187,080	----------
Fiscal year [3]				
1946	81,850	34,722	116,572	----------
1947	80,615	17,593	98,208	----------
1948	84,123	27,891	112,014	154,531
1949	182,662	44,577	227,239	202,675
1950	302,861	8,091	310,952	232,870
1951	501,434	1,715	503,149	325,225
1952 (est.)	661,380	----------	661,380	540,127

[1] Export figures, except 1950, include crude and refined iodine and potassium iodide in iodine equivalents.
[2] Records not available.
[3] Japanese fiscal year, Apr. 1 to Mar. 31.

TABLE 5.—Japan's principal producers of iodine

[Ministry of International Trade and Industry]

Name	Location of main office	Number and location of plants	Operative production capacity per month (metric tons)
Aioi Kogyo K. K. (Aioi Industrial Co., Ltd.)	Tokyo	2; Chiba	17
Nippo Kohatsu K. K. (Nipp Development Co., Ltd.)	do	1; Chiba	3
Nippon Ten-nen Gas Kogyo K. K. (Nippon Natural Gas Industry Co., Ltd.)	do	do	4
Ise Kagaku Kogyo K. K. (Ise Chemical Industry Co., Ltd.)	do	do	4
Chiba Yodo K. K. (Chiba Iodine K. K.)	do	do	0.5
Daiichi Yakuhin Kogyo K. K	Niigata	1; Niigata	.3
Total			29

These producers are small, independent concerns usually engaged exclusively in producing iodine. Frequently there is a close association between the producer and the exporter, with long-term loans extended by the latter in exchange for favorable terms of sale.

The industry is represented by the Brine Iodine Association (Kansui Yodo Kyokai), Saiwai Building, No. 3, Uchisaiwaicho 2-chome, Chiyoda-ku, Tokyo.

With the exception of Daiichi Pharmaceutical Co., Ltd., Niigata Prefecture, which produces iodine as a byproduct in the manufacture of natural gas and has the smallest output of the established producers, the manufacturers of iodine are on the Chiba Peninsula east of Tokyo in an area where three strata contain brine and natural gas. The brine content of these strata is estimated at about 25 percent, and originally 1 liter of brine contained 90 to 140 milligrams of iodine. However, after wells have been operated for several years in areas where layers above the brine are permeable, water dilutes the brine and greatly reduces its iodine content. In other cases, after an area has been exploited for some time the brine content of the strata decreases. It has been found that wells in the northern half of the sector are less subject to these deteriorating factors than those in the southern part of the region, where the average lifetime is only 4 to 5 years.

The 3 strata vary in thickness from 190 to 500 meters and have an estimated combined brine content of 5.01 cubic kilometers or an iodine content of 483,000 metric tons, of which approximately 101,400 tons can be extracted.

Data on iodine resources

[Ministry of International Trade and Industry]

a. Districts:
- Northern area—Mobara to Seki-mara 140° 20′–35° 25′
- Western area—Mobara to Otaki 140° 15′–35° 20′
- Southern area—Fumoto mura—Kuniyoshi—Shikiyado 140° 20′–35° 15′
- Eastern area—Beach 140° 25′–35° 10′–25′

b. Stratum:
- Umegase—Northern and northwestern areas
- Otashiro—Western and southern areas
- Kiwada—Southern and southeastern areas

c. Average iodine content: 96.4 milligrams per liter

d. Average brine percentage contained in strata: 25

e. Brine amount and iodine content:

Stratum	*Thickness, (m.)*	*Volume (cu. km.)*	*Average percent of brine*	*Average percent of sand in stratum*	*Quantity of brine (cu. km.)*
Umegase	330	8. 7	25	48	1. 05
Otashiro	190	20. 6	25	31	1. 60
Kiwada	500 or more	45. 0	25	21	2. 36
					5. 01

Total iodine content: 5.01 cu. km.×96.4 mg. per liter—482,964 metric tons.

f. Potential production:

483,000 metric tons	Total iodine content of brine.
30 percent	Estimated producible percentage of brine.
×70 percent	Productive percentage of iodine from brine.
101,430 metric tons	Quantity of producible iodine.

Most producers operate their own wells and pump the brine and natural-gas solution to a nearby plant, where the iodine is extracted by 1 of 3 processes—the copper method, the active carbon method, or electrolysis. Aioi Industrial Co., Ltd., employs the copper method, for which it has exclusive rights in Japan, while Nippo Kohatsu has received license rights on the active carbon process. Most of the other firms produce iodine by electrolysis.

In each case the natural gas is separated from the brine at the beginning of the process and later used as fuel to sublimate the iodine in the final stages.

The purity of the iodine produced generally is 99.0 to 99.9 percent.

Since the Japanese satisfy their physiological requirements for iodine through seaweed, which is a part of their diet, there is no domestic market for iodine-enriched food, salt, or tablets, and the principal uses for iodine in Japan are in the pharmaceutical, photographic, and dyestuffs industries. Although domestic consumption has increased steadily in the last 5 years, it has not paced the rise in exports and absorbs less than 25 percent of production. The Ministry of International Trade and Industry (MITI) has no actual statistics but estimates domestic consumption during the last 5 years as follows: 1948, 12 metric tons; 1949, 25; 1950, 35; 1951, 35 to 40; 1952, 50.

TABLE 6.—Postwar exports of crude iodine, by destination, from Japan, 1948–52,[1] in metric tons

[Ministry of International Trade and Industry]

Country of destination	1948	1949	1950	1951	1952 (Apr.-Dec.) (est.)
United States	56.6	69.1	9.0	86.3	107.9
United Kingdom		3.0	0	12.0	57.5
India	1.0	0	0	1.5	5.2
Sweden				4.1	3.8
Germany		5.9	13.0	10.6	3.6
Netherlands		.5	.3	0	1.0
Switzerland	5.5	0	0	9.0	1.0
Cuba		6.1	[2] 41.0	[2] 10.0	.2
Mexico			7.0		.2
Canada			[2] 6.0	[2] 11.0	
Formosa				.5	
South Africa			.04	.5	
Italy		1.0	8.1		
Argentina		2.0	7.1	0	0
Belgium			4.0		
Venezuela		.3	0	0	0
Total	63.1	87.9	95.6	145.5	180.4

[1] Japanese fiscal year, Apr. 1 to Mar. 31.
[2] Through United States firms.

Japanese producers estimate that Japan could export 500 to 600 metric tons annually.

The exportation of iodine is handled by a small number of Japanese and foreign trading firms. The principal exporters and the firms they have represented are as follows:

Exporter:	*Manufacturer*
Daiichi Bussan Kaisha, Ltd	Nippon Tennen Gas Kogye K. K. (Japan Natural Gas Industry Co., Ltd.).
Takeda Yakuhin Kogyo K. K. (Takeda Pharmaceutical Industries, Ltd.).	Nippo Kohatsu K. K.
Sogo Boeki K. K	Aioi Kogyo K. K.
Hakuyo Boeki K. K. (Haykuyo Trading Co., Ltd.).	Do
Bunge Far East Agencies, Inc., 2 Marunouchi 2-chome Chiyoda-ku Tokyo.	Do
Felix Kramarsky Corp., Fukoku Bldg., Chiyoda-ku Tokyo.	Aioi Kogyo K. K., Nippon Tennen Gas Kogyo K. K., Ise Kagaku Kogyo K. K.

Bunge Far East Agencies, Inc., exports to the sterling area through Hakuyo Boeki K. K.; and Felix Kramarsky Corp., probably the largest purchaser of Japanese iodine, exports exclusively to the United States, where the main office of the firm is located.

Since iodine is predominantly an export industry, its future growth depends upon long-term overseas demand. The immediate problem, however, is to raise production to meet current requirements.

Iron Ore

By Jachin M. Forbes [1]

UNITED STATES iron mines, as an integral part of the iron and steel industry, were idle during 2 months of 1952. The major steel strike of June and July cut iron-ore production for 1952 to 84 percent of 1951 output and threatened winter ore supplies of furnaces dependent upon the Lake Superior region. However, new shipping capacity on the Great Lakes, together with emergency all-rail shipments to the lower Lakes area, succeeded in building stocks capable of supplying substantially increased requirements during the closed season for navigation on the Great Lakes.

Development of two major foreign sources of new supply in Canada and Venezuela proceeded during 1952 with good prospects for initial shipments as scheduled. The railroad from Quebec-Labrador deposits to Seven Islands on the Gulf of St. Lawrence was expected to be completed in time to begin operations in the summer of 1954, with large-scale shipments expected in 1955. Similarly, Cerro Bolivar in Venezuela is to be served by rail and river facilities which are being rushed to completion in time for shipments in 1955.

The St. Lawrence Seaway was debated in 1952, with increasing emphasis on its importance to United States iron-ore supply. Hearings before the Senate Foreign Relations Committee in February led to debate on the Senate floor in June. However, legislation authorizing United States participation did not gain approval.

TABLE 1.—Salient statistics of iron ore in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Iron ore (usable; [1] less than 5 percent Mn):						
Production by districts:						
Lake Superior gross tons	75,059,061	82,630,430	68,494,123	79,627,294	93,946,990	77,094,762
Southeastern do	7,140,963	8,365,390	7,601,822	7,507,508	8,587,408	7,623,779
Northeastern do	3,504,132	4,422,971	3,863,833	4,474,834	5,180,959	4,426,378
Western do	3,268,659	5,104,703	4,441,671	5,860,755	8,181,465	8,030,331
Undistributed (by product ore) gross tons	562,498	479,998	535,998	574,969	[2] 607,850	[2] 742,754
Total do	89,535,313	101,003,492	84,937,447	98,045,360	116,504,672	97,918,004
Production by types of product:						
Direct gross tons	69,199,811	76,882,338	63,970,016	70,309,322	85,281,923	70,358,493
Concentrates	16,388,241	19,055,357	16,412,639	22,810,818	25,708,840	22,037,106
Sinter gross tons	3,384,763	4,585,799	4,018,794	4,350,251	4,945,278	4,918,264

For footnotes, see end of table.

[1] Commodity-industry analyst.

TABLE 1.—Salient statistics of iron ore in the United States, 1943–47 (average) and 1948–52—Continued

	1943–47 (average)	1948	1949	1950	1951	1952
Iron ore (usable);[1] less than 5 percent Mn)—Con.						
Production by types of product—Continued						
Byproduct material (pyrites cinder and sinter) gross tons	562,498	479,998	535,998	574,969	568,631	604,141
Total do	89,535,313	101,003,492	84,937,447	98,045,360	116,504,672	97,918,004
Production by types of ore:						
Hematite gross tons	82,540,645	90,686,138	76,262,577	87,156,235	101,530,954	83,515,561
Brown ore do	1,135,344	2,176,149	1,545,595	2,615,402	3,014,761	2,729,524
Magnetite do	5,296,332	7,661,207	6,593,277	7,698,754	11,390,326	11,068,778
Byproduct material (pyrites cinder and sinter) gross tons	562,498	479,998	535,998	574,969	568,631	604,141
Total do	[3] 89,535,313	101,003,492	84,937,447	98,045,360	116,504,672	97,918,004
Shipments do	89,228,057	100,821,714	84,687,275	97,764,410	116,230,052	97,972,584
Value	$261,106,890	$394,460,751	$381,515,831	$487,990,404	$634,728,583	$596,306,850
Average value per ton at mine	$2.94	$3.91	$4.50	$4.99	$5.46	$6.09
Stocks at mines Dec. 31 gross tons	5,022,705	6,284,773	5,333,660	5,725,569	5,599,466	5,528,295
Imports do	1,936,726	6,091,677	7,391,291	8,281,237	[4] 10,139,678	9,760,625
Value	$8,063,739	$27,271,681	$36,707,534	$43,968,426	[4] $59,520,046	$83,040,614
Exports gross tons	2,192,664	3,080,666	2,424,775	2,550,738	[4] 4,328,910	5,121,242
Value	$7,494,764	$13,744,979	$14,653,817	$15,716,509	[4] $30,996,784	$37,420,615
Consumption gross tons	90,969,666	100,498,557	89,218,498	106,610,273	114,837,112	100,640,636
Manganese-bearing ore (5 to 35 percent Mn):						
Shipments gross tons	1,263,904	1,196,933	962,853	971,069	1,092,825	900,909
Value	$3,693,105	(5)	$4,040,155	$4,609,432	$5,385,986	$5,020,419

[1] Direct-shipping ore, washed ore, concentrates, sinter, and byproduct pyrites cinder and sinter.
[2] Includes Puerto Rican ore—39,219 tons in 1951 and 138,613 tons in 1952.
[3] Includes 494 tons carbonate ore (siderite).
[4] Revised figure.
[5] Bureau of Mines not at liberty to publish figure.

DOMESTIC PRODUCTION

The rate of iron-ore production in 1952 reached record levels, notwithstanding a 16-percent decrease in the total output as compared with 1951. Shipments were adequate to supply furnaces operating at over 100-percent capacity during much of the year. In September, mine shipments reached 16,300,506 gross tons; if this total had been shipped in each of the strike-bound months (June and July), the annual total could have reached 126 million tons. This much iron ore would not have been needed if there had been no strike, but the figure illustrates the improved transportation capacity resulting from recent additions to the ore-carrier fleet.

Crude-ore (mine product before any treatment to eliminate waste constituents) production decreased 16 percent from 1951, as did the usable ore. Nearly four-fifths of the crude ore was hematite, with magnetite and brown ore constituting 13.4 percent and 7.8 percent, respectively. Similarly, about four-fifths of the crude ore was extracted by open-pit methods, and only 21.9 percent came from underground mines. Trends with respect to types of ore and mining methods were obscured in 1952 because strike effects were more evident in the Lake Superior district. Shipments of crude ore in-

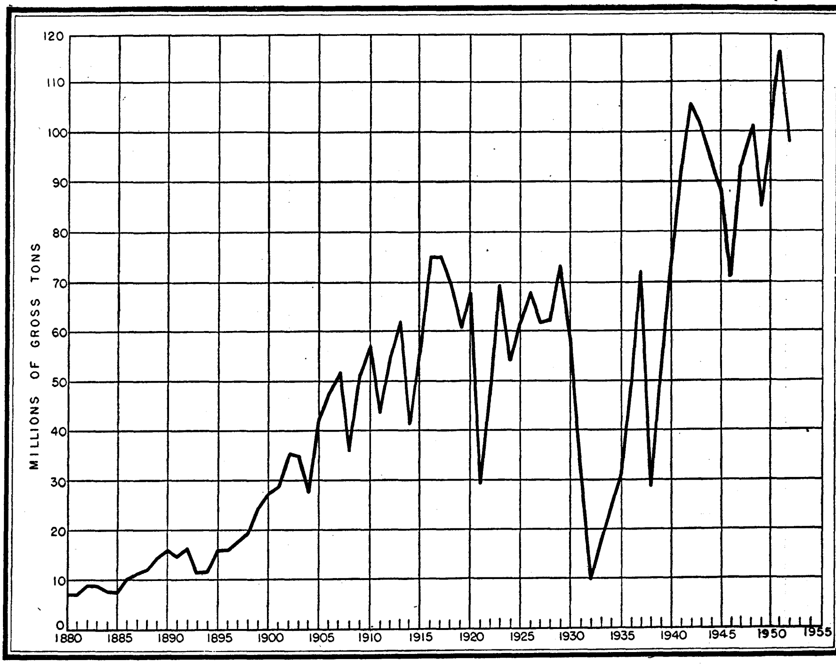

FIGURE 1.—Production of iron ore in the United States, 1880–1952.

cluded 70,351,028 gross tons (54.8 percent of the total), which proceeded to consumers without treatment other than sizing and separation as to various grades. The remaining 45.2 percent went to beneficiation plants, where it was processed by means of log washers, jigs, Wilfley tables, heavy-medium separators, cyclones, Humphreys spirals, and magnetic separators. Some of the concentrates were sintered, and increasing quantities were nodulized and pelletized.

Among the 18 States and Puerto Rico, which supplied the domestic production of crude ore in 1952, Minnesota led with 63 percent of the total. Michigan and Alabama supplied 9 percent each. However, Michigan's tonnage was slightly higher and was virtually all direct-shipping ore, as compared with Alabama's total, which included a substantial tonnage of clay washed from crude brown ore. New York was fourth largest producer with 6 percent and Utah fifth with 3 percent. Here again the percentages apply only to crude ore, inasmuch as nearly all New York's production was for beneficiating plants and all of Utah's production went direct to consumers.

The remaining 10 percent came from 13 States and Puerto Rico. Of these, Texas produced over 2 million tons; California, Georgia, New Jersey, Pennsylvania, and Wisconsin produced over 1 million tons each; and other sources ranged from 600 to 912,084 each. Tables 2 and 3 list crude-ore production by States, varieties, and mining methods. Table 4 shows mine shipments of crude ore to beneficiating plants and consumers, by States. Table 5 lists production of both crude and usable ore by mining districts and types of ore.

342070—55——33

TABLE 2.—Crude iron ore mined in the United States, 1951–52, by States and varieties, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

State	1951 Number of mines	1951 Hematite	1951 Brown ore	1951 Magnetite	1951 Total	1951 Rank	1952 Number of mines	1952 Hematite	1952 Brown ore	1952 Magnetite	1952 Total	1952 Rank
Alabama	[1] 44	7,444,467	5,064,950		12,509,417	3	[1] 40	6,273,538	4,970,934		11,244,472	3
Arkansas	2			6,047	6,047	19	1			600	600	18
California	2			[2] 1,198,847	1,198,847	10	3			[2] 1,516,373	1,516,373	9
Georgia	[1] 12		1,783,520		1,783,520	8	[1] 13	200	1,687,332		1,687,532	7
Michigan	39	13,918,614			13,918,614	2	41	11,994,915			11,994,915	2
Minnesota	146	98,824,060	641,846	703,953	100,169,859	1	171	80,163,188	677,171	602,394	81,442,753	1
Missouri	[1] 6	518,221	85,400		603,621	13	[1] 5	580,648	177,700		758,348	13
Nevada	5	258,205		73,122	331,327	14	12	169,332		742,752	912,084	12
New Jersey	4			1,166,495	1,166,495	11	5			1,318,599	1,318,599	11
New Mexico	3			32,210	32,210	17	5			7,793	7,793	17
New York	7	(3)		[3] 7,741,434	7,741,434	4	6	(3)		[3] 7,267,202	7,267,202	4
Pennsylvania	1			1,878,743	1,878,743	7	1			1,596,191	1,596,191	8
Tennessee	3	2,000	177,000		179,000	15	3	47	[4] 46,197		[4] 46,244	16
Texas	4		3,447,275		3,447,275	6	4		2,417,864		2,417,864	6
Utah	6			[2] 4,726,159	4,726,159	5	6			[2] 4,060,003	4,060,003	5
Virginia	1		7,753		7,753	18	1		(4)		(4)	
Wisconsin	2	1,757,234			1,757,234	9	2	1,495,109			1,495,109	10
Wyoming	1	616,949			616,949	12	1	484,945			484,945	14
Puerto Rico	1			39,219	39,219	16	1			138,613	138,613	15
Total	289	[3] 123,339,750	11,207,744	[3] 17,566,229	152,113,723		321	[3] 101,161,922	9,977,198	[3] 17,250,520	128,389,640	
Percent of total		81.1	7.4	11.5	100.0			78.8	7.8	13.4	100.0	

[1] Excludes an undetermined number of small pits. Output of these pits included in tonnage given.
[2] Semialtered magnetite containing varying proportions of hematite.
[3] Includes small tonnage of hematite for nonmetallurgical use.
[4] Small tonnage mined in Virginia included with Tennessee.

TABLE 3.—Crude iron ore mined in the United States, 1951–52, by States and mining methods, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

State	1951			1952		
	Open pit	Underground	Total	Open pit	Underground	Total
Alabama	5,423,623	7,085,794	12,509,417	5,263,769	5,980,703	11,244,472
Arkansas		6,047	6,047		600	600
California	1,198,847		1,198,847	1,516,373		1,516,373
Georgia	1,783,520		1,783,520	1,687,532		1,687,532
Michigan	1,085,662	12,832,952	13,918,614	1,038,261	10,956,654	11,994,915
Minnesota	96,431,377	3,738,482	100,169,859	77,789,725	3,653,028	81,442,753
Missouri	506,161	97,460	603,621	389,806	368,542	758,348
Nevada	331,327		331,327	912,084		912,084
New Jersey		1,166,495	1,166,495		1,318,599	1,318,599
New Mexico	32,210		32,210	7,793		7,793
New York	4,310,190	3,431,244	7,741,434	4,375,790	2,891,412	7,267,202
Pennsylvania	659,537	1,219,206	1,878,743	564,696	1,031,495	1,596,191
Tennessee	179,000		179,000	[1] 46,244		[1] 46,244
Texas	3,447,275		3,447,275	2,417,864		2,417,864
Utah	4,726,159		4,726,159	4,060,003		4,060,003
Virginia	7,753		7,753	(1)		(1)
Wisconsin		1,757,234	1,757,234		1,495,109	1,495,109
Wyoming		616,949	616,949		484,945	484,945
Puerto Rico	39,219		39,219	138,613		138,613
Total	120,161,860	31,951,863	152,113,723	100,208,553	28,181,087	128,389,640
Percent of total	79.0	21.0	100.0	78.1	21.9	100.0

[1] Small tonnage mined in Virginia included with Tennessee.

TABLE 4.—Crude iron ore shipped from mines in the United States, 1951–52, by States and disposition, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

State	1951			1952		
	Direct to consumers	To beneficiation plants	Total	Direct to consumers	To beneficiation plants	Total
Alabama	6,200,469	6,303,185	12,503,654	5,089,437	6,156,421	11,245,858
Arkansas	47	6,000	6,047		600	600
California	1,182,799		1,182,799	1,463,239		1,463,239
Georgia		1,783,520	1,783,520	38,221	1,649,311	1,687,532
Michigan	13,533,359	292,975	13,826,334	11,710,737	253,599	11,964,336
Minnesota	56,394,129	43,972,058	100,366,187	44,798,372	36,812,301	81,610,673
Missouri	2,500	601,011	603,511		758,348	758,348
Nevada	299,010		299,010	911,657		911,657
New Jersey	193,143	989,544	1,182,687	166,962	1,147,862	1,314,824
New Mexico	32,210		32,210	7,793		7,793
New York	112,686	7,633,037	7,745,723	58,473	7,206,929	7,265,402
Pennsylvania		1,876,904	1,876,904		1,595,256	1,595,256
Tennessee		179,000	179,000	[1] 6,229	39,900	[1] 46,129
Texas		3,447,275	3,447,275		2,417,864	2,417,864
Utah	4,637,239		4,637,239	3,990,505		3,990,505
Virginia	7,248		7,248	(1)		(1)
Wisconsin	1,745,120		1,745,120	1,485,845		1,485,845
Wyoming	616,949		616,949	484,945		484,945
Puerto Rico	39,219		39,219	138,613		138,613
Total	84,996,127	67,084,509	152,080,636	70,351,028	58,038,391	128,389,419
Percent of total	55.9	44.1	100.0	54.8	45.2	100.0

[1] Small tonnage mined in Virginia included with Tennessee.

TABLE 5.—Iron ore mined in the United States, 1951–52, by mining districts and varieties, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

Variety of ore	Lake Superior district	Southeastern States	Northeastern States	Western States	Total
1951					
Crude ore:					
Hematite	114,499,908	7,446,467	(1)	1,393,375	[1] 123,339,750
Brown ore	[2] 641,846	7,033,223		3,532,675	11,207,744
Magnetite	703,953		[1] 10,786,672	6,036,385	[1 3] 17,566,229
Total	115,845,707	14,479,690	10,786,672	10,962,435	[3] 152,113,723
Usable iron ore:					
Hematite	93,356,118	7,144,625	(1)	1,030,211	[1] 101,530,954
Brown ore	[2] 452,405	1,442,783		1,119,573	3,014,761
Magnetite	138,467		[1] 5,180,959	6,031,681	[1 3] 11,390,326
Total	93,946,990	8,587,408	5,180,959	8,181,465	[3] 115,936,041
1952					
Crude ore:					
Hematite	93,653,212	6,273,785	(1)	1,234,925	[1] 101,161,922
Brown ore	[2] 677,171	6,704,463		2,595,564	9,977,198
Magnetite	602,394		[1] 10,181,992	6,327,521	[1 3] 17,250,520
Total	94,932,777	12,978,248	10,181,992	10,158,010	[3] 128,389,640
Usable iron ore:					
Hematite	76,441,769	6,186,910	(1)	886,882	[1] 83,515,561
Brown ore	[2] 476,242	1,436,869		816,413	2,729,524
Magnetite	176,751		[1] 4,426,378	6,327,036	[1 3] 11,068,778
Total	77,094,762	7,623,779	4,426,378	8,030,331	[3] 97,313,863

[1] Small tonnage of hematite included with magnetite to avoid disclosure of individual company operations.
[2] Produced in Fillmore County, Minn.; not in the true Lake Superior district.
[3] Total includes Puerto Rican ore; 39,219 tons in 1951 and 138,613 tons in 1952.

Usable ore (from mines and beneficiating plants) production and shipments in 1952 approximated the totals of 1950 when no serious work stoppages hampered operations. The strike in 1952 occurred during June and July, at the peak of the operating season; yet, notwithstanding the time factor, shipments for the year decreased only 16 percent below 1951 and reflected great credit on mine operators and transportation firms. Hematite constituted 85 percent, magnetite 11 percent, brown ore 3 percent, and byproduct ore (obtained as a residue of burned pyrites) 1 percent of all usable iron ore produced. Direct-shipping grades accounted for 72 percent of the total, while the 58,038,391 tons of crude ore shipped to beneficiating plants resulted in 22,037,106 tons of concentrates and 4,918,264 tons of sinter. Concentrates and sinter, together with 604,141 tons of byproduct ore, made up the beneficiated-iron-ore supply from domestic sources and 28 percent of all domestic production.

The Lake Superior district supplied 79.2 percent of all usable ore (excluding byproduct ore) in 1952 compared with 81.0 percent in 1951 and 81.7 percent in 1950. However, the trend indicated by these percentages was accentuated in 1952 because many mines in other districts continued to operate during the strike period. Western States, with the assistance of substantial export trade as well as important strike-free production, displaced Southeastern States as the second largest producing district. The percentage was 8.3 percent

TABLE 6.—Iron ore produced in the United States, 1951–52, by States and types of product, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

State	1951					1952				
	Direct-shipping ore	Sinter [1]	Concentrates	Total	Iron content natural (percent)	Direct-shipping ore	Sinter [1]	Concentrates	Total	Iron content natural (percent)
Mined ore:										
Alabama	6,194,253	949,902	1,041,838	8,185,993	37.48	5,084,612	990,896	1,164,840	7,240,348	37.76
Arkansas	47		1,296	1,343	54.36			115	115	52.17
California	1,198,847			1,198,847	53.35	1,516,373			1,516,373	56.16
Georgia			357,754	357,754	39.57	38,221		331,038	369,259	41.53
Michigan	13,625,639		78,262	13,703,901	54.13	11,741,316		68,629	11,809,945	51.06
Minnesota	56,444,522	194,971	21,846,362	78,485,855	50.53	44,628,318	781,459	18,379,931	63,789,708	50.16
Missouri	2,610		169,966	172,576	51.27			268,218	268,218	51.57
Nevada	331,327			331,327	56.19	912,084			912,084	59.44
New Jersey	193,417		465,328	658,745	62.60	177,232		529,723	706,955	62.38
New Mexico	32,210			32,210	53.15	7,793			7,793	56.38
New York	111,737	2,951,834	240,814	3,304,385	62.12	67,645	2,367,693	293,878	2,729,216	62.49
Pennsylvania		756,578	461,251	1,217,829	58.56		641,020	349,187	990,207	58.03
Tennessee			35,908	35,908	39.02	[2] 6,229		7,943	[2] 14,172	41.39
Texas		91,993	1,010,061	1,102,054	46.46		137,196	643,604	780,800	45.41
Utah	4,726,159			4,726,159	55.60	4,060,003			4,060,003	53.97
Virginia	7,753			7,753	33.54	(2)			(2)	
Wisconsin	1,757,234			1,757,234	52.58	1,495,109			1,495,109	52.81
Wyoming	616,949			616,949	48.30	484,945			484,945	48.20
Puerto Rico	39,219			39,219	58.00	138,613			138,613	58.00
Total mined ore	85,281,923	4,945,278	25,708,840	115,936,041	50.71	70,358,493	4,918,264	22,037,106	97,313,863	50.17
Byproduct ore: [3]										
Colorado, Michigan, Delaware, Tennessee, Virginia		568,631		568,631	66.17		604,141		604,141	66.39
Grand total	85,281,923	5,513,909	25,708,840	116,504,672	50.79	70,358,493	5,522,405	22,037,106	97,918,004	50.27

[1] Exclusive of sinter produced at consuming plants.
[2] Small tonnage mined in Virginia included with Tennessee.
[3] Cinder and sinter obtained from pyrites treated in, but not necessarily mined in, States indicated.

in 1952 as compared with 7.8 percent for Southeastern States. Northeastern States output closely approximated last year's percentage of usable ore.

Minnesota continues preeminent among the iron-ore-producing States and in 1952 supplied 66 percent of the total. Michigan produced 12, Alabama 7, Utah 4, and New York 3 percent. All other States produced less than 2 million tons each and together supplied 8 percent of the total.

The iron content of usable products averaged 50.27 percent and ranged from an average of 37.76 percent in Alabama to 62.49 in New York. Northeastern States produced mainly high-iron-content concentrates and sinter, Western States supplied high-iron-content direct-shipping ore, and Lake Superior ore was close to the United States average.

TABLE 7.—Iron ore produced in the United States, 1951–52, by States and varieties, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

State	1951				1952			
	Hematite	Brown ore	Magnetite	Total	Hematite	Brown ore	Magnetite	Total
Alabama	7,144,155	1,041,838		8,185,993	6,186,663	1,053,685		7,240,348
Arkansas			1,343	1,343			115	115
California			1,198,847	1,198,847			1,516,373	1,516,373
Georgia		357,754		357,754	200	369,059		369,259
Michigan	13,703,901			13,703,901	11,809,945			11,809,945
Minnesota	77,894,983	452,405	138,467	78,485,855	63,136,715	476,242	176,751	63,789,708
Missouri	155,057	17,519		172,576	232,605	35,613		268,218
Nevada	258,205		73,122	331,327	169,332		742,752	912,084
New Jersey			658,745	658,745			706,955	706,955
New Mexico			32,210	32,210			7,793	7,793
New York	(1)		[1] 3,304,385	[1] 3,304,385	(1)		[1] 2,729,216	[1] 2,729,216
Pennsylvania			1,217,829	1,217,829			990,207	990,207
Tennessee	470	35,438		35,908	47	[2] 14,125		[2] 14,172
Texas		1,102,054		1,102,054		780,800		780,800
Utah			4,726,159	4,726,159			4,060,003	4,060,003
Virginia		7,753		7,753		(2)		(2)
Wisconsin	1,757,234			1,757,234	1,495,109			1,495,109
Wyoming	616,949			616,949	484,945			484,945
Puerto Rico			39,219	39,219			138,613	138,613
Total	[1] 101,530,954	3,014,761	[1] 11,390,326	115,936,041	[1] 83,515,561	2,729,524	[1] 11,068,778	97,313,863
Byproduct ore: [3] Colorado, Michigan, Delaware, Tennessee, Virginia				568,631				604,141
Grand total	[1] 101,530,954	3,014,761	[1] 11,390,326	116,504,672	[1] 83,515,561	2,729,524	[1] 11,068,778	97,918,004

[1] Small tonnage of hematite included with magnetite to avoid disclosure of individual company operations.
[2] Small tonnage mined in Virginia included with Tennessee.
[3] Cinder and sinter obtained from pyrites treated in, but not necessarily mined in, States indicated.

TABLE 8.—Shipments of iron ore in the United States in 1952, by States and uses, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

State	Iron and Steel			Cement	Paint	Miscellaneous	Total	
	Direct shipping ore	Sinter [1]	Concentrates				Gross tons	Value
Mined ore:								
Alabama	5,089,347	993,914	1,159,863			90	7,243,214	$37,940,412
Arkansas			115				115	(2)
California	1,392,899			43,258		27,082	1,463,239	(2)
Georgia	38,221		281,738				319,959	1,439,251
Michigan	11,689,339		68,629		21,398		11,779,366	76,088,935
Minnesota	44,798,372	781,459	18,326,238				63,906,069	375,765,251
Missouri			268,169		49		268,218	(2)
Nevada	907,657					4,000	911,657	3,991,970
New Jersey	166,962		505,136	13,272	96		685,466	6,760,467
New Mexico	4,380			3,413			7,793	(2)
New York	58,473	2,364,811	433,822	11,146		[3] 28,279	2,896,531	34,514,879
Pennsylvania		641,137	350,973				992,110	(2)
Tennessee	47		7,943		[4] 6,182		[4] 14,172	108,923
Texas		137,267	646,877		3,049		787,193	(2)
Utah	3,989,679			826			3,990,505	15,025,899
Virginia					(4)		(4)	(4)
Wisconsin	1,485,845						1,485,845	(2)
Wyoming	484,945						484,945	(2)
Puerto Rico	138,613						138,613	(2)
Undistributed								39,508,008
Total	70,244,779	4,918,588	22,049,503	71,915	30,774	59,451	97,375,010	591,143,995
Byproduct ore: [5]								
Delaware, Tennessee, Virginia		597,574					597,574	5,162,855
Grand total	70,244,779	5,516,162	22,049,503	71,915	30,774	59,451	97,972,584	596,306,850

[1] Exclusive of sinter produced at consuming plants.
[2] Values that may not be shown separately are combined as "Undistributed."
[3] Small tonnage used as earth pigments included with miscellaneous.
[4] Small tonnage mined in Virginia included with Tennessee.
[5] Cinder and sinter obtained from pyrites treated in, but not necessarily mined in, States indicated.

TABLE 9.—Iron ore mined in the United States in 1952, by States and counties, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

State and county	Active mines	Crude ore	Usable ore
Alabama:			
Blount	1	190,400	39,231
Butler	1		
Calhoun	8	388,700	81,372
Cherokee	3	115,000	22,925
Etowah	1	3,159,067	686,750
Franklin	8		
Jefferson	11	6,270,336	6,183,461
Marshall	1	12,159	5,018
St. Clair	1		
Shelby	2	104,000	20,660
Talladega	2	1,004,810	200,931
Tuscaloosa	1		
Total	[1] 40	11,244,472	7,240,348
Arkansas: Hot Spring	1	600	115
California:			
Riverside	1	1,471,465	1,471,465
San Bernardino	2	44,908	44,908
Total	3	1,516,373	1,516,373
Georgia:			
Bartow	5	863,332	203,537
Chattooga	1		
Floyd	1		
Polk	5	824,200	165,723
Walker	1		
Total	[1] 13	1,687,532	369,259
Michigan:			
Baraga	1	153,534	153,534
Dickinson	2		
Gogebic	9	3,155.892	2,972,930

For footnotes, see end of table.

TABLE 9.—Iron ore mined in the United States in 1952, by States and counties, in gross tons—Continued

[Exclusive of ore containing 5 percent or more manganese]

State and county	Active mines	Crude ore	Usable ore
Michigan—Con.			
Iron	15	4,076,446	4,074,438
Marquette	14	4,609,043	4,609,043
Total	41	11,994,915	11,809,945
Minnesota:			
Crow Wing	23	3,197,145	2,289,763
Fillmore	1	677,171	476,242
Itaska	38	24,819,537	12,361,400
Morrison	1		
St. Louis	108	52,748,900	48,662,303
Total	171	81,442,753	63,789,708
Missouri:			
Butler	2	175,000	35,077
Howell	1		
St. Francois	2	583,348	233,141
Total	[1] 5	758,348	268,218
Nevada:			
Churchill	1	725,875	725,875
Douglas	1		
Eureka	1		
Humboldt	1		
Lander	2		
Mineral	2		
Nye	1		
Pershing	3	186,209	186,209
Total	12	912,084	912,084
New Jersey:			
Morris	3	1,318,599	706,955
Passaic	1		
Warren	1		
Total	5	1,318,599	706,955
New Mexico:			
Grant	2	7,793	7,793
Lincoln	3		
Total	5	7,793	7,793
New York:			
Clinton	1	4,249,132	1,736,494
Essex	3		
Oneida	1	3,018,070	992,722
St. Lawrence	1		
Total	6	7,267,202	2,729,216
Pennsylvania: Lebanon	1	1,596,191	990,207
Tennessee:			
Bradley	1	[2] 46,244	[2] 14,172
Monroe	2		
Total	3	46,244	14,172
Texas:			
Cass	3	2,417,864	780,800
Morris	1		
Total	4	2,417,864	780,800
Utah: Iron	6	4,060,003	4,060,003
Virginia: Pulaski	1	(2)	(2)
Wisconsin: Iron	2	1,495,109	1,495,109
Wyoming: Platte	1	484,945	484,945
Puerto Rico	1	138,613	138,613
Grand total	321	128,389,640	97,313,863

[1] Excludes undetermined number of small pits. Estimated output of these mines included in tonnage given.
[2] Small tonnage mined in Virginia included with Tennessee.

TABLE 10.—Iron ore produced in the Lake Superior district, 1854–1952, by ranges, in gross tons

[Exclusive after 1905 of ore containing 5 percent or more manganese]

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Total
1854–1944	229,773,915	205,736,670	242,702,380	75,704,578	1,376,030,818	32,807,310	2,162,755,671
1945	4,664,816	4,140,239	4,395,653	1,481,007	58,355,320	1,784,010	74,821,045
1946	3,455,961	2,662,308	3,633,078	1,232,008	46,678,679	1,380,120	59,042,154
1947	5,070,631	3,741,217	5,227,005	1,471,879	58,772,404	2,100,846	76,383,982
1948	4,830,341	4,259,378	5,504,971	1,580,497	64,071,983	2,030,281	82,277,451
1949	4,392,732	3,483,375	4,756,474	1,381,327	52,551,346	1,826,711	68,391,965
1950	5,085,500	4,068,458	5,238,781	1,580,217	60,838,025	2,480,843	79,291,824
1951	5,617,935	4,864,831	4,978,369	1,806,818	73,574,908	2,651,724	93,494,585
1952	4,668,550	4,168,465	4,468,039	1,573,748	59,370,538	2,369,180	76,618,520
Total	267,560,381	237,124,941	280,904,750	87,812,079	1,850,244,021	49,431,025	2,773,077,197

TABLE 11.—Average analyses of total tonnages (bill-of-lading weights) of all grades of iron ore from all ranges of Lake Superior district, 1943–47 (average) and 1948–52

[Lake Superior Iron Ore Association]

Year	Gross tons	Content (natural), percent				
		Iron	Phosphorus	Silica	Manganese	Moisture
1943–47 (average)	75, 509, 600	51. 45	0. 089	8. 62	0. 76	11. 10
1948	82, 655, 757	50. 49	. 093	9. 30	. 76	11. 35
1949	68, 531, 664	50. 39	. 096	9. 72	. 78	11. 12
1950	79, 150, 079	50. 38	. 092	9. 85	. 77	11. 11
1951	93, 549, 414	50. 25	. 090	9. 87	. 77	11. 22
1952	77, 225, 818	50. 49	. 111	10. 05	. 77	10. 78

In table 8, values are shown for those States having over 3 producers and where the output of 1 producer does not predominate. These values are for ore at the mine before transportation costs.

Average analyses of Lake Superior ore shown in table 11 indicate that iron content improved slightly in 1952, while phosphorus and silica contents continued to rise. Moisture dropped slightly, and manganese remained at the level of the past 3 years.

In addition to the tonnages produced in 1952 from the Lake Superior iron ranges, 476,242 tons of brown ore concentrates was mined in Fillmore County, Minn., which is not considered a part of the true Lake Superior district. Production of manganiferous iron ore containing (natural) 5 percent or more manganese and considered a special grade of iron ore by the trade totaled 843,308 tons, of which 834,119 tons was shipped. Including these tonnages, the Lake Superior district produced 77,938,070 tons and shipped 78,005,399.

TABLE 12.—Beneficiated iron ore shipped from mines in the United States, 1925–29 (average) and 1930–52, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

Year	Beneficiated	Total	Proportion of beneficiated to total (percent)	Year	Beneficiated	Total	Proportion of beneficiated to total (percent)
1925–29 (av.)	8, 653, 590	66, 697, 126	13. 0	1941	19, 376, 120	93, 053, 994	20. 8
1930	8, 973, 888	55, 201, 221	16. 3	1942	23, 104, 945	105, 313, 653	21. 9
1931	4, 676, 364	28, 516, 032	16. 4	1943	20, 117, 685	98, 817, 470	20. 4
1932	407, 486	5, 331, 201	7. 6	1944	20, 303, 422	94, 544, 635	21. 5
1933	3, 555, 892	24, 624, 285	14. 4	1945	19, 586, 782	87, 580, 942	22. 4
1934	4, 145, 590	25, 792, 606	16. 1	1946	15, 588, 763	69, 494, 052	22. 4
1935	6, 066, 601	33, 426, 486	18. 2	1947	21, 407, 760	92, 670, 188	23. 1
1936	9, 658, 699	51, 465, 648	18. 8	1948	23, 629, 265	100, 274, 965	23. 6
1937	12, 350, 136	72, 347, 785	17. 1	1949	20, 658, 232	84, 174, 399	24. 5
1938	4, 836, 435	26, 430, 910	18. 3	1950	26, 717, 928	97, 150, 704	27. 5
1939	9, 425, 809	54, 827, 100	17. 2	1951	30, 664, 648	115, 660, 775	26. 5
1940	12, 925, 741	75, 198, 084	17. 2	1952	27, 023, 982	97, 375, 010	27. 8

Of the 321 active mines in 1952, 78 are listed individually with a production over 500,000 tons of crude ore each. Forty-five of these were in Minnesota, 9 in Alabama, 8 in Michigan, 4 each in New York and Utah, 2 in Wisconsin, and 1 each in California, Georgia, Missouri,

TABLE 13.—Iron-ore mines in the United States in 1952, by size of crude output

Name of mine	State	Nearest town	Range or district	Mining method	Production (gross tons)	
					Crude ore	Usable ore
Sherman	Minnesota	Fraser	Mesabi	Open pit	7,527,846	7,509,695
Rouchleau	do	Virginia	do	do	4,672,670	4,570,100
Hull Rust	do	Hibbing	do	do	3,139,945	3,083,910
Mountain Iron	do	Mountain Iron	do	do	3,066,484	2,643,509
Mahoning	do	Hibbing	do	do	3,014,717	3,014,717
Benson	New York	Star Lake	Adirondack	do	3,012,865	989,662
Monroe	Minnesota	Chisholm	Mesabi	do	2,314,746	2,314,608
Lone Star	Texas	Daingerfield	East Texas	do	2,022,344	571,963
Wenonah	Alabama	Bessemer	Birmingham	Underground	1,929,082	1,928,891
Hill-Trumbull	Minnesota	Marble	Mesabi	Open pit	1,918,348	607,681
Walker	do	Coleraine	do	do	1,790,068	1,021,826
Gross Marble	do	Marble	do	do	1,759,577	917,211
Spruce	do	Eveleth	do	Combined	1,724,085	1,667,820
Mather	Michigan	Ishpeming	Marquette	Underground	1,701,343	1,701,343
Holman Cliffs	Minnesota	Taconite	Mesabi	Open pit	1,610,181	884,166
Cornwall-Lebanon	Pennsylvania	Lebanon	Cornwall	Combined	1,596,191	990,207
Canton	Minnesota	Biwabik	Mesabi	Open pit	1,595,766	1,595,766
Canisteo	do	Coleraine	do	do	1,510,816	743,024
Eagle Mountain	California	Desert Center	Eagle Mountain	do	1,471,465	1,471,465
Gilbert	Minnesota	Gilbert	Mesabi	do	1,407,718	1,402,815
Iron Mountain	Utah	Cedar City	Iron Mountain	do	1,305,684	1,305,684
Auburn Group	Minnesota	Virginia	Mesabi	do	1,290,648	1,283,216
MacIntyre	New York	Tahawus	Adirondack	do	1,280,250	505,095
New Bed Harmony & Old Bed	do	Mineville	do	Underground	1,272,402	846,505
Hill Annex	Minnesota	Calumet	Mesabi	Open pit	1,267,436	638,067
Chateaugay	New York	Lyon Mountain	Adirondack	Combined	1,257,765	346,952
Mesabi Chief	Minnesota	Keewatin	Mesabi	Open pit	1,156,866	541,302
Hawkins	do	Nashwauk	do	do	1,080,666	562,879
Muscoda	Alabama	Bessemer	Birmingham	Underground	1,078,889	1,078,782
Embarrass	Minnesota	Biwabik	Mesabi	Open pit	1,059,500	1,059,500
Excelsior	Utah	Cedar City	Iron Mountain	do	1,047,514	1,047,514
Ishkooda	Alabama	Bessemer	Birmingham	Underground	1,041,713	1,041,609
Arcturas	Minnesota	Marble	Mesabi	Open pit	1,035,700	539,345
Patrick	do	Nashwauk	do	do	1,018,962	371,651
Galbraith	do	do	do	do	1,006,007	512,999
Adkins	Alabama	Woodstock	Birmingham	do	999,710	199,942
Montreal	Wisconsin	Montreal	Gogebic	Underground	977,191	977,191
Pyne	Alabama	Bessemer	Birmingham	do	966,704	966,704
South Agnew	Minnesota	Hibbing	Mesabi	Open pit	965,425	754,538
Danube	do	Bovey	do	do	965,269	582,179
Desert Mound	Utah	Cedar City	Iron Mountain	do	963,080	963,080
Warner	Alabama	Russellville	Birmingham	do	950,000	188,688
Susquehanna	Minnesota	Hibbing	Mesabi	do	934,659	802,343

Blackburn	Alabama	Russellville	Birmingham	do	920,000	184,170
Section 18	Minnesota	Hibbing	Mesabi	do	838,673	778,150
Halobe	do	Nashwauk	do	do	798,289	225,573
Pioneer	do	Ely	Vermilion	Underground	785,448	785,448
Perry	do	Keewatin	Mesabi	Open pit	760,540	445,948
Kevin	do	Cooley	do	do	758,239	322,334
Longyear	do	Hibbing	do	do	757,203	720,247
Bray	do	Keewatin	do	do	746,581	559,199
Scranton	do	Hibbing	do	do	738,322	731,916
Mary Ellen	do	Biwabik	do	do	727,020	364,489
Olson	do	Nashwauk	do	do	696,624	259,678
Blowout	Utah	Cedar City	Iron Mountain	do	689,747	689,747
Buckeye	Minnesota	Coleraine	Mesabi	do	689,659	369,416
Spring Valley	do	Ostrander	Southern Minn	do	677,171	476,242
Jennison	do	Coleraine	Mesabi	do	676,290	335,153
Fayal	do	Eveleth	do	do	663,535	663,535
Canton (St. James)	do	Biwabik	do	do	651,876	651,876
Scrub Oaks	New Jersey	Dover	N. J. & SE N. Y	Underground	627,803	245,656
Schroeder	Alabama	Russellville	Birmingham	Open pit	622,300	124,454
Russellville No. 14	do	do	do	do	612,724	178,679
Geneva	Michigan	Ironwood	Gogebic	Underground	587,742	587,742
Portsmouth	Minnesota	Crosby	Cuyuna	Open pit	584,211	430,527
Iron Mountain	Missouri	Iron Mountain	Iron Mountain	Combined	580,648	232,605
Iron Hill	Georgia	Taylorsville	Cartersville	Open pit	572,840	114,568
Buck Group	Michigan	Iron River	Menominee	Underground	556,730	556,730
Hiawatha	do	do	do	do	555,949	555,949
Cliffs Shaft	do	Ishpeming	Marquette	do	548,076	548,076
Wauseca	do	Iron River	Menominee	do	546,621	546,621
Godfrey	Minnesota	Chisholm	Mesabi	do	545,218	545,218
Anvil-Palms-Keweenaw	Michigan	Bessemer	Gogebic	do	532,884	532,884
Cary	Wisconsin	Hurley	do	do	517,918	517,918
Bennett	Minnesota	Keewatin	Mesabi	Combined	516,298	479,180
Carmi Carson Lake	do	Kelly Lake	do	Open pit	515,098	515,098
Newport	Michigan	Ironwood	Gogebic	Underground	514,448	514,448
Pennington	Minnesota	Ironton	Cuyuna	Open pit	514,196	260,239
Output of 78 mines producing more than 500,000 tons of crude ore each					96,335,218	72,795,857
Output of 16 mines producing 400,000 to 500,000 tons of crude ore each					7,196,249	5,013,609
Output of 18 mines producing 300,000 to 400,000 tons of crude ore each					6,272,531	4,891,501
Output of 30 mines producing 200,000 to 300,000 tons of crude ore each					7,417,628	6,020,808
Output of 51 mines producing 100,000 to 200,000 tons of crude ore each					7,636,627	5,913,200
Output of 29 mines producing 50,000 to 100,000 tons of crude ore each					2,104,506	1,639,791
Output of 99 mines producing under 50,000 tons of crude ore each					1,426,881	1,039,097
Grand total United States (321 mines)					128,389,640	97,313,863

New Jersey, Pennsylvania, and Texas. Forty-one of the mines are on the Mesabi range, including the 5 leading producers. The 35 mines producing 1 million tons or more contributed 51 percent of the total crude ore and 53 percent of all usable ore, excluding by-product ore. The 78 mines producing over 500,000 tons each accounted for 75 percent of both crude and usable ore. It should be noted that the order of listing is based on ore tonnage, not iron content of product, and mines producing low-grade crude ore are considered comparable in size with mines producing similar tonnages of direct-shipping ore. The 8 largest mines were open-pit operations; of those listed, 55 were completely above ground, 18 were underground, and 5 were combined operations.

Hematite was the predominant iron mineral in 26 of the million-ton mines and magnetite in 8; 1 operation produced a mixed limonite-carbonate ore. The magnetite group includes mines of the Adirondack (New York) district, which recover nonmagnetic martite by gravity concentration, and mines in Western States producing direct-shipping ore semialtered to hematite.

CONSUMPTION AND USES

Iron ore, as a basic raw material of prime importance and bulk proportions, directly affects a number of industries. Over 99 percent of total consumption is by furnaces manufacturing iron and steel. However, iron oxides constitute a substantial part of mineral-earth pigments produced in the United States, and other uses include chemical functions in the manufacture of portland cement and certain basic refractories. Ferroalloy manufacturers use a small tonnage to add iron in the alloy product; magnetite concentrates are employed as a heavy medium in ore-dressing processes; and lump magnetite is used as ship ballast. Occasionally, small quantities are used as a fluxing agent in nonferrous smelting operations, as constituents of fertilizers, and as mineral supplement to stock feeds. Mining-, smelting-, and transportation-equipment manufacturers are directly interested in the iron-ore industry as well as numerous other auxiliary activities.

Distribution of consumption, in percentage, indicates that blast furnaces continued to use 78 percent of the total, sintering plants 16 percent, steel furnaces 5 percent, and 1 percent is consumed for all other uses. The ore consumed in sintering plants, as noted below, was later consumed as sinter in iron and steel furnaces.

Sinter.—Sintering plants at mines and blast furnaces, in line with other phases of the iron and steel industry, reduced output 10 percent in 1952. However, increased sintering capacity helped to offset the loss of output during the strike. Consumption of sinter was 93 percent in blast furnaces and 7 percent in steel furnaces. Iron-bearing materials consumed in the manufacture of sinter included 15,694,302 tons of iron-ore fines and concentrates, 23,904 tons of manganiferous iron ore, 654,260 tons of pyrite cinder, 6,567,156 tons of flue dust, and 478,243 tons of mill cinder and roll scale. The total, 23,417,865 tons, resulted in a conversion yield of 87 percent. Sintering plants at mines in 5 States produced 5,522,405 tons—27 percent of the total; and plants at blast furnaces and custom mills in 15 States produced 14,766,710 tons or 73 percent.

TABLE 14.—Consumption of iron ore in the United States in 1952, by States and uses, in gross tons

[Exclusive of ore containing 5 percent or more manganese]

State	Metallurgical uses				Miscellaneous uses			Total [1]
	Iron blast furnaces	Steel furnaces	Sintering plants	Ferro-alloy furnaces	Cement	Paint	Other	
Alabama	6,977,833	55,241	1,162,725		69,658		90	8,265,547
California					44,579	(2)	27,082	
Colorado	2,932,611	454,264	1,744,250					5,202,786
Utah					(2)			
Illinois	8,476,032	379,566	271,604		67	(2)		9,127,269
Indiana	9,742,314	650,104	813,516					11,205,934
Kentucky	758,664	56,419						815,083
Maryland								
Massachusetts	6,185,212	567,248	361,055					7,113,515
Michigan								
Minnesota	968,149	91,440	926,907					1,986,496
New Jersey						(2)		(2)
New York	4,402,304	403,552	3,449,294	55,512	(2)	(2)	(2)	8,310,662
Ohio	15,812,840	943,841	2,453,025	315,048	4,521	(2)		19,529,275
Pennsylvania	19,344,366	1,541,603	4,360,399	1,585	(2)	41,957		25,289,910
Tennessee	257,921				10,727			268,648
Texas	803,843	8,360	151,527		29,566			993,296
Virginia					(2)	(2)		(2)
West Virginia	2,319,611	15,405			(2)			2,335,016
Undistributed [3]				15,951	83,954	68,075	29,219	197,199
Total	78,981,700	5,167,043	15,694,302	388,096	243,072	110,032	56,391	100,640,636

[1] State totals include only tonnages shown. Other tonnages included with "Undistributed."
[2] Included with "Undistributed."
[3] Includes States indicated by footnote 2 plus the following: For cement, Arkansas, Arizona, Florida, Idaho, Iowa, Kansas, Louisiana, Missouri, Montana, Oregon, South Dakota and Washington; for paint, Georgia, North Dakota and Wisconsin; and a small tonnage from Nevada used as ship ballast and in making refractories.

TABLE 15.—Production and consumption of sinter in the United States in 1952, by States, in gross tons

State	Sinter produced	Sinter consumed	
		In blast furnaces	In steel furnaces
Alabama	1,230,380	1,556,285	85,108
California			
Colorado	1,674,681	1,659,536	
Utah			
Delaware	105,028		
Illinois	757,930	709,384	142,561
Indiana	1,574,221	1,321,432	226,379
Maryland			
Kentucky	516,769	675,044	31,451
Tennessee			
West Virginia			
Michigan	538,038	564,193	
Minnesota	781,459		
New York	3,816,272	1,672,686	54,019
Ohio	2,988,644	3,510,870	319,398
Pennsylvania	6,168,497	6,591,169	582,613
Texas	137,196	137,267	
Total	20,289,115	18,397,866	1,441,529

STOCKS

Usable iron ore in stockpiles at mines on December 31, 1952 is listed by States in table 16. Minnesota and Michigan were the largest holders, with 42 and 36 percent, respectively, of the total. Including Wisconsin, these 3 States, comprising the Lake Superior district, held 81 percent. New York was the third largest holder, with 8 percent. Total stocks were substantially the same as at the end of 1951. Consuming plants held stocks of iron ore and sinter totaling 43,130,833 gross tons on December 31, 1952, as compared with 40,952,788 tons at the end of 1951.

Stocks at Lake Erie Ports.—A total of 6,395,884 gross tons was reported on Lake Erie docks January 1, 1952. By May 1 this tonnage was reduced to 3,104,543 tons, according to the Lake Superior Iron Ore Association. The difference, 3,291,341 tons, represents only approximately actual withdrawals during the period of closed navigation inasmuch as reporting dates do not correspond exactly with the closed season. Stocks were reduced 3,584,864 tons during the same period in 1951.

TABLE 16.—Stocks of usable iron ore at mines, Dec. 31, 1951–52, by States, in gross tons

State	1951	1952	State	1951	1952
Alabama	44,389	51,864	New York	584,647	418,097
California	107,394	160,678	Pennsylvania	8,153	6,250
Georgia	----------	49,300	Texas	103,055	101,860
Michigan	1,985,840	2,016,419	Utah	149,379	204,403
Minnesota	2,445,286	2,328,925	Virginia	1,081	----------
Missouri	110	----------	Wisconsin	137,000	146,264
Nevada	32,317	21,931			
New Jersey	815	22,304	Total	5,599,466	5,528,295

PRICES [2]

The average value per gross ton of iron ore f. o. b. mines was $6.09 in 1952 as compared with $5.46 in 1951 and $4.99 in 1950. Table 17 gives the average value at mines of the different types of product and varieties of ore for each of the producing States, except where there are fewer than three shippers of a certain class of ore in a State and where permission has not been given to publish the value. These data are taken directly from statements of producers and probably represent the commercial selling prices only approximately. Usually the delivered cost is given less transportation costs to the consuming plant. In the Lake Superior district the mine value is the Lake Erie price less freight from mines to lower Lake ports. This value appears to be applied also to ore that is not sold on the open market.

Prices of Lake Superior Iron Ore.—The Office of Price Stabilization lifted control from iron-ore transactions between affiliated corporations, effective April 28, 1952. Merchant ore remained at the Lake Erie base prices, effective December 2, 1950, and through 1951 until July 26, 1952. OPS Ceiling Price Regulation 169, September 12, 1952, established new ceiling prices for sales of ore produced in Michigan,

[2] For an explanation of the factors affecting the price of iron ore, *see* Minerals Yearbook, 1948, p. 647.

TABLE 17.—Average value per gross ton of iron ore at mines in the United States, 1951–52

[Exclusive of ore containg 5 percent or more manganese]

State	1951							1952						
	Direct			Concentrates				Direct			Concentrates			
	Hematite	Brown ore	Magnetite	Hematite	Brown ore	Magnetite	Sinter	Hematite	Brown ore	Magnetite	Hematite	Brown ore	Magnetite	Sinter
Mined ore:														
Alabama	$4.08	-----	-----	-----	$3.29	-----	(1)	$5.04	-----	-----	$5.86	$5.71	-----	(1)
Georgia	-----	-----	-----	-----	3.74	-----	-----	(1)	$2.63	-----	-----	4.75	-----	-----
Michigan	6.01	-----	-----	$5.10	-----	-----	-----	6.46	-----	-----	6.38	-----	-----	-----
Minnesota	5.19	-----	-----	5.44	(1)	(1)	(1)	5.83	-----	-----	5.94	(1)	(1)	(1)
New Jersey	-----	-----	(1)	-----	-----	$11.86	-----	-----	-----	(1)	-----	-----	$9.41	-----
New York	-----	-----	(1)	(1)	-----	7.02	$11.71	-----	-----	(1)	(1)	-----	7.74	$12.80
Pennsylvania	-----	-----	-----	-----	-----	(1)	(1)	-----	-----	-----	-----	-----	(1)	(1)
Utah	-----	-----	$2.19	-----	-----	-----	-----	-----	-----	$3.77	-----	-----	-----	-----
Other States [2]	4.91	$11.04	6.52	8.44	5.51	3.64	(1)	5.29	9.98	6.27	8.72	4.13	4.40	(1)
Average, all States	5.23	11.04	3.54	5.46	4.44	9.37	10.47	5.87	3.66	4.91	5.98	5.30	9.17	10.14
Byproduct ore: [3]														
Colorado, Michigan, Delaware, Tennessee, Virginia	-----	-----	-----	-----	-----	-----	8.20	-----	-----	-----	-----	-----	-----	8.64

[1] Included with average for all States.
[2] Includes Arkansas, California, Missouri, Nevada, New Mexico, Tennessee, Texas, Virginia, Wisconsin, Wyoming, and Puerto Rico.
[3] Cinder and sinter obtained from pyrites treated in, but not necessarily mined in, States indicated.

Minnesota, or Wisconsin and delivered on or after July 26, 1952. The new prices were: Old Range Bessemer $9.45, Old Range non-Bessemer $9.30, Mesabi Bessemer $9.20, Mesabi non-Bessemer $9.05, and High-Phosphorus $9.05. These prices are for ore delivered at lower Lake ports, carrying 51.5 percent natural iron content with 0.045 percent (max.) phosphorus (dry), for Bessemer grades; ores exceeding 0.18 percent phosphorus (dry) are classified as High-Phosphorus. Premiums and penalties are applied for variations in analyses and physical structure.

To arrive at a representative Pittsburgh value, average value at the mines must be added to transportation charges plus a Federal tax (3 percent) on the transportation charges. For ore from the Mesabi range, these were, respectively, $5.86, $4.98, and $0.15. Thus, the average value per ton of Mesabi iron ore delivered in Pittsburgh was approximately $11.00 in 1952. This value applies more closely to the non-Bessemer grades, which constitute the bulk of the tonnage shipped.

TRANSPORTATION

The movement of iron ore from mines to mills constitutes an important segment of industrial organization. Traditionally, consuming mills are established near supplies of coking coal, and ore usually is transported over greater distances than coal or fluxing stone. However, with increasing concentration of heavy industries, market location has assumed greater importance in plant location, especially since transportation costs for finished products are much more conspicuous to the consumer than for raw materials.

Iron ore in the United States moves by rail and water; about three-fourths of the total supply utilizes the Great Lakes waterway system. Consuming plants in Alabama, California, Colorado, Minnesota, Tennessee, Texas, and Utah receive virtually all their supply over all-rail routes, while those furnaces in the lower Lakes area must depend on an 8-month open season of navigation on the Great Lakes. Rail movement is more expensive but is rarely interrupted; thus, transportation is most critical for furnaces in the lower Lakes area and for furnaces depending upon imported ore.

The American fleet of ore vessels operating on the Great Lakes was expected to number 285 by the opening of the 1953 season. Trip capacity will total 3,194,000 tons or an average of 11,200 tons per ship. Many older ships have been modernized and some replaced. The number of ships has decreased from 312 in 1944 and reached a low of 264 in 1950; however, due to larger vessels of recent construction, the capacity of the 1953 fleet will be greater than ever before.

Ore movement on the Lakes in 1952 opened with the departure of the Albert E. Heekin from Escanaba, Mich., on April 2. Upper Lake navigation opened 3 days later, and a total of 6,458,572 tons was shipped from United States ports during April, according to the Lake Superior Iron Ore Association. All-rail shipments during 1952 from the Lake Superior district totaled 5,062,663 tons, of which about 3,500,000 tons was emergency shipments to furnaces normally supplied over water routes.

Freight Rates.—Transportation charges for Lake Superior iron ore specified in the Second Interim Decision, Interstate Commerce Commission Ex Parte 175, effective August 28, 1951, applied until May 2, 1952, when new rates specified in the Third Decision, Ex Parte 175, went into effect. Increases between the Mesabi range and Pittsburgh totaled $0.2022 per gross ton, bringing total charges to $4.9806 per ton. Comparable all-rail rates increased $0.3378 to $6.3056 per ton, a difference of $1.325 per ton between the 2 routes.

FOREIGN TRADE [3]

Although the tonnage of iron ore received in the United States in 1952 was 4 percent below the previous year, its total declared value increased 40 percent. Average value per ton increased from $5.87 in 1951 to $8.51 in 1952, 45 percent above the previous year. Sweden, Chile, Venezuela, Canada, and Brazil were the largest suppliers, in respective order, and the 5 countries together supplied 89 percent of the total; 12 additional sources supplied the remaining 11 percent. Aside from drastic increases indicated in the value figures, the most significant aspect of 1952 foreign trade is the decline of Chile's tonnage, with a concomitant rise in the tonnage from Venezuela. This trend is expected to continue until virtually all of Chile's output is for domestic consumption.

International trade patterns in most commodities take shape gradually as statistical reports from various countries filter through many revisions, checks, and rechecks. When the trade is undergoing development or changes in response to political and economic influences,

[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines from records of the U. S. Department of Commerce.

342070—55——34

TABLE 18.—Iron ore imported for consumption in the United States, 1943–47 (average) and 1948–52, by countries, in gross tons

[U. S. Department of Commerce]

Country	1943–47 (average)		1948		1949		1950		1951		1952	
	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value
Algeria	[1] 112,686	[1] $479,809	405,224	$2,066,463	415,501	$2,349,746	494,342	$2,917,910	446,273	$2,919,490	66,008	$518,994
Argentina	4	27			20	24,809						
Belgium-Luxembourg	244	820										
Brazil	17,109	84,336	295,926	1,524,539	351,134	2,281,797	701,329	4,732,136	1,037,828	[1] 8,921,991	1,010,919	14,931,563
British West Africa	4,594	38,344	18,528	171,199	59,548	395,034	192,669	1,615,728	255,817	1,586,940	217,760	1,108,055
Canada	774,644	3,530,684	968,772	5,779,942	1,615,803	10,742,201	} 1,852,508	12,728,135	[1] 1,961,990	[1] 14,399,135	1,822,038	14,076,738
Newfoundland-Labrador	3,100	12,400										
Chile	594,508	1,513,912	2,631,997	7,526,640	2,627,007	6,891,016	2,606,557	6,821,829	2,767,207	8,587,746	1,861,575	8,240,661
Colombia	2	6										
Costa Rica											449	1,005
Cuba	62,312	305,025	34,500	101,775	11,589	24,763	29,000	61,770	[1] 4,223	[1] 29,926	87,536	882,684
Dominican Republic											18,408	197,943
Egypt					7,500	88,650						
France	794	2,203	9,041	63,302			500	1,550				
French Morocco	5,455	27,608	8,690	60,830								
French Oceania	(2)	2										
Greece	[1] 200	[1] 600										
Iran	300	8,400	3,000	162,000	1,500	90,000	3,000	180,000	1,500	60,000	2,972	165,755
Italy	103	210	9,450	64,938								
Liberia			4	85	30	105	(2)	51	110,123	552,694	572,485	3,156,561
Mexico	34,581	[1] 85,589	163,149	334,447	169,823	284,557	190,958	475,299	169,563	506,482	114,309	356,845
Netherlands					7,114	64,026						
Norway	[1] 10,541	[1] 63,052	108,616	634,602								
Peru	2	12										
Philippines			4,160	28,880	5,250	51,816	3,600	36,000				
Spain	(2)	4	6,449	66,825	9,200	78,658			74,306	599,350	4,600	33,482
Spanish Africa			8,500	48,875			39,680	250,717	8,750	62,335		
Sweden	303,957	1,828,281	1,358,962	8,317,362	2,027,155	12,893,385	2,047,250	13,511,874	[1] 2,522,011	[1] 16,920,468	2,111,100	24,504,292
Tunisia	9,359	46,210	56,358	297,748	82,815	424,076	119,093	608,377	134,775	528,617	19,200	188,260
Union of South Africa	1,787	9,911							9,450	35,343	4,800	43,536
United Kingdom	444	26,294	351	21,229	302	22,895	751	27,050	446	28,837	690	23,369
Venezuela									635,416	3,780,692	1,845,776	14,610,871
Total	[1] 1,936,726	[1] 8,063,739	6,091,677	27,271,681	7,391,291	36,707,534	8,281,237	43,968,426	[1] 10,139,678	[1] 59,520,046	9,760,625	83,040,614

[1] Revised figure.
[2] Less than 1 ton.

TABLE 19.—Pyrites cinder [1] imported for consumption in the United States, 1943–47 (average) and 1948–52, by countries, in gross tons

[U. S. Department of Commerce]

Country	1943–47 (average)		1948		1949		1950		1951		1952	
	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value
Belgium-Luxembourg			2	$88								
Canada	5,223	$14,512	17,074	58,703	7,588	$27,601	15,735	$58,260	8,675	$34,758	11,149	$48,028
France	140	148										
Italy			1	10								
Total	5,363	14,660	17,077	58,801	7,588	27,601	15,735	58,260	8,675	34,758	11,149	48,028

[1] Byproduct iron ore.

TABLE 20.—Iron ore exported from the United States, 1943–47 (average) and 1948–52, by countries of destination, in gross tons

[U. S. Department of Commerce]

Destination	1943–47 (average)		1948		1949		1950		1951		1952	
	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value	Gross tons	Value
Australia	(1)	$231			12	$3,109	7	$2,748	4	$1,439	4	$1,918
Brazil									4	326		
Canada	2,192,580	7,492,325	3,019,683	$13,192,918	2,168,763	12,312,318	2,550,712	15,709,693	[2] 3,340,170	21,734,997	3,790,253	24,507,789
Canal Zone	2	45			9	200			4	138	7	212
French Morocco			99	4,951								
Gold Coast							1	463				
Japan			60,869	546,089	251,791	2,293,560			[2] 987,814	[2] 9,245,943	1,330,977	12,910,576
Mexico	28	385							46	127		
Netherlands	2	139	15	1,021	75	5,804						
Norway					75	788			854	11,129		
Philippines					4,047	36,806	7	639	[2] 5	485	1	120
United Kingdom	(1)	12			3	1,232	11	2,966	9	2,200		
Other countries	52	1,627										
Total	2,192,664	7,494,764	3,080,666	13,744,979	2,424,775	14,653,817	2,550,738	15,716,509	[2] 4,328,910	[2] 30,996,784	5,121,242	37,420,615

[1] Less than 1 ton.
[2] Revised figure.

the information is disseminated through commercial channels, trade literature, and official reports. However, the statistical pattern does not emerge with acceptable accuracy for at least 2 years. For the first time, MINERALS YEARBOOK presents a table showing exports of iron ore, by country of origin, with country of destination. In table 21, exports and destinations are listed for 1950 as reported by the country of origin wherever possible. In some instances, the figures are listed as reported by the receiving country; where statistics are available from both the exporting and importing country, the figures are correlated. Small discrepancies usually may be attributed to ore in transit at the end of the year, differences in reporting periods, and various allowances. A precise statistical balance is not practicable. However, the pattern for trade outside the Soviet Union and some of its neighbors is reliable.

TABLE 21.—World trade of iron ore in 1950, in thousands of metric tons

[Compiled by Berenice B. Mitchell and John E. McDaniel]

Exports by countries of origin	Percent Fe	Production	Exports by countries of destination								
			Exports	North America		Europe					Asia
				Canada	United States	Belgium-Luxembourg	West Germany	Saar	United Kingdom	Other European	Japan
North America:											
Canada	55	3,271	2,021	------	1,843	------	48	------	130	------	------
Cuba	34	12	29	------	29	------	------	------	------	------	------
Mexico	68	420	192	(1)	192	------	------	------	------	------	------
United States	49	99,619	2,592	2,592	------	------	------	------	(1)	------	------
South America:											
Brazil	68	1,987	890	106	686	7	22	------	18	51	------
Chile	60	2,976	2,596	------	2,596	------	------	------	------	------	------
Europe:											
Austria	31	1,859	58	------	------	------	58	------	------	(1)	------
Belgium-Luxembourg	28	3,891	103	------	------	------	60	------	------	43	------
France	33	29,983	11,201	------	1	6,871	139	3,654	366	170	------
Germany, West	27	10,882	52	------	------	------	------	42	------	10	------
Greece	30	5	41	------	------	------	28	------	13	------	------
Italy	50	476	9	------	------	------	------	------	9	------	------
Norway	65	298	283	------	------	------	[2] 198	------	------	85	------
Spain	45	2,088	936	------	------	14	62	------	729	131	------
Sweden	61	13,611	12,944	9	2,045	1,472	3,877	------	3,475	2,066	------
Switzerland	31	55	54	------	------	------	52	------	------	2	------
Yugoslavia	45	826	339	------	------	------	33	------	188	118	------
Asia:											
Hong Kong	45	172	170	------	------	------	------	------	------	------	170
India	53	3,005	56	------	------	------	------	------	------	------	56
Malaya	45	507	529	------	------	------	------	------	------	------	529
Philippines	54	599	560	------	------	------	------	------	------	------	560
Portuguese India	55	131	67	------	------	------	7	------	------	7	53
Africa:											
Algeria	54	2,573	2,398	------	476	(1)	113	------	1,362	447	------
French Morocco	46	319	290	------	------	------	------	------	279	11	------
Sierra Leone	60	1,185	1,161	------	213	------	215	------	733	------	------
Spanish Morocco	66	951	965	------	40	32	------	------	466	427	------
Tunisia	54	758	701	------	99	------	52	------	467	83	------
Oceania: New Caledonia	57	15	[3] 5	------	------	------	------	------	------	------	------
Other countries	(4)	[5,6] 67,526	(4)	------	------	------	------	------	------	------	------
Total	------	[5] 250,000	41,242	2,707	8,220	8,396	4,964	3,696	8,235	3,651	1,368

1 Less than 500 tons.
2 Including approximately 5,000 tons for East Germany.
3 Exports went to Australia.
4 Data not available.
5 Estimate.
6 Includes 50,000,000 tons produced in U. S. S. R. and 16,234,000 tons produced in United Kingdom.

TECHNOLOGY AND INDUSTRIAL DEVELOPMENT

Taconite Review.—If the iron formation is to be considered an ore, there is enough ore in the Lake Superior region to last a thousand years. * * * At the eastern end of the Mesabi range there is an area in which the taconite has been so magnetized; that is to say, so much of the iron oxides has been converted into the mineral magnetite that concentration by magnetic processes becomes possible. The possibility of such concentration has been fully demonstrated by extensive experiments on a commercial scale, made in Duluth, Minn., under the direction of Mr. C. E. Swart.[4]

The foregoing, published in 1919, was by no means the first recognition of the future importance of taconite. Test pits were sunk in eastern Mesabi taconite as early as 1871, and it was obvious to the early Mesabi miners that vast quantities of iron-bearing material would have to be bypassed until economic conditions required its use.

The term "taconite" refers to iron-bearing rocks of the Mesabi range from which virtually none of the silica has been removed. Taconite occurs among sedimentary beds overlying granite. These beds are covered at the surface by glacial drift of varying thickness and dip gently southeast under a thick formation of slate. Within the iron formation are many divisions and subdivisions, according to horizons of varying quality and character. Where conditions were favorable, the leaching action of water over the years has removed most of the silica from the iron-bearing beds leaving commercial grades of ore. Taconite remains in that part of the iron formation that has not been subject to such action, or, as regards surfaces now exposed, has not been exposed long enough to effect enrichment.

Taconite averages 25 to 30 percent iron content, including oxides and a small percentage of silicates. However, the manner in which the iron minerals are present is as important as the iron content. Only oxides may be considered available, and of these only the magnetic variety is important at the present time. Within the magnetic classification, horizons must be selected for mining that have magnetite grains of sufficient size to permit economic liberation from the silica particles. Thus, of an estimated 60 billion tons of taconite within a reasonable depth, only about 5 billion tons are magnetic and amenable to practical grinding for liberation of the iron oxide particles. This tonnage will provide about 1.7 billion tons of concentrate containing 60–65 percent iron.

Mining methods for taconite are similar to other surface practices, with modifications made necessary by its extremely hard and abrasive character. Drilling and blasting are especially difficult. Conventional practice promises to be replaced by a heating and quenching technique referred to as jet piercing, a process developed by Linde Air Products Co. and described in a recent publication.[5]

As it comes from the mine, taconite may be in lumps up to 36 inches in greatest diameter. It is fed to giant crushers of the gyratory or jaw types and broken in stages through fine grinding until a liberation is achieved that will permit satisfactory recovery of the iron particles. Between the crushing units are magnetic separators adjusted to eliminate the larger pieces of barren rock that may be in

---

[4] Finlay, J. R., Method of Administering Leases of Iron Ore Deposits Belonging to the State of Minnesota: Bureau of Mines, Tech. Paper 222, 1919, p. 35.

[5] Aitchison, R. B., Calamon, J. J., and Fleming, D. H., Jet Piercing Costs Cut: Min. World, vol. 14, No. 7, June 1952, pp. 29–33.

the ore, and within the grinding series are hydraulic classifiers that eliminate smaller grains of silica. Final separation of the fine iron oxide powder is accomplished magnetically and followed by filters to remove much of the water. Water acts as a vehicle while inhibiting dust losses.

The filter-cake concentrate soon would become an unmanageable mass if it were not reagglomerated. To accomplish this, various binders are added and the damp concentrates heat treated to produce pellets, nodules, briquets or sinter. The most satisfactory process and product have not been fully determined, although various experimenters favor one or the other. The subject was discussed in several technical papers of special interest.[6 7 8 9]

Notes on commercial participation in current taconite development have appeared in recent editions of Minerals Yearbook. Of the three principal organizations, Reserve Mining Co. was most advanced at the end of 1952.[10] Oliver Iron Mining Division, U. S. Steel Corp., was operating its agglomeration plant on nontaconite concentrates and fine ores, while its new Pilotac plant at Mountain Iron, Minn., was nearing completion. Erie Mining Co. announced plans for a $300 million project to produce up to 10.5 million tons per year of taconite pellets.[11]

RESERVES

It should be borne in mind that reserve data shown in tables 22 and 23 represent only taxable and State-owned reserves and not the total that may be expected to become available. Tonnages are added to the reserve figures each year, and undoubtedly eventual production in the Lake Superior district will greatly exceed that indicated by present reserve tonnages.

TABLE 22.—Iron-ore reserves in Michigan, Jan. 1, 1944–48 (average) and 1949–53, in gross tons

[Michigan Department of Conservation]

Range	1944–48 (average)	1949	1950	1951	1952	1953
Gogebic	32, 115, 141	30, 511, 502	29, 098, 914	33, 466, 792	34, 162, 005	30, 467, 972
Marquette	56, 304, 814	67, 101, 475	65, 109, 601	68, 323, 382	65, 119, 690	64, 945, 858
Menominee	50, 660, 263	55, 913, 371	55, 594, 843	60, 136, 726	62, 940, 226	62, 188, 665
Total Michigan	139, 080, 218	153, 526, 348	149, 803, 358	161, 926, 900	162, 221, 921	157, 602, 495

[6] Mitchell, Will, Jr., Sollenberger, C. L., and Miskell, Ford F., Factors in the Economics of Heat-Treated Taconites: Min. Eng., vol. 4, No. 10, October 1952, pp. 962–967.
[7] Kende, Marvin A., The Agglomeration of Taconite Concentrate: Mines Mag., vol. 42, No. 5, May 1952, pp. 39–42.
[8] Cook, S. R. B. and Ban, Thomas E., Microstructures in Iron Ore Pellets: Min. Eng., vol. 4, No. 11, November 1952, pp. 1053–1058.
[9] Wood, G. V., Heat Hardening of Taconite Pellets: Proc., Blast-Furnace Coke-Oven, and Raw Materials Committee, Iron and Steel Div., Am. Inst. Min. and Met. Eng., New York, 1952, pp. 93–100.
[10] Mining World, Reserve Mining Company's Taconite Program Underway: Vol. 14, No. 13, December 1952, pp. 28–32.
[11] Mining World, vol. 14, No. 4, April 1952, p. 85

TABLE 23.—Unmined iron-ore reserves in Minnesota, May 1, 1943–47 (average) and 1948–52, in gross tons

[Minnesota Department of Taxation]

	1943–47 (average)	1948	1949	1950	1951	1952
Mesabi	974,707,617	915,220,248	900,959,665	912,226,039	893,007,833	854,280,596
Vermilion	12,131,924	10,435,800	12,196,016	12,498,639	11,660,302	12,390,557
Cuyuna	60,019,217	38,040,129	37,308,274	42,977,068	41,415,581	43,472,578
Total Lake Superior district (taxable)	1,046,858,758	963,696,177	950,463,955	967,701,746	946,083,716	910,143,731
Fillmore County	135,590	394,248	547,744	582,820	908,996	574,908
Morrison County				88,286	44,300	15,000
Aitkin County						850,000
State ore (not taxable)	16,218,062	3,515,084	2,435,729	2,642,853	2,643,033	2,486,297
Total Minnesota	1,063,212,410	967,605,509	953,447,428	971,015,705	949,680,045	914,069,936

EMPLOYMENT

The average number of workers employed in iron-ore mines and mills remained substantially unchanged at 34,000 (preliminary) in 1952. However, because of the steel strike, the total man-hours worked decreased 16 percent below 1951 to 63.4 million (preliminary). Usable iron-ore output per man-hour in 1952, as indicated by the preliminary figures, was 1.527 tons as compared with 1.549 in 1951 and 1.492 in 1950.

Production figures used above and in table 24 include, in the Lake Superior district, manganiferous ore, which is considered a special grade of iron ore.

WORLD REVIEW

CANADA [12]

Widespread interest was shown in Canadian iron-ore deposits during 1952. Exploration and development approached boom proportions and included a number of significant projects. Production increased 11 percent over 1951, with ore from British Columbia more than offsetting slight declines in other Provinces. The total (4,647,373 gross tons) came from mines in British Columbia, Newfoundland, and Ontario.

British Columbia.—Magnetite concentrates from Vancouver and Texada Islands totaled 760,000 tons in 1952, most of which went to Japan with small tonnages to domestic consumers and the United States. The Argonaut Co., Ltd., operated the Iron Hill mine at Quinsam Lake, Vancouver Island, and investigated the Iron River deposit, also on Vancouver Island. Texada Mines, Ltd., operated the Prescott and Lake pits and began shipments in May. Both companies are controlled in the United States.

Newfoundland.—Dominion Wabana Mines, Ltd., completed mechanization of its underground mines in 1952 and shipped 1,477,000 tons of hematite ore. The goal for 1953 is 2.5 million tons.

[12] Information in this section is principally from Buck, W. Keith, Iron Ore in Canada in 1952 (Preliminary): Canada Department of Mines and Technical Surveys, Ottawa, 1953, 15 pp.

TABLE 24.—Employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man in 1951, by districts and States [1]

District and State	Employment					Production									
	Average number of men employed	Time employed				Crude ore (gross tons)	Usable ore			Average per man (gross tons)					
		Average number of days	Total man shifts	Man-hours			Gross tons	Iron contained		Crude ore		Usable ore			
				Average per shift	Total			Gross tons	Percent natural	Per shift	Per hour	Per shift	Per hour	Iron contained	
														Per shift	Per hour
Lake Superior: [1]															
Michigan Wisconsin	8, 766	278	2, 441, 308	8. 00	19, 530, 970	15, 770, 367	15, 555, 654	8, 383, 122	53. 89	6. 460	0. 807	6. 372	0. 796	3. 434	0. 429
Minnesota	14, 638	279	4, 090, 968	8. 04	32, 878, 635	101, 142, 724	79, 458, 720	40, 010, 768	50. 35	24. 723	3. 076	19. 423	2. 417	9. 780	1. 217
Total	23, 404	279	6, 532, 276	8. 02	52, 409, 605	116, 913, 091	95, 014, 374	48, 393, 890	50. 93	17. 898	2. 231	14. 545	1. 813	7. 408	0. 923
Southeastern States: [2]															
Alabama	5, 519	241	1, 327, 600	8. 16	10, 837, 341	12, 509, 417	8, 185, 993	3, 068, 452	37. 48	9. 423	1. 154	6. 166	. 755	2. 311	. 283
Georgia	197	200	39, 389	9. 58	377, 364	1, 783, 520	357, 754	141, 564	39. 57	45. 280	4. 726	9. 083	. 948	3. 594	. 375
Tennessee	18	256	4, 600	10. 17	46, 800	179, 000	35, 908	14, 010	39. 02	38. 913	3. 825	7. 806	. 767	3. 046	. 299
Total	5, 734	239	1, 371, 589	8. 21	11, 261, 505	14, 471, 937	8, 579, 655	3, 224, 026	37. 58	10. 551	1. 285	6. 255	. 762	2. 351	. 286
Northeastern States:															
New Jersey	791	259	205, 164	7. 96	1, 633, 221	1, 166, 495	658, 745	412, 362	62. 60	5. 686	. 714	3. 211	. 403	2. 010	. 252
New York Pennsylvania	2, 913	305	888, 816	8. 00	7, 110, 520	9, 620, 177	4, 522, 214	2, 765, 795	61. 16	10. 824	1. 353	5. 088	. 636	3. 112	. 389
Total	3, 704	295	1, 093, 980	7. 99	8, 743, 741	10, 786, 672	5, 180, 959	3, 178, 157	61. 34	9. 860	1, 234	4. 736	. 593	2. 905	. 363
Western States:															
California Nevada	236	246	58, 001	8. 00	463, 834	1, 530, 174	1, 530, 174	825, 744	53. 96	26. 382	3. 299	26. 382	3. 299	14. 237	1. 780
Arkansas Missouri	128	190	24, 310	8. 02	194, 880	609, 668	173, 919	89, 215	51. 30	25. 079	3. 128	7. 154	. 892	3. 670	. 458
New Mexico Texas	385	252	97, 197	8. 00	777, 577	3, 479, 485	1, 134, 264	529, 105	46. 65	35. 798	4. 475	11. 670	1. 459	5. 444	. 680
Wyoming Utah	741	279	206, 468	8. 08	1, 668, 127	5, 343, 108	5. 343, 108	2, 925, 476	54. 75	25. 879	3. 203	25. 879	3. 203	14. 169	1. 754
Total	1, 490	259	385, 976	8. 04	3, 104, 418	10, 962, 435	8, 181, 465	4, 369, 540	53. 41	28. 402	3. 531	21. 197	2. 635	11. 321	1. 408
Total 1951 [2]	34, 332	273	9, 383, 821	8. 05	75, 519, 269	153, 181, 107	117, 003, 425	59, 190, 960	50. 59	16. 324	2. 028	12. 469	1. 549	6. 308	. 784

[1] Includes manganese-bearing ore from the Lake Superior district.
[2] Man-hour data for Puerto Rico and Virginia are not available and are therefore excluded from all totals ;however, production data (46,972 tons of usable ore) are included with total production.

TABLE 25.—World production of iron ore, by countries,[1] 1943–47 (average) and 1948–52, in thousands of metric tons [2]

[Compiled by Lee S. Petersen]

Country [1]	1943–47 (average)	1948	1949	1950	1951	1952
North America:						
Canada	2,003	2,705	3,334	3,271	4,246	4,722
Cuba	28	37	12	12	17	101
Mexico	289	333	363	420	460	500
United States	90,972	102,625	86,301	99,619	118,375	99,490
South America:						
Argentina [3]	32	33	40	40	50	(4)
Brazil	685	1,572	1,888	1,987	2,407	[3] 2,972
Chile [5]	976	2,545	2,597	2,976	3,252	2,209
Venezuela	----	----	----	198	1,270	1,970
Europe:						
Austria	1,575	1,269	1,488	1,859	2,370	2,653
Belgium	60	89	42	46	79	135
Bulgaria [3]	(4)	11	20	27	(4)	(4)
Czechoslovakia	1,257	1,428	[3] 1,400	[3] 1,600	[3] 1,800	[3] 2,000
France	18,722	23,061	31,424	29,983	35,264	41,176
Germany:						
East Germany [3]	} 7,184	250	250	328	485	(4)
West Germany		7,276	9,112	10,882	12,923	15,404
Greece	3	----	----	5	53	137
Hungary	338	318	339	368	[3] 370	[3] 370
Italy	344	549	554	476	553	790
Luxembourg	2,762	3,399	4,137	3,845	5,625	7,245
Norway	150	199	275	298	332	769
Poland	481	659	699	790	[3] 900	[3] 1,000
Portugal	----	(6)	(6)	----	21	(4)
Rumania [3]	174	209	324	395	478	560
Spain	1,476	1,631	1,876	2,088	2,389	2,891
Sweden	7,552	13,286	13,729	13,611	16,111	17,381
Switzerland	114	75	70	55	86	(4)
U. S. S. R.[3] [7]	19,000	30,000	35,000	44,000	48,000	50,000
United Kingdom	14,515	13,299	13,612	13,143	14,882	16,234
Yugoslavia	[3] 312	879	835	826	581	676
Asia:						
China [3]	4,724	[8] 247	500	2,000	3,000	4,000
Hong Kong	----	1	60	172	164	130
India	2,477	2,321	2,854	3,005	3,642	[3] 3,455
Japan [9]	1,969	561	794	927	1,168	1,295
Korea:						
Korea, Republic of	} [3] 1,349	{ ----	----	----	----	17
North Korea		[3] 200	(4)	(4)	(4)	(4)
Malaya	15	1	9	507	860	1,031
Philippines	[3] 300	18	370	599	903	1,170
Portuguese India	----	8	151	131	436	494
Thailand (Siam)	1	----	----	3	6	3
Turkey	114	192	211	234	226	482
U. S. S. R.	(7)	(7)	(7)	(7)	(7)	(7)
Africa:						
Algeria	1,080	1,872	2,538	2,573	2,823	3,092
French Morocco	60	301	357	319	533	651
Liberia	----	----	----	----	171	904
Northern Rhodesia	----	(6)	2	----	----	6
Sierra Leone	719	968	1,104	1,185	1,204	1,401
Southern Rhodesia	----	30	51	57	52	65
Spanish Morocco	732	885	893	951	937	970
Tunisia	168	696	712	758	923	977
Union of South Africa	878	1,164	1,242	1,189	1,421	1,759
Oceania:						
Australia	2,053	2,077	1,484	2,403	2,468	2,785
New Caledonia	19	----	----	15	----	(4)
New Zealand	6	5	4	4	3	(4)
Total (estimate)	188,000	219,000	223,000	250,000	294,000	297,000

[1] In addition to countries listed Egypt and Madagascar report production of iron ore in past years, but quantity produced is believed insufficient to affect estimate of world total.
[2] This table incorporates a number of revisions of data published in previous iron ore chapters.
[3] Estimate.
[4] Data not available; estimate by author of chapter included in total.
[5] Production of Tofo mines.
[6] Less than 500 tons.
[7] U. S. S. R. in Asia included with U. S. S. R. in Europe.
[8] Production of National Resources Commission only.
[9] Includes iron sand production as follows: 1948, 2,592 tons; 1949, 33,120 tons; 1950, 101,544 tons; 1951, 213,924 tons; 1952, 262,620 tons.

Ontario.—Algoma Ore Properties, Ltd., Helen mine shipped 1,146,000 tons of siderite sinter, principally to United States consumers, and Steep Rock Iron Mines, Ltd., shipped 1,275,000 tons from the Errington pit. Both companies continued development of their properties, and elsewhere in Ontario exploration for iron ore was intensified.

Marmoraton Mining Co., Ltd., subsidiary of Bethlehem Steel Corp., was developing a magnetite deposit at Marmora and expects initial shipments of concentrates in 1954. Although mill facilities are designed for 500,000-ton annual capacity, no reserve estimates have been released. Oliver Iron Mining Division, United States Steel Corp., was exploring for subsurface magnetite deposits near Simcoe on the north shore of Lake Erie; drilling will continue in 1953. Nipiron Mines, Ltd., explored 2 leases totaling 38 square miles at Lake Nipissing. Magnetometer surveys were made, and drilling will continue in 1953. The Steel Co. of Canada, Ltd., examined 250 properties during 1952, most of which were in Ontario. Five of these were selected for further investigation. Algoma Ore Properties, Ltd., made concentration tests of magnetite samples from properties drilled in 1951 near Calabogie. Jalore Mining Co., Ltd., a subsidiary of Jones & Laughlin Steel Corp., continued investigations of siderite deposits in the Michipicoten district and magnetite prospects in the Peterborough and Kingston areas. Others active in iron-ore exploration in Ontario included Canadian Cliffs, Ltd., Dominion Gulf Co., Trent River Mines, Ltd., Frobisher, Ltd., and numerous individual property owners and prospectors.

Quebec-Labrador.—The Iron Ore Co. of Canada pushed large-scale construction and development, with emphasis on the 360-mile railway from Burnt Creek to Seven Islands on the Gulf of St. Lawrence. Construction on the ore docks progressed on schedule, and they were in partial use at the end of the year. Crews were test-drilling the Ferriman No. 3 ore body in Quebec and the Ruth Lake No. 3 ore body in Labrador in preparation for initial production, and geological parties were mapping large areas to establish ground control and evaluate ore possibilities. No drilling was done to establish additional ore reserves.

North and west of the areas under development, several companies were exploring concession tracts for new deposits of commercial ore. Fenimore Iron Mines, Ltd., sank 10,012 feet of drill holes in the region of the Koksoak River. Iron-bearing material was discovered but not of the character sought. Fort Chimo Mines, Ltd., a subsidiary of Frobisher, Ltd., has employed geological parties and trenching crews for the past four seasons. A deposit of manganiferous hematite was discovered that will be further investigated. Quebec-Labrador Development Co., Ltd., discovered two occurrences of high-grade ore along the Kaniapiskau River and plans further investigation.

Elsewhere in Quebec, the Oliver Iron Mining Division, United States Steel Corp., explored subsurface possibilities in the area of Matonipi Lake and staked claims for future exploration in the Mount Wright area near the southwestern Labrador border. Trent River Iron, Ltd., a subsidiary of the W. S. Moore Co. of Duluth, explored the Old Bristol Magnetite property 35 miles northwest of Ottawa.

Plans were being made for producing concentrates. Gravimetric Surveys, Ltd., investigated iron-ore prospects in Gatineau and Buckingham Counties.

The Quebec Iron & Titanium Corp. at Sorel produced 15,000 tons of iron and steel in 1952 from Allard Lake titaniferous magnetite as a coproduct with titanium oxide slag.

OTHER COUNTRIES

Algeria.—Algeria supplies iron ore both to the United States and Europe. Since 1947, 400,000 to 500,000 gross tons has been exported annually to the United States, and the remainder goes to the Benelux countries, United Kingdom, France, Germany, and Italy. However, in 1952, United States imports dropped to 66,000 tons, notwithstanding a 10-percent increase in production over the preceding year. Inasmuch as United States demand was strong during the year, it is reasonable to assume that price negotiations failed and the resultant surplus was taken by European buyers.

Austria.—The Erzberg and Radmer deposits have been reactivated with Economic Cooperation Administration assistance totaling $3,111,000.[13] Production, including that from the Hatenberg and Schaferotz deposits has climbed steadily from 323,000 tons in 1945 to 2,653,000 in 1952.

Brazil.—Cia. Vale do Rio Doce mines and exports near-perfect iron ore, especially suitable for use in open-hearth steel furnaces. The ore commands premium prices and is in strong demand in Europe and the United States. Recent mechanization at Caue Peak mining operations and rail transportation improvements are reflected in increased Brazilian production totals. From 518,000 metric tons in 1946, output rose to 2,407,000 tons in 1951. The Caue Peak mine in Central Minas Gerais was described in two recent articles.[14] [15]

Chile.—Bethlehem Chile Iron Mines Co. produced 2,209,000 metric tons from the open-pit Tofo mine, a decrease of 32 percent below 1951 which reflects declining reserves and the transfer of shipping facilities to the Venezuelan trade.

Cuba.—The United States received 87,536 gross tons of ore from Cuba in 1952. However, most of this tonnage is believed to have been nonlateritic and included open-hearth grades of magnetite supplied by independent producers.

Egypt.—A report on the survey of Aswan iron-ore deposits conducted by the Department of Mines and Quarries is in preparation [16] and is expected to influence decisions concerning a possible iron and steel industry in Egypt.

French West Africa.—Two iron-ore areas—the Conakry deposits in French Guinea and the Fort Gouraud deposits in Mauretania—were under development and promised substantial contributions to world supply. Conakry was expected to begin shipments by the end of 1952, and Fort Gouraud was in the early stages of development plan-

[13] Engineering and Mining Journal, vol. 153, No. 10, October 1952, p. 168.
[14] Van Denberg, Joseph K. Jr., Itabira Is Breaking Its Bottleneck: Eng. and Min. Jour., vol. 153, No. 7, July 1952, pp. 86–89.
[15] Packard, W. V., Iron Ore; Brazil Pecks Away at Vast Blue Lode: Iron Age, vol. 169, No. 20, May 15, 1952, pp. 67–70.
[16] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 1, January 1953, p. 12.

ning.[17] ECA assistance in the development of the Conakry deposits were described.[18]

India.—Iron ore from mines in India supply domestic furnaces as well as exports to Japan and Europe. Reserves are large enough to support increased exports as well as possible future domestic requirements. However, development of this trade is retarded by inadequate rail facilities. In 1952 considerable activity involved new exploration as well as international negotiations for foreign participation in the expansion of output. United States Technical Cooperation funds were made available in appropriate circumstances, and Japanese importers appeared ready to invest in long-term iron-ore supplies for their furnaces. Production of iron ore by mine, producer, and State were published for 1949 and 1950.[19]

Japan.—Imports of iron ore from the United States reached an annual rate of nearly 2 million tons during the first half of 1952. However, this trade tapered off in the second half owing to increased exports from British Columbia. Japanese efforts to procure iron ore continued in India, Malaya, and the Philippines.

Liberia.—Production at Bomi Hills approached 1 million tons in 1952, of which over half came to the United States. Geologic investigations of the area over a period extending from 1944 to 1952 were summarized and the entire report was placed on open file at the Federal Geological Survey in Washington.[20] In 1952 the Government of Liberia expressed dissatisfaction with existing royalty contracts and asked for renegotiation. Aspects of the situation were discussed.[21] The settlement specified that Liberia was to receive a royalty starting immediately, and a share-the-profits plan would go into effect in 1957: 25 percent of the net profits for 5 years, 35 percent for the next 10 years, and 50 percent thereafter.[22]

Mexico.—Iron ore has been produced in Mexico for domestic consumption as well as export. A number of deposits remain undeveloped which the export market could support. However, the Mexican Government announced recently that new export permits would be granted only on the condition that facilities for domestic beneficiation (smelting) be constructed and operated in conjunction with exploitation of the deposits.[23]

Norway.—The Sydvaranger mines near Kirkenes have been rehabilitated following destruction of all facilties during World War II. ECA funds financed the reconstruction which is now complete.[24] Norwegian iron ore 1952 output including the Sydvaranger mines more than doubled the 1951 production.

Peru.—The Marcona iron deposit is to be exploited under a provisional contract between the Santa Corp., a wholly owned Government firm, and the Utah Construction Co. A part of the production is to

[17] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 2, February 1952, p. 7.
[18] Moyal, Maurice, The Role of ECA in the Development of French Africa's Mineral Resources: Min. Jour. (London), vol. 238, No. 6082, Mar. 14, 1952, pp. 267–268.
[19] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 1, January 1952, p. 9.
[20] Thayer, Thomas P., Iron-Ore Deposits of Liberia: Econ. Geol., vol. 47, No. 7, November 1952, p. 777.
[21] Mining Journal (London), vol. 239, No. 6103, Aug. 8, 1952, pp. 148–149.
[22] Steel magazine, vol. 131, No. 15, Oct. 13, 1952, p. 72.
[23] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 4, April 1953, p. 13.
[24] Metal Bulletin (London) No. 3571, Dec. 12, 1952, p. 21.

be reserved for domestic consumption in a new steel plant and the remainder is for export.[25]

Sweden.—Production of iron ore continued to expand in 1952 with an increase of 8 percent over 1951. The increase, however, went to European consumers where the need for this high-grade ore was pressing. Germany and the United Kingdom are the largest users with the United States as third largest, receiving slightly over 2 million tons annually.

Union of South Africa.—A review of the Union's iron ore resources and plans to install Krupp-Renn smelting facilities was published.[26]

Venezuela.—El Pao production and receipts of El Pao ore in the United States approached 2,000,000 tons in 1952. Development at Cerro Bolivar and dock construction at Puerto Ordaz progressed rapidly during the year. These activities and facilities were reviewed in an illustrated article.[27]

[25] American Metal Market, vol. 59, No. 233, Dec. 5, 1952, p. 1.
[26] South African Mining and Engineering Journal, Krupp-Renn Process and Union Iron Ores: Vol. 63, No. 3081, Mar. 1, 1952, pp. 7–11.
[27] United States Steel News, Ore Is Where You Find It: Vol. 17, No. 4, October 1952, pp. 1–7.

Iron and Steel

By James C. O. Harris [1]

THE IRON and steel industry experienced the most disastrous work stoppages in its history in 1952. In addition to the 54-day strike that started June 3, there were other stoppages in April and May. The loss of steel production caused workers to be idled in the automotive, railroad, construction, and other industries, which curtailed the production of many finished products. Although the percentage of capacity operating rate for steel and pig iron dropped from 101 and 97, respectively, in 1951 to 86 and 85, respectively, in 1952, steel companies made a strong recovery following the strikes and operated at an average of 105 percent of capacity for the last 4 months of the year, with a high of 107 percent of capacity in October. Contributing to the makeup in lost production was an increased steelmaking capacity of 8,935,000 tons in 1952—the largest annual gain on record—to a new high of 117,522,000 tons. This was over twice the 1951 expansion of 4,358,000 tons.

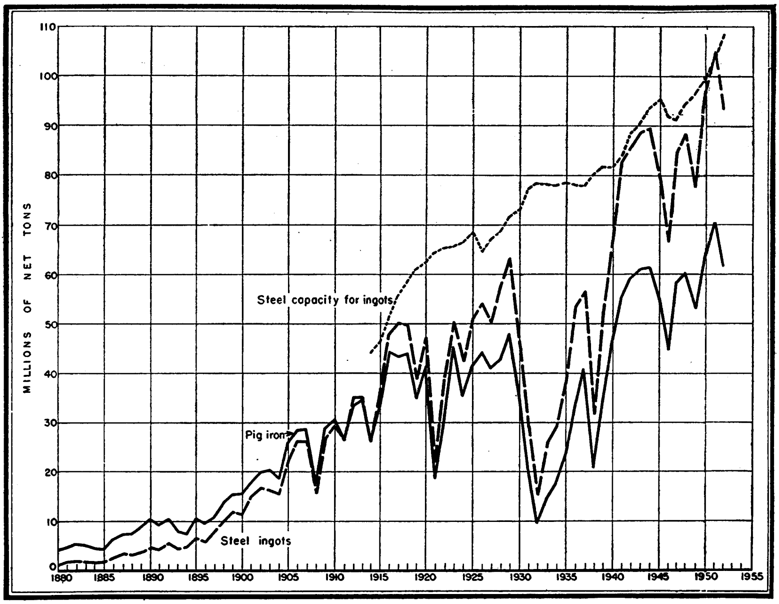

FIGURE 1.—Production of pig iron and steel ingots (1880–1952) and steel-ingot capacity (1914–52) in the United States.

[1] Commodity-industry analyst.

The automotive industry was the largest user of steel in 1952, receiving 11.4 million tons or 17.6 percent of total shipments, valued at 1.5 billion dollars.[2] Total passenger car, truck, and coach sales were 5,538,558 units an 18-percent decrease from 1951.

The construction industry received 12.1 percent of steel shipments in 1952. Construction of new houses (permanent, nonfarm dwellings) was high in 1952, with an estimated 1,127,000 units started during the year compared with 1,091,300 in 1951. Total new construction during the year was valued at $32.6 billion, compared with $31 billion in 1951, and absorbed 7.8 million tons of steel products.

The container industry used less steel in 1952 than in 1951, but its percentage of total United States domestic shipments was the same (8.6 percent). Railroads received 4 million net tons of steel products in 1952 compared with 5.8 million net tons in 1951. Freight-car loading in 1952 decreased 6.3 percent from 1951. Shipbuilding requirements were the highest since 1945, and exports were the greatest since 1949, with a 29-percent increase over 1951

United States Department of Commerce statistics show that semimanufactured and manufactured steel products for export exceeded the 1951 figure. There was a marked increase in steel ingots, blooms, billets, slabs, sheet bars, concrete reinforcing bars, iron and steel wire (uncoated), and welded galvanized pipes and tubes. Iron bars and wire nails decreased considerably. Total structural shapes decreased, but fabricated structural shapes increased.

TABLE 1.—Salient statistics of iron and steel in the United States, 1943–47 (average) and 1948–52, in net (short) tons

	1943–47 (average)	1948	1949	1950	1951	1952
Pig iron:						
Production	55, 632, 485	60, 073, 140	53, 323, 142	64, 499, 983	70, 277, 938	61, 308, 424
Shipments	55, 698, 378	60, 051, 350	52, 919, 019	64, 626, 146	70, 250, 379	61, 234, 790
Imports	15, 074	219, 252	99, 804	804, 799	1, 066, 513	389, 588
Exports	100, 844	7, 032	81, 309	6, 813	6, 555	14, 085
Steel: [1]						
Production of ingots and castings:						
Open-hearth:						
Basic	72, 753, 522	78, 714, 852	69, 742, 110	85, 661, 651	92, 387, 447	82, 143, 400
Acid	948, 701	625, 305	506, 693	600, 858	779, 071	703, 039
Bessemer	4, 506, 203	4, 243, 172	3, 946, 656	4, 534, 558	4, 890, 946	3, 523, 677
Electric	3, 726, 885	5, 057, 141	3, 782, 717	6, 039, 008	7, 142, 384	6, 797, 923
Total	81, 935, 311	88, 640, 470	77, 978, 176	96, 836, 075	105, 199, 848	93, 168, 039
Capacity, annual, as of January 1	92, 625, 600	94, 233, 460	96, 120, 930	99, 392, 800	104, 229, 650	108, 587, 670
Percent of capacity	88. 5	94. 1	81. 1	97. 4	100. 9	85. 8
Production of alloy steel:						
Stainless	509, 576	617, 378	455, 093	832, 309	933, 730	930, 164
Other than stainless	8, 677, 632	7, 863, 736	5, 442, 476	7, 737, 796	9, 190, 857	8, 204, 587
Total	9, 187, 208	8, 481, 114	5, 897, 569	8, 570, 105	10, 124, 587	9, 134, 751
Shipments of steel products:						
For domestic consumption	54, 323, 974	62, 728, 250	54, 586, 039	69, 665, 819	76, 164, 539	64, 732, 412
For export	4, 310, 771	3, 244, 888	3, 517, 971	2, 566, 473	2, 764, 411	3, 271, 200
Total	58, 634, 745	65, 973, 138	58, 104, 010	72, 232, 292	78, 928, 950	68, 003, 612

[1] American Iron and Steel Institute.

[2] Computed using unit value determined from data on all steel shipments as reported by Facts for Industry series M22B–02, pp. 6–7, Bureau of the Census, U. S. Department of Commerce, Aug. 28, 1953.

Average weekly hours worked per employee in the steel industry was 39.7 in 1952, compared with 41.1 hours in 1951 and 37.9 hours in 1949, another strike year. The average number of employees was 489,000, with a high of 570,000 in January and a low of 132,000 in July. There was an increase from 530,000 in August to 561,000 in December. The average, earned hourly, per worker was $1.98, as compared with $1.89 in 1951 and $1.69 in 1950. The average composite price of finished steel, as published by the Iron Age, was 4.237 cents per pound. The price was increased from 4.131 cents to 4.180 in July and to 4.376 in August.

A development of major significance to the world's iron and steel industry was the establishment of the European Coal and Steel Community (Schuman Plan) for Western Europe on July 23, 1952, when the legislative bodies of France, West Germany, Belgium, Italy, Luxembourg, and the Netherlands completed ratification of the treaty that set up this community. This plan is designed to do away with old differences between the countries of western Europe and to eliminate frontier barriers by removing customs duties, quotas, and other restrictions that hinder free movement of goods. The administration of this plan is being carried out by a governing body composed of representatives from each member nation.

GOVERNMENT REGULATIONS

During the year 1952 distribution of iron and steel, in addition to copper and aluminum, was regulated under the Controlled Materials Plan instituted in 1951 by the National Production Authority. The CMP regulations covered those materials for production, construction, and maintenance, repair and operating supplies for industry in general. There were a few cases where those materials were distributed under the orders of NPA where the peculiar circumstances within an industry made it difficult to use the CMP basic structure. Examples of these were Order M–50 for electric utilities, and the M–46 series for the petroleum and gas industries. Under the Controlled Materials Plan steel was allotted to the Federal units that were designated to act as claimant agencies for certain industries. The Federal agencies in turn processed the applications for production and construction materials filed by individual firms and made the allotments of steel to each applicant.

M–1, Steel, governed the steel mills as to production of steel-mill products. It among other things established the lead times required for placing of orders for the different steel mill products.

M–6A, Steel Distributors, governed the receipt and distribution of steel-mill products by distributors.

M–80, Iron and Steel, Alloying Materials and Alloy Products, required all processors and melters to prepare and submit to NPA melting or processing schedules and reports on their inventories of these materials. Revisions of the order were issued from time to time governing allocation or use limitation of the individual alloying material.

PRODUCTION AND SHIPMENTS OF PIG IRON

Domestic production of pig iron, exclusive of ferro-alloys, decreased 13 percent from 1951 and was the lowest since 1949. Tennessee and West Virginia, whose production figures are listed together, and California were the only group of States to report an increase in 1952. Pennsylvania, Ohio, Indiana, and Illinois produced 67 percent of the total in 1952 compared with 69 percent in 1951. Pig-iron production in Pennsylvania and Illinois decreased 16 and 17 percent, respectively, while Indiana and Ohio decreased 15 and 10 percent, respectively, in 1952 as compared with 1951. Pig-iron production in 1952 consumed 84,042,000 net tons of domestic iron and manganiferous ores and 5,521,000 tons of foreign ores with 52 percent of the imports coming from Chile and Venezuela. Consumption of Venezuelan iron ore in the blast furnace increased 128 percent, and that of Swedish origin decreased 41 percent compared with 1951. Blast furnaces consumed 20,606,000 tons of sinter and 9,043,000 tons of miscellaneous iron-bearing materials. In addition to the above raw materials, 1,808,000 tons of home scrap and 436,000 tons of flue dust were used.

Shipments of pig iron decreased 13 percent in quantity and 10 percent in value from 1951. The figures in table 4 cover total shipments, which consist predominantly of molten pig iron transferred to steel furnaces on the site. Values for merchant pig iron are included; however, the average value per ton of pig iron is lower than market prices published in trade journals because handling charges, selling commissions, freight costs, and other related items are not considered. The term "shipped" as distinguished from "production" refers in the case of on site transfers to departmental transfers, upon which value is placed for bookkeeping purposes rather than to actual sales, as in the case of merchant pig iron.

TABLE 2.—Pig iron produced and shipped in the United States, 1951–52, by States

State	Produced		Shipped from furnaces			
	1951 (net tons)	1952 (net tons)	1951		1952	
			Net tons	Value	Net tons	Value
Alabama	4,370,527	4,172,583	4,384,286	$192,359,317	4,108,562	$185,300,714
California	921,695	977,121	919,877	178,012,998	974,953	177,409,364
Colorado, Texas, Utah	2,866,062	2,624,715	2,881,411		2,644,168	
Illinois	6,575,674	5,484,209	6,592,721	306,764,003	5,461,716	263,873,529
Indiana	7,759,741	6,594,197	7,699,783	358,743,571	6,603,756	318,029,698
Kentucky	766,344	545,417	766,344	(1)	545,417	(1)
Maryland	3,658,335	2,948,210	3,657,171	(1)	2,946,157	(1)
Massachusetts	186,296	124,897	182,184	(1)	137,963	(1)
Michigan	2,207,665	2,083,677	2,163,862	(1)	2,130,969	(1)
Minnesota	697,101	604,334	696,228	(1)	600,589	(1)
New York	4,512,389	4,067,393	4,542,343	218,058,754	4,025,323	198,482,363
Ohio	13,710,153	12,273,225	13,725,969	626,822,217	12,265,698	584,460,102
Pennsylvania	20,211,510	16,890,004	20,205,913	951,282,026	16,870,493	829,288,945
Tennessee, West Virginia	1,834,446	1,918,442	1,832,287	(1)	1,919,026	(1)
Undistributed [1]				452,066,935		408,564,615
Total	70,277,938	61,308,424	70,250,379	3,284,109,821	61,234,790	2,965,409,330

[1] Data that may not be shown separately because they would reveal individual company operations are combined as "Undistributed."

TABLE 3.—Foreign iron ore and manganiferous iron ore consumed in the manufacture of pig iron in the United States, 1951–52, by sources of ore, in net tons

Source	1951	1952	Source	1951	1952
Africa	614,743	435,607	Mexico	185,536	137,583
Brazil	233,046	378,610	Sweden	1,067,691	633,724
Canada	910,639	959,256	Venezuela	451,692	1,031,891
Chile	2,977,266	1,841,327	Unclassified	39,239	58,012
Cuba	16,898	44,313			
India	2,095	615	Total	6,498,845	5,520,938

TABLE 4.—Pig iron shipped from blast furnaces in the United States, 1951–52, by grades [1]

Grade	1951			1952		
	Net tons	Value		Net tons	Value	
		Total	Average		Total	Average
Foundry	3,371,400	$154,735,170	$45.90	2,674,827	$122,952,546	$45.97
Basic	55,045,515	2,571,504,501	46.72	48,378,353	2,343,116,271	48.43
Bessemer	8,191,237	383,395,106	46.81	6,728,619	328,589,203	48.83
Low-phosphorus	327,570	17,756,536	54.21	303,494	16,655,961	54.88
Malleable	3,106,087	146,691,219	47.23	2,965,932	144,951,694	48.87
All other (not ferroalloys)	208,570	10,027,289	48.08	183,565	9,143,655	49.81
Total	70,250,379	3,284,109,821	46.75	61,234,790	2,965,409,330	48.43

[1] Includes pig iron transferred directly to steel furnaces at same site.

Metalliferous Materials Used.—The production of pig iron in 1952 required 110,168,932 net tons of iron ore, sinter, and manganiferous iron ore; 3,182,218 net tons of mill cinder and roll scale; 3,391,402 net tons of open-hearth and Bessemer slags; 2,373,823 tons of purchased scrap; and 95,899 tons of other materials—an average of 1.944 tons of metalliferous materials (exclusive of home scrap and flue dust) per ton of pig iron made.

Alabama furnaces used hematite from the Birmingham district, Missouri, and the Lake Superior region, brown ores from Alabama and Georgia, and byproduct ores from Tennessee. Foreign iron ores were from Africa, Brazil, Chile, Cuba, and Sweden and foreign manganese-bearing ores from Africa, Brazil, and India.

Blast furnaces at Fontana, Calif., used iron ore from Eagle Mountain, Riverside County, Calif.

Pueblo, Colo., furnaces (Colorado Fuel & Iron Corp.) used iron ore from Wyoming and Utah.

Seventy-five percent of the iron ore used at Sparrows Point, Md., came from Chile and Venezuela. Other sources besides the domestic supply were Sweden, Africa, Cuba, and Canada. African and Egyptian manganiferous ores were also used.

In addition to the Lake Superior ore used in Pennsylvania, iron ore was used from Brazil, Canada (Algoma sintered ore), Sweden, Africa, Cuba, Venezuela, Puerto Rico, Spain, and Norway. A small quantity of manganiferous ore came from Africa and Mexico.

342070—55——35

Blast furnaces in Illinois, Indiana, Ohio, and West Virginia used iron and manganiferous ores from the Lake Superior region of the United States and Canada almost exclusively. Republic Steel at Cleveland used some Liberian iron ore.

The Everett, Mass., blast furnaces used iron ore from Brazil, Algeria, Newfoundland, and Spain, as well as from the Lake Superior region. In New York, the blast furnaces in the Buffalo district used magnetite from the Mineville district of New York, hematite from Canadian and domestic mines in the Lake Superior region, and a small tonnage of Liberian ore as well as manganiferous ores from Minnesota. The Troy furnace consumed magnetite from Chateaugay mine at Lyon Mountain, N. Y., and manganiferous ore from India and South Africa. Texas furnaces used domestic, treated domestic, and Mexican ores; manganese ore from Mexico was also used.

Utah furnaces used iron ore from Iron County, Utah, and manganiferous ore from Nevada and Utah.

TABLE 5.—Number of blast furnaces (including ferroalloy blast furnaces) in the United States, December 31, 1951–52

[American Iron and Steel Institute]

State	Dec. 31, 1951			Dec. 31, 1952		
	In blast	Out of blast	Total	In blast	Out of blast	Total
Alabama	19	2	21	19	2	21
California	2		2	2		2
Colorado	3	1	4	4		4
Illinois	21	1	22	22		22
Indiana	21	1	22	22	1	23
Kentucky	3		3	3		3
Maryland	8		8	8		8
Massachusetts	1		1		1	1
Michigan	6		6	7		7
Minnesota	3		3	3		3
New York	16		16	17		17
Ohio	50		50	50	1	51
Pennsylvania	74	3	77	74	6	80
Tennessee	3		3	3		3
Texas	2	1	3	2		2
Utah	5		5	5		5
Virginia	1		1	1		1
West Virginia	4		4	5		5
Total	242	9	251	247	11	258

TABLE 6.—Iron ore and other metallic materials consumed and pig iron produced in the United States, 1951–52, by States, in net tons

State	Metalliferous materials consumed					Pig iron produced	Materials consumed per ton of pig iron made			
	Iron and manganiferous iron ores		Sinter	Miscellaneous [1]	Total		Ores	Sinter	Miscellaneous	Total
	Domestic	Foreign								
1951										
Alabama	8,407,299	55,811	1,870,622	253,467	10,587,199	4,370,527	1.936	0.428	0.058	2.422
California	862,977		623,836	121,854	1,608,667	921,695	.936	.677	.132	1.745
Colorado, Texas, Utah	3,474,102	187,631	1,523,618	136,783	5,322,134	2,866,062	1.278	.531	.048	1.857
Illinois	11,762,281		1,110,851	997,464	13,870,596	6,575,674	1.789	.169	.152	2.110
Indiana	13,292,905	106,520	1,578,502	619,489	15,597,416	7,759,741	1.727	.203	.080	2.010
Kentucky	1,214,304		96,218	166,054	1,476,576	766,344	1.585	.125	.217	1.927
Maryland	550,696	4,582,020	683,878	596,759	6,413,353	3,658,335	1.403	.187	.163	1.753
Massachusetts	181,678	119,400		20,092	321,170	186,296	1.616		.108	1.724
Michigan	3,076,112	2,852	623,458	752,211	4,454,633	2,207,665	1.395	.282	.341	2.018
Minnesota	1,269,460			143,984	1,413,444	697,101	1.821		.207	2.028
New York	5,903,809	33,896	2,036,261	667,870	8,641,836	4,512,389	1.316	.451	.148	1.915
Ohio	19,043,978	634,432	4,631,816	2,137,676	26,447,902	13,710,153	1.435	.338	.156	1.929
Pennsylvania	25,654,976	607,150	8,622,428	3,443,590	38,328,144	20,211,510	1.299	.427	.170	1.896
Tennessee, West Virginia	2,580,228	169,133	110,148	181,783	3,041,292	1,834,446	1.499	.060	.099	1.658
Total	97,274,805	6,498,845	23,511,636	10,239,076	137,524,362	70,277,938	1.477	.334	.146	1.957
1952										
Alabama	7,734,858	93,493	1,743,039	133,990	9,705,380	4,172,583	1.876	.418	.032	2.326
California	952,606		612,356	172,227	1,737,189	977,121	.975	.627	.176	1.778
Colorado, Texas, Utah	3,160,945	131,675	1,400,063	139,492	4,832,175	2,624,715	1.255	.533	.053	1.841
Illinois	9,607,782		794,510	861,417	11,263,709	5,484,209	1.752	.145	.157	2.054
Indiana	10,898,052	61,790	1,480,004	695,179	13,135,025	6,594,197	1.662	.225	.105	1.992
Kentucky	849,905		90,397	128,122	1,068,424	545,417	1.558	.166	.235	1.959
Maryland	355,085	3,590,849	522,458	635,510	5,103,902	2,948,210	1.338	.177	.215	1.731
Massachusetts	168,977	57,083		8,583	234,643	124,897	1.810		.069	1.879
Michigan	2,946,089		631,896	390,499	3,968,484	2,083,677	1.414	.303	.188	1.905
Minnesota	1,091,608			158,239	1,249,847	604,334	1.806		.262	2.068
New York	5,082,100	53,790	1,873,408	651,463	7,660,761	4,067,393	1.263	.460	.160	1.883
Ohio	17,388,909	643,759	3,932,175	2,030,875	23,995,718	12,273,225	1.469	.320	.166	1.955
Pennsylvania	21,087,233	719,858	7,382,109	2,893,234	32,082,434	16,890,004	1.291	.437	.171	1.899
Tennessee, West Virginia	2,718,235	168,641	143,195	144,512	3,174,583	1,918,442	1.505	.075	.075	1.655
Total	84,042,384	5,520,938	20,605,610	9,043,342	119,212,274	61,308,424	1.461	.336	.147	1.944

[1] Excludes recycled materials.

PRODUCTION OF STEEL

Steel production decreased 11 percent in 1952 from 1951, and capacity continued to increase. The capacity increase during 1952 was 8 percent compared with 4 percent during 1951. Steel capacity at the end of the year was 117,522,000 tons. Of the total tonnage of steel ingots produced in the United States in 1952, 89 percent was made in open-hearth furnaces, virtually unchanged from 1951 and 1950; 7 percent was made in the electric furnaces, the same as 1951; and 4 percent was made in the Bessemer converters, compared with 5 percent in 1951 and 1950.

In 1952, 39 percent of the domestic steel was produced in the Pittsburgh-Youngstown district, 21 percent in the Chicago district, 19 percent in the Eastern district, 10 percent in Cleveland-Detroit district, 6 percent in the Western district, and 5 percent in the Southern district, compared with 39, 21, 20, 9, 6, and 5 percent, respectively, in 1951.

The data concerning steel production used by the Bureau of Mines are furnished by the American Iron and Steel Institute. The output from steel foundries that do not produce steel ingots is not included in the production data.

TABLE 7.—Steel capacity, production, and percentage of operations, in the United States, 1943–47 (average) and 1948–52, in net tons [1]

[American Iron and Steel Institute]

Year	Annual capacity as of Jan. 1	Production				
		Open-hearth	Bessemer	Electric [2]	Total	Percent of capacity
1943–47 (average)	92, 625, 600	73, 702, 223	4, 506, 203	3, 726, 885	81, 935, 311	88. 5
1948	94, 233, 460	79, 340, 157	4, 243, 172	5, 057, 141	88, 640, 470	94. 1
1949	96, 120, 930	70, 248, 803	3, 946, 656	3, 782, 717	77, 978, 176	81. 1
1950	99, 392, 800	86, 262, 509	4, 534, 558	6, 039, 008	96, 836, 075	97. 4
1951	104, 229, 650	93, 166, 518	4, 890, 946	7, 142, 384	105, 199, 848	100. 9
1952	108, 587, 670	82, 846, 439	3, 523, 677	6, 797, 923	93, 168, 039	85. 8

[1] The figures include only that portion of the capacity and production of steel for castings used by foundries operated by companies producing steel ingots. Omitted portion is about 2 percent of total steel production.
[2] Includes a small quantity of crucible.

TABLE 8.—Open-hearth steel ingots and castings manufactured in the United States, 1943–47 (average) and 1948–52, by States, in net tons [1]

[American Iron and Steel Institute]

State	1943–47 (average)	1948	1949	1950	1951	1952
New England States	432, 199	454, 524	381, 763	485, 007	535, 014	436, 993
New York and New Jersey	4, 024, 580	4, 277, 040	4, 020, 711	4, 820, 177	5, 271, 387	[2] 4, 521, 685
Pennsylvania	22, 165, 554	23, 648, 314	19, 759, 983	24, 610, 259	26, 977, 599	24, 224, 361
Ohio	13, 744, 447	14, 045, 722	12, 215, 389	15, 200, 938	16, 842, 144	14, 759, 616
Indiana	10, 066, 023	10, 453, 975	9, 099, 413	11, 055, 043	11, 888, 961	10, 414, 109
Illinois	5, 943, 456	6, 269, 723	5, 886, 460	6, 831, 337	7, 271, 633	6, 508, 525
Other States	17, 325, 964	20, 190, 859	18, 885, 084	23, 259, 748	24, 379, 780	21, 981, 150
Total	73, 702, 223	79, 340, 157	70, 248, 803	86, 262, 509	93, 166, 518	82, 846, 439

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.
[2] New York only in 1952. New Jersey included in other States.

Alloy Steel.—Alloy-steel data include steels in which the minimum of the range specified in one or more of the elements named exceeds the following percentages: Manganese, 1.65 percent; silicon, 0.60 percent; copper, 0.60 percent; or aluminum, boron, chromium, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, and other alloying elements, any added percent.

The steel output for 1952 includes 9,135,000 net tons of alloy-steel ingots and castings, a decrease of 10 percent from 1951. The production represents 10 percent of the total steel produced, as in 1951, compared with 9 percent in 1950 and 8 percent in 1949. The production of stainless steel increased from 9 percent of total alloy-steel output in 1951 to 10 percent in 1952. There was a 13-percent increase in the production of austenitic stainless steel, AISI 300 series, in 1952 over 1951, while ferritic and martensitic, AISI 400 series, decreased 15 percent. The output of type 501, 502, and other high-chromium

TABLE 9.—Bessemer-steel ingots and castings manufactured in the United States, 1943–47 (average) and 1948–52, by States, in net tons [1]

[American Iron and Steel Institute]

State	1943–47 (average)	1948	1949	1950	1951	1952
Ohio	1, 986, 542	1, 936, 873	1, 760, 006	2, 000, 294	2, 208, 456	1, 922, 776
Pennsylvania	1, 489, 730	1, 355, 934	1, 174, 866	1, 293, 746	1, 345, 297	751, 297
Other States	1, 029, 931	950, 365	1, 011, 784	1, 240, 518	1, 337, 193	849, 604
Total	4, 506, 203	4, 243, 172	3, 946, 656	4, 534, 558	4, 890, 946	3, 523, 677

[1] Includes only that portion of steel for castings produced in foundries by companies manufacturing steel ingots. See table 7.

TABLE 10.—Steel electrically manufactured in the United States, 1943–47 (average) and 1948–52, in net tons [1]

[American Iron and Steel Institute]

Year	Ingots	Castings	Total [2]	Year	Ingots	Castings	Total [2]
1943–47 (average)	3, 629, 306	97, 579	3, 726, 885	1950	5, 927, 509	111, 499	6, 039, 008
1948	4, 973, 611	83, 530	5, 057, 141	1951	7, 043, 366	99, 018	7, 142, 384
1949	3, 687, 077	95, 640	3, 782, 717	1952	6, 703, 734	94, 189	6, 797, 923

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.
[2] Includes a very small quantity of crucible steel.

TABLE 11.—Alloy-steel ingots and castings manufactured in the United States, 1943–47 (average) and 1948–52, by processes, in net tons [1]

[American Iron and Steel Institute]

Process	1943–47 (average)	1948	1949	1950	1951	1952
Open hearth:						
Basic	6, 090, 540	6, 285, 054	4, 192, 344	5, 738, 067	6, 585, 635	5, 807, 191
Acid	342, 486	128, 915	105, 550	123, 253	238, 034	218, 867
Crucible, Electric	2, 754, 182	2, 067, 145	1, 599, 675	2, 708, 785	3, 300, 918	3, 108, 693
Total	9, 187, 208	8, 481, 114	5, 897, 569	8, 570, 105	10, 124, 587	9, 134, 751

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.

heat-resisting steel, included in the stainless-steel production figures, increased 93 percent (to 38,000 net tons) in 1952, over 1951. Of the alloy steel produced in 1952, 64 percent was produced in basic open-hearth furnaces, 2 percent in acid open-hearths, and 34 percent in electric furnaces. There was a 1-percent gain in alloy-steel production in electric furnaces, as compared to 1951.

Metalliferous Materials Used.—Scrap and pig iron used in steel furnaces in 1952 totaled 105.7 million net tons. The percentage of each used was 49 and 51, respectively, compared with 48 and 52 in 1951. In addition, steel furnaces used 3,511,000 tons of domestic iron ore and 2,276,000 tons of foreign ore; the latter originated in Africa, Brazil, Canada, Sweden, and Venezuela, with small tonnages from Cuba, Dominican Republic, and Puerto Rico. Also used was 1,615,000 tons of sinter made from both foreign and domestic ores.

Iron ore is employed both as a part of the charge and as a source of oxygen in the refining process. The ore for the first use is termed "charge ore" and for the second "feed ore." The characteristics required of charge and feed ore are similar—hard lump structure, high in iron, with freedom from fines.

TABLE 12.—Metalliferous materials consumed in steel furnaces in the United States, 1943–47 (average) and 1948–52, in net tons

Year	Iron ore		Sinter	Manganese ore		Pig iron	Ferro-alloys	Iron and steel scrap	
	Domestic	Foreign		Domestic	Foreign			Home	Purchased
1943–47 (average)	3, 982, 120	267, 954	1, 254, 625	2, 920	10, 035	48, 616, 440	1, 431, 600	25, 522, 124	18, 367, 775
1948	3, 808, 155	1, 064, 513	1, 114, 032	2, 698	4, 159	52, 177, 785	1, 300, 000	24, 689, 529	22, 890, 571
1949	3, 152, 797	1, 107, 625	1, 051, 746	1, 231	3, 033	46, 502, 503	950, 000	22, 675, 212	17, 753, 002
1950	3, 495, 862	1, 799, 089	1, 310, 471	2, 877	1, 335	56, 269, 610	1, 320, 000	27, 353, 503	23, 738, 078
1951	3, 774, 770	2, 369, 165	1, 701, 404	660	2, 847	61, 750, 383	1, 470, 000	30, 100, 917	26, 986, 412
1952	3, 511, 221	2, 275, 868	1, 614, 512	15	1, 935	53, 491, 734	1, 461, 000	27, 389, 744	24, 827, 316

CONSUMPTION OF PIG IRON

Consumption of pig iron in 1952 decreased 14 percent from the 1951 figure. Pig iron, a product of the blast furnace, is a semiraw material; except for a small quantity used in direct casting, it moves to steelmaking or iron-melting furnaces for refining, alone or mixed with other ingredients. In 1952, 87 percent of the pig iron went to the steelmaking furnaces (open-hearth, Bessemer, and electric) to be processed into steel, 4 percent was used to make direct castings, and 9 percent was consumed in ironmaking furnaces. The percentage changes that occurred comparing 1951 and 1952 consumption of pig iron are as follows: Open-hearth increased 2 percent; Bessemer decreased 1 percent; cupola, the major iron-furnace consumer, decreased less than 1 percent; and other consumers remained the same. Plants using pig iron in 1950 were located in all 48 States and the District of Columbia, but consumption was concentrated largely in the steelmaking centers of the East North Central, Middle Atlantic, South Atlantic, and East South Central States. These areas in 1952 consumed 93 percent of the pig iron. Pennsylvania (the leading consumer) used 28 percent of the total and Ohio (the second-largest consumer), 19 percent.

TABLE 13.—Consumption of pig iron in the United States, 1949–52, by type of furnace

Type of furnace or equipment	1949		1950		1951		1952	
	Net tons	Percent of total	Net tons	Percent of total	Net tons	Percent of total	Net tons	Percent of total
Open-hearth	41, 782, 506	78. 2	50, 946, 134	78. 5	56, 055, 103	78. 5	49, 374, 315	80. 2
Bessemer	4, 612, 408	8. 6	5, 169, 835	8. 0	5, 551, 149	7. 8	3, 998, 751	6. 5
Electric	107, 589	. 2	153, 641	. 2	144, 131	. 2	118, 668	. 2
Cupola	4, 764, 003	8. 9	6, 059, 188	9. 3	6, 559, 800	9. 2	5, 438, 294	8. 8
Air Brackelsberg	273, 514	. 5	334, 613	. 5	400, 267	. 5	317, 500	. 5
Crucible	1, 052	(1)	1, 190	(1)	243	(1)	152	(1)
Puddling	3, 880	(1)	3, 168	(1)				
Direct castings	1, 901, 760	3. 6	2, 275, 349	3. 5	2, 703, 624	3. 8	2, 303, 281	3. 8
Miscellaneous	53	(1)						
Total	53, 446, 765	100. 0	64, 943, 118	100. 0	71, 414, 317	100. 0	61, 550, 961	100. 0

[1] Less than 0.05 percent.

TABLE 14.—Consumption of pig iron in the United States, 1948–52, by States and districts

State and district	1948 Consumers	1948 Net tons	1949 Consumers	1949 Net tons	1950 Consumers	1950 Net tons	[1] 1951 Net tons	[1] 1952 Net tons
Connecticut	59	73,173	56	56,835	54	75,868	83,101	60,598
Maine	15	14,882	11	10,304	13	9,657	9,647	4,072
Massachusetts	100	219,453	95	174,401	101	218,931	231,897	165,324
New Hampshire	16	4,178	15	3,252	16	4,190	4,762	4,607
Rhode Island	11	23,520	11	32,217	15	41,223	57,792	46,842
Vermont	14	7,687	13	6,328	13	8,783	17,331	14,643
Total New England	215	342,893	201	283,337	212	358,652	404,530	296,086
New Jersey	80	279,352	78	243,854	73	274,116	295,182	244,320
New York	174	2,948,785	170	2,652,854	163	3,060,001	3,416,408	3,128,013
Pennsylvania	401	17,667,350	390	14,834,486	347	18,315,008	20,314,328	17,026,406
Total Middle Atlantic	655	20,895,487	638	17,731,194	583	21,649,125	24,025,918	20,398,739
Illinois	216	4,809,697	209	4,498,693	204	5,465,752	5,948,201	4,893,725
Indiana	137	7,075,885	135	6,303,356	132	7,480,127	8,339,759	7,044,738
Michigan	167	2,718,956	169	2,689,505	171	3,687,724	3,605,019	3,294,753
Ohio	327	11,633,581	319	10,134,409	283	11,667,857	13,230,964	11,650,525
Wisconsin	125	260,572	121	243,420	123	295,792	341,120	278,670
Total East North Central	972	26,498,691	953	23,869,383	913	28,597,252	31,465,063	27,162,411
Iowa	50	91,291	52	107,353	54	101,702	152,275	101,833
Kansas	25	24,410	24	16,624	21	16,887	10,395	6,682
Nebraska	11		11		10			
Minnesota	58		54		59			
North Dakota	1	458,374	1	383,952	2	542,101	620,166	506,084
South Dakota	1		1		2			
Missouri	51	87,654	49	63,524	45	86,939	103,115	80,995
Total West North Central	197	661,729	192	571,453	193	747,629	885,951	695,594
Delaware	7		7		6			
District of Columbia	3	2,994,431	2	3,058,103	1	3,666,178	3,871,880	3,144,907
Maryland	23		21		18			
Florida	15	38,565	14	70,171	13	86,243	79,929	60,528
Georgia	51		50		49			
North Carolina	44	20,482	45	20,958	52	30,658	29,946	27,194
South Carolina	14	9,404	14	7,360	16	11,424	21,521	12,911
Virginia	51	1,670,691	49	1,662,263	49	1,952,608	1,929,435	1,862,646
West Virginia	26		23		22			
Total South Atlantic	234	4,733,573	225	4,818,855	226	5,747,111	5,932,711	5,108,186
Alabama	74	3,500,614	72	3,152,311	79	3,777,495	3,902,199	3,527,809
Kentucky	25		22		22			
Mississippi	8	924,040	8	761,149	8	973,876	1,041,910	845,718
Tennessee	53		50		51			
Total East South Central	160	4,424,654	152	3,913,460	160	4,751,371	4,944,109	4,373,527
Arkansas	4		3		5			
Louisiana	12	7,025	12	6,015	11	7,280	13,981	11,961
Oklahoma	9		11		15			
Texas	38	230,947	37	198,318	45	356,724	578,593	418,964
Total West South Central	63	237,972	63	204,333	76	364,004	592,574	430,925
Arizona								
Nevada	4	1,251	4	1,194	3	1,520	866	144
New Mexico								
Colorado	30	1,583,437	31	1,364,097	25	1,766,874	1,864,848	1,776,397
Utah								
Montana	4	320	4	305	3	207	276	181
Idaho	2	315	2	194	2	167	689	504
Wyoming	2	4	2	5	2	4		
Total Mountain	42	1,585,327	43	1,365,795	35	1,768,772	1,866,679	1,777,226
California	111	625,229	108	673,613	105	937,740	1,271,574	1,288,561
Oregon	23	20,849	23	15,342	24	21,462	25,208	19,706
Washington	29		35		28			
Total Pacific	163	646,078	166	688,955	157	959,202	1,296,782	1,308,267
Total United States	2,701	60,026,404	2,633	53,446,765	2,555	64,943,118	71,414,317	61,550,961

[1] Consumption for 1951 and 1952 obtained from sample monthly canvasses; therefore, exact number of consumers by States not available.

PRICES

The average value of all grades of pig iron given in the accompanying table is compiled from producers' reports to the Bureau of Mines. The figures represent value f. o. b. blast furnaces and do not include the value of ferroalloys. The average value for all grades of pig iron at furnaces was $48.43 in 1952 compared with $46.75 in 1951.

TABLE 15.—Average value of pig iron at blast furnaces in the United States; 1943–47 (average) and 1948–52, by States, per net ton

State	1943–47 (average)	1948	1949	1950	1951	1952
Alabama	$20.50	$36.52	$35.79	$39.00	$43.87	$45.10
California, Colorado, and Utah	22.46	40.93	42.92	44.52	48.50	50.83
Illinois	24.24	35.72	41.69	42.77	46.53	48.31
Indiana	24.71	37.86	41.26	42.43	46.59	48.16
New York	22.60	32.70	43.81	42.68	48.01	49.31
Ohio	24.40	37.98	40.92	42.38	45.67	47.65
Pennsylvania	23.99	36.68	43.04	43.09	47.08	49.16
Other States [1]	22.57	38.77	44.59	44.73	47.98	48.70
Average	24.41	37.17	42.05	42.85	46.75	48.43

[1] Comprises Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Tennessee, Texas, Virginia, and West Virginia.

TABLE 16.—Average monthly prices per net ton of chief grades of pig iron, 1951–52

[Metal Statistics, 1953]

Month	Foundry pig iron at Birmingham furnaces		Foundry pig iron at Valley furnaces		Bessemer pig iron at Valley furnaces		Basic pig iron at Valley furnaces	
	1951	1952	1951	1952	1951	1952	1951	1952
January	$43.64	$43.64	$46.87	$46.87	$47.32	$47.32	$46.43	$46.43
February	43.64	43.64	46.87	46.87	47.32	47.32	46.43	46.43
March	43.64	43.64	46.87	46.87	47.32	47.32	46.43	46.43
April	43.64	43.64	46.87	46.87	47.32	47.32	46.43	46.43
May	43.64	43.64	46.87	46.87	47.32	47.32	46.43	46.43
June	43.64	43.64	46.87	46.87	47.32	47.32	46.43	46.43
July	43.64	44.04	46.87	47.28	47.32	47.72	46.43	46.83
August	43.64	45.88	46.87	49.11	47.32	49.55	46.43	48.66
September	43.64	45.88	46.87	49.11	47.32	49.55	46.43	48.66
October	43.64	45.88	46.87	49.11	47.32	49.55	46.43	48.66
November	43.64	45.88	46.87	49.11	47.32	49.55	46.43	48.66
December	43.64	45.88	46.87	49.11	47.32	49.55	46.43	48.66
Average	43.64	44.61	46.87	47.84	47.32	48.29	46.43	47.39

TABLE 17.—Composite prices of finished steel in the United States, 1945–52, by months, in cents per pound

[Iron Age]

Month	1945	1946	1947	1948	1949	1950	1951	1952
January	2.412	2.464	2.877	3.193	3.720	3.837	4.131	4.131
February	2.427	2.555	2.884	3.125	3.719	3.837	4.131	4.131
March	2.432	2.719	2.884	3.241	3.715	3.837	4.131	4.131
April	2.433	2.719	2.884	3.241	3.709	3.837	4.131	4.131
May	2.436	2.719	2.884	3.214	3.706	3.837	4.131	4.131
June	2.464	2.719	2.884	3.211	3.705	3.837	4.131	4.131
July	2.464	2.719	2.914	3.293	3.705	3.837	4.131	4.180
August	2.464	2.719	3.193	3.720	3.705	3.837	4.131	4.376
September	2.464	2.719	3.193	3.720	3.705	3.837	4.131	4.376
October	2.464	2.719	3.193	3.720	3.705	3.837	4.131	4.376
November	2.464	2.719	3.193	3.720	3.705	3.837	4.131	4.376
December	2.464	2.747	3.193	3.720	3.756	4.131	4.131	4.376
Average	2.449	2.686	3.014	3.434	3.713	3.862	4.131	4.237

FOREIGN TRADE [3]

Pig-iron imports decreased from 1,067,000 tons in 1951 to 390,000 in 1952. Pig-iron exports in 1951 were 7,000 tons ($352,000), and in 1952 exports were 14,000 tons ($719,000). Total imports of steel (manufactures and semimanufactures) decreased from 2,289,000 tons in 1951 to 1,231,000 in 1952. Exports of steel rose from 3,429,000 tons in 1951 to 4,412,000 in 1952, an increase of 29 percent.

Seventy-three percent of the total pig iron imported came from Canada and 16 percent from Germany, Norway, and Spain. The United Kingdom received 59 percent of the pig iron exported; Canada and Mexico received a total of 27 percent.

Steel bars, boiler and other iron and steel plate, and structural iron and steel again headed the principal import list, as they did in 1950 and 1951. Tinplate and terneplate, casing and line pipe, and structural shapes made up 34 percent of the total exports.

The balance of trade shifted from exports to imports of steel for the United Kingdom and Germany in 1952. Increasing demands for steel far exceeded the supply possibilities. Japan was the chief exporter to Germany during the first half of 1952, but during the second half of the year French and Saar mills had driven Japan from the German market by underquoting it for the dollar area.[4]

TABLE 18.—Pig iron imported for consumption in the United States, 1948–52, by countries, in net tons

[U. S. Department of Commerce]

Country	1948	1949	1950	1951	1952
North America: Canada	5,729	12,270	195,807	220,094	282,990
South America:					
Argentina	2	-----	-----	-----	-----
Brazil	551	-----	-----	33,936	-----
Chile	-----	-----	7,583	57,241	2,577
Europe:					
Austria	19,145	5,145	56,635	82,628	11,071
Belgium-Luxembourg	33,147	15,688	8,086	16,605	3,045
France	17,876	340	37,640	37,323	343
Germany	24,558	2,383	225,132	331,244	[1] 16,203
Italy	5,001	-----	-----	123	1
Netherlands	45,020	20,527	243,434	99,189	12,735
Norway	23,919	146	5,364	15,352	21,489
Spain	-----	-----	-----	34,048	25,224
Sweden	1,301	436	14,798	43,822	2,096
Turkey	-----	-----	-----	36,587	622
United Kingdom	-----	193	2,816	3,957	-----
Asia: India	16,101	23,077	7,168	34,158	-----
Africa: Union of South Africa	-----	-----	336	20,206	-----
Oceania: Australia	26,902	19,599	-----	-----	11,192
Total: Net tons	219,252	99,804	804,799	1,066,513	389,588
Value	$11,810,853	$4,591,779	$26,237,334	$49,169,985	$19,580,837

[1] West Germany.

[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

[4] Metal Bulletin (London), No. 3757, Jan. 6, 1953, pp. 12–13.

TABLE 19.—Major iron and steel products imported for consumption in the United States, 1950–52

[U. S. Department of Commerce]

Products	1950		1951		1952	
	Net tons	Value	Net tons	Value	Net tons	Value
Semimanufactures:						
Steel bars:						
Concrete reinforcement bars	60,421	$3,612,285	[1] 138,534	[1] $14,818,748	124,942	$13,238,368
Solid or hollow, n. e. s	108,527	6,435,303	[1] 246,489	[1] 25,027,123	111,347	14,800,749
Hollow and hollow drill steel	799	196,267	[1] 944	[1] 270,536	588	241,121
Iron slabs, blooms, or other forms			5	765	110	12,488
Bar iron	387	58,826	695	108,286	208	45,187
Wire rods, nail rods, and flat rods up to 6 inches in width	112,354	7,341,986	122,009	12,094,127	44,307	5,636,629
Boiler and other plate iron and steel, n. e. s	163,301	13,825,592	[1] 585,529	[1] 74,073,926	143,837	17,466,883
Steel ingots, blooms, and slabs	115,384	6,738,677	40,227	3,019,220	8,195	1,500,626
Billets, solid or hollow	67,089	4,200,255	99,401	8,470,562	52,918	6,244,473
Die blocks or blanks, shafting, etc	12,211	780,128	1,142	274,858	827	486,591
Circular saw plates	16	13,860	35	25,260	14	11,672
Sheets of iron or steel, common or black and boiler or other plate iron or steel	27,301	2,579,819	71,542	[1] 10,308,898	29,699	3,768,689
Sheets and plates and steel, n. s. p. f	33,101	2,806,693	[1] 36,461	[1] 4,499,488	11,068	1,106,692
Tin plate, terneplate, and taggers' tin	4,289	687,562	445	88,213	2,550	530,076
Total semimanufactures	705,180	49,277,253	[1] 1,343,458	[1] 153,080,010	530,610	65,090,244
Manufactures:						
Structural iron and steel	178,007	12,134,078	[1] 459,919	[1] 46,914,054	321,143	35,957,687
Rails for railways	7,169	318,545	11,026	561,766	3,687	236,444
Rail braces, bars, fishplates, or splice bars and tie plates	295	25,283	118	9,343	641	40,264
Pipes and tubes:						
Cast-iron pipe and fittings	1,215	119,756	6,932	733,645	5,308	675,862
Other pipes and tubes	40,495	4,724,099	[1] 239,798	[1] 40,005,096	274,066	64,506,357
Wire:						
Barbed	9,505	1,008,545	7,245	1,082,260	26,252	3,981,349
Round wire, n. e. s	17,829	1,808,094	26,977	[1] 3,793,165	9,217	1,535,857
Telegraph, telephone, etc., except copper, covered with cotton jute, etc	214	76,355	860	325,594	222	262,266
Flat wire and iron or steel strips	8,082	1,998,968	41,219	8,808,230	7,194	3,708,208
Rope and strand	2,305	718,828	[1] 4,346	[1] 1,426,796	3,343	1,307,259
Galvanizing fencing wire and wire fencing	1,367	136,107	1,466	185,472	1,597	234,207
Hoop or band iron or steel, for baling	17,885	1,574,263	14,547	1,436,478	7,324	1,049,706
Hoop, band and strips, or scroll iron or steel, n. s. p. f	41,548	2,683,009	[1] 71,705	[1] 7,459,013	18,052	1,982,130
Nails	67,524	7,189,462	56,419	7,795,986	18,520	3,030,927
Castings and forgings, n. e. s	803	177,518	3,235	1,020,793	4,083	1,234,058
Total manufactures	394,243	34,692,910	[1] 945,812	[1] 121,557,691	700,649	119,742,581
Grand total	1,099,423	83,970,163	[1] 2,289,270	[1] 274,637,701	1,231,259	184,832,825

[1] Revised figure.

TABLE 20.—Major iron and steel products exported from the United States, 1950–52

[U. S. Department of Commerce]

Products	1950		1951		1952 [1]	
	Net tons	Value	Net tons	Value	Net tons	Value
Semimanufactures:						
Steel ingots, blooms, billets, slabs, and sheet bars	61,612	$4,962,518	[2] 134,527	[2] $11,971,343	732,185	$66,321,638
Iron and steel bars and rods:						
Iron bars	1,006	164,924	2,941	499,453	1,479	216,940
Concrete reinforcement bars	18,589	1,820,988	44,426	4,820,793	93,186	10,382,546
Other steel bars	99,245	13,201,530	[2] 150,436	[2] 21,117,654	164,944	26,089,875
Wire rods	6,264	596,163	4,148	481,320	29,681	3,312,103

See footnotes at end of table.

TABLE 20.—Major iron and steel products exported from the United States, 1950–52—Continued

Products	1950		1951		1952 [1]	
	Net tons	Value	Net tons	Value	Net tons	Value
Semimanufactures—Continued						
Iron and steel plates, sheets, skelp, and strips:						
Plates, including boiler plate, not fabricated	112, 225	$12,111,005	160, 542	$19, 322, 830	232, 075	$27, 025, 828
Skelp iron and steel	116, 581	8, 720, 436	107, 878	8, 946, 310	124, 497	11, 407, 272
Iron and steel sheets, galvanized	100, 361	16, 663, 184	68, 087	12, 515, 185	64, 045	12, 389, 082
Steel sheets, black, ungalvanized	501, 175	68, 025, 075	[2] 525, 081	[2] 80, 998, 187	600, 994	92, 260, 835
Iron sheets, black	17, 046	2, 086, 764	14, 050	1, 773, 745	(3)	(3)
Strip, hoop, band, and scroll iron and steel:						
Cold-rolled	43, 289	10, 553, 658	52, 625	13, 903, 833	59, 862	15, 308, 477
Hot-rolled	49, 592	5, 598, 381	60, 589	7, 899, 601	69, 765	9, 094, 492
Tin plate and terneplate	495, 994	81, 741, 856	558, 664	113, 562, 793	599, 160	116, 325, 825
Total semimanufactures	1,622,979	226,246,482	[2] 1,883,994	[2] 297,813,047	2,771,873	390, 134, 913
Manufactures—steel-mill products:						
Structural iron and steel:						
Water, oil, gas, and other storage tanks, complete and knocked-down material	39, 147	8, 441, 499	33, 304	8, 796, 908	37, 732	10, 180, 878
Structural shapes:						
Not fabricated	153, 570	13, 800, 340	232, 035	22, 466, 923	192, 222	19, 133, 730
Fabricated	110, 348	27, 957, 015	77, 136	23, 535, 603	83, 843	21, 382, 794
Plates, sheets, fabricated, punched, or shaped	7, 370	1, 733, 857	[2] 13, 015	[2] 3, 621, 664	16, 081	4, 265, 933
Metal lath	3, 000	805, 043	4, 684	1, 326, 342	2, 693	788, 648
Frames, sashes, and sheet piling	12, 264	1, 934, 753	13, 182	2, 136, 551	8, 780	1, 671, 974
Railway-track material:						
Rails for railways	137, 391	10, 105, 145	105, 599	8, 755, 167	168, 101	14, 906, 465
Rail joints, splice bars, fishplates, and tie plates	23, 649	2, 791, 794	33, 779	4, 411, 717	50, 265	7, 099, 749
Switches, frogs, and crossings	2, 505	696, 517	2, 514	733, 539	6, 622	2, 079, 720
Railroad spikes	7, 516	1, 064, 531	8, 319	1, 466, 060	8, 955	1, 376, 618
Railroad bolts, nuts, washers, and nut locks	1, 600	371, 125	1, 673	463, 363	2, 064	584, 415
Tubular products:						
Boiler tubes	15, 541	3, 760, 427	[2] 18, 205	[2] 5, 299, 047	36, 798	9, 946, 893
Casing and line pipe	452, 160	61, 864, 657	[2] 463, 137	[2] 70,412,183	502, 611	81, 305, 482
Seamless black and galvanized pipe and tubes, except casing, line and boiler, and other pipes and tubes	17, 328	3, 112, 500	[2] 17, 196	[2] 3, 785, 263	27, 307	5, 875, 067
Welded black pipe and tubes	59, 881	8, 369, 201	68, 415	11, 096, 062	51, 439	8, 879, 217
Welded galvanized pipe and tubes	64, 990	10, 683, 312	44, 005	8, 736, 989	45, 426	8, 919, 059
Malleable-iron screwed pipe fittings	4, 099	2, 739, 743	4, 489	3, 554, 624	3, 805	3, 156, 293
Cast-iron screwed pipe fittings	620	274, 257	692	349, 614	3, 143	2, 444, 977
Cast-iron pressure pipe fittings	21, 179	2, 538, 927	[2] 38, 545	[2] 4, 594, 174	41, 946	6, 003, 320
Cast-iron soil pipe and fittings	5, 802	1, 014, 642	10, 712	2, 083, 057	9, 874	1, 722, 738
Iron and steel pipe and fittings, n. e. s.	39, 394	19, 301, 638	[2] 53, 884	[2] 24,892,631	46, 452	26, 167, 786
Wire and manufactures:						
Barbed wire	10, 976	1, 587, 017	13, 900	2, 159, 062	6, 663	1, 018, 347
Galvanized wire	11, 123	2, 023, 933	15, 741	3, 070, 636	19, 578	4, 337, 848
Iron and steel wire, uncoated	25, 936	5, 214, 337	54, 574	10, 197, 841	58, 262	9, 735, 093
Wire rope and strand	11, 632	4, 650, 253	18, 040	8, 200, 077	15, 556	7, 279, 680
Woven-wire fencing and screen cloth	8, 774	3, 205, 089	12, 933	4, 910, 328	6, 512	[4] 3, 277, 644
All other	24, 478	7, 547, 144	38, 004	12, 168, 578	33, 141	10, 772, 111
Nails and bolts, iron and steel, n. e. s.:						
Wire nails	3, 097	554, 609	8, 737	1, 534, 790	6, 990	1, 960, 237
All other nails, including tacks and staples	3, 717	1, 562, 514	5, 520	2, 241, 352	3, 316	1, 634, 850
Bolts, machine screws, nuts, rivets, and washers, n. e. s	16, 213	8, 595, 585	21, 594	13, 530, 637	25, 672	17, 383, 888
Castings and forgings:						
Horseshoes, muleshoes, and calks	340	62, 588	568	107, 699	(5)	(5)
Iron and steel, including car wheels, tires, and axles	87, 491	14, 630, 082	110, 869	20, 195, 167	118, 269	24, 153, 477
Total manufactures	1,383,131	232,994,074	[2] 1,545,000	[2] 290,833,648	1,640,118	319, 444, 931
Advanced manufactures:						
House-heating boilers and radiators		784, 595		1, 709, 679		3, 581, 725
Oil burners and parts		5, 952, 281		8, 333, 848		7, 364, 653
Tools (iron and steel chief value)		31, 570, 192		42, 999, 558		47, 086, 743
Total advanced manufactures		38, 307, 068		53, 043, 085		58, 033, 121

[1] Due to changes in classifications some data not strictly comparable to earlier years.
[2] Revised figure.
[3] Effective January 1, 1952, data included with steel sheets, black, ungalvanized.
[4] Includes wire cloth valued at $1,542,736 (12,667,342 square feet; weight not available).
[5] Effective January 1, 1952, not separately classified.

TECHNOLOGY

Several plants in the United States are now using high top-pressure blast furnaces. This process was patented (United States Patent 2,131,031, issued in 1938) by Julian Avery, a chemical engineer with Arthur D. Little, Inc. The process is designed to reduce the velocity of the reducing gas (carbon monoxide), to increase the gaseous reduction of the ore and thus minimize the direct reduction by coke. These conditions would cause the blast furnace to be more efficient, since direct reduction is an endothermic reaction, while the gaseous reduction is exothermic. Avery's theory has been tested through the construction or conversion of over 20 blast furnaces to high top-pressure type throughout the world. Results of these furnaces have shown up to an 11-percent increase in pig-iron production, 70 pounds less coke required per ton of pig iron produced, and a 50-percent lower flue-dust rate.[5]

Woodward Iron Co., Woodward, Ala., has been using conditioned air in its blast furnaces for the past 14 years, and the company reports a saving of $1.55 per ton or $1.45 net after deducting 10 cents per ton for operation of air-conditioning units. The above figure is based on coke at $15 per ton. There are also other savings, such as increased pig-iron production, probably higher yields, and a more uniform analysis. The equipment used at Woodward is designed to reduce the moisture content of the blast to 3 grains per cubic foot.[6]

In casting steel ingots, extensions of the mold (the hot tops) are now being gas heated to increase production. The purpose of the hot top is to furnish metal for feeding the cavity formed by shrinkage on cooling in killed steel. By heating hot tops with gas, it is claimed that an extra ingot is made for every 12 or 13 ingots cast.

Republic Steel Corp. has developed a method for automatically pouring ingots. One open-hearth claims that the method increased the number of good ingots from 83 to 93 percent.[7]

The production of boron steel in the United States increased 43 percent in 1952 over 1951 to 507,000 net tons, or 9 percent of total alloy steel produced. About 90 percent of the boron steel is made in the open-hearth furnaces and the remainder in the electric furnaces.

Boron is added to steel to increase hardenability. In general, the effects of boron on the mechanical properties of steel are similar to those of carbon. Boron increases the elastic limit and the ultimate strength, but at the same time decreases the toughness.

The new spectrochemical excitation unit used in steel analysis has played an important part in the increased use of boron. Because of the low specification range (0.0005 to 0.005 percent) of boron, very accurate methods are required to insure that the correct quantity of boron is employed.[8]

In 1952 Bureau of Mines engineers worked on the following projects that will be of great value to the steel industry: (1) Investigated substitutes for manganese in steel, (2) improved methods for adding and removing some elements from the steel-furnace bath by lance

---

[5] Iron and Steel Engineer, vol. 30, No. 1, January 1953, pp. 123–161.
Metal Progress, vol. 63, No. 2, February 1953, p. 71.
[6] AIME, Blast Furnace, Coke-Oven, and Raw Materials Conference: April 1952.
[7] Metal Progress, vol. 63, No. 2, February 1953, pp. 110–112. Electric-Furnace Steel Conference held in December 1952.
[8] Dean, R. S., and Silkes, B., Boron in Iron and Steel Inf. Cir. 7363, 1946, 56 pp.
Iron and Steel Engineer, p. 138, January 1953.
Materials and Methods, vol. 35, No. 1, January 1953.

injection of certain materials into the bath, (3) determined the effects of various elements on the hot-working characteristics of steel, (4) developed high-damping alloys, and (5) recovered manganese from open-hearth slag and low-grade manganese ore.

In a laboratory study on possible substitutes for manganese in sulfur control of steel, titanium and zirconium have proved partial substitutes in killed steels. A summary of results, based on sulfur ranges of 0.03 to 0.06 percent and a residual manganese of 0.15 percent, indicate that a ratio of 7.5 : 1 Mn : S is necessary for heats containing only manganese; a ratio of 5 : 1 for (Mn+Zr) : S is necessary in zirconium heats; and a ratio of 5.5 to 6.1 (Mn+Ti) : S in titanium heats was necessary to prevent hot shortness.[9]

The measurement and control of molten-steel temperatures have been subjects of considerable research for many years. Much progress has been made by the steel industry and by instrument manufacturers with the bath-immersion thermocouple employing platinum vs. platinum-rhodium wires, the blow-tube immersion pyrometer, and the spoon-immersion couple using platinum vs. platinum-rhodium wires. The most widely used is the bath-immersion thermocouple which gives consistant true temperatures with proper care. The advantages derived from proper temperature control are as follows: Longer furnace life, less bottom delays, longer ladle-lining life, less fuel consumption, increased steel production, reduction in the number of skulls, longer mold and stool life, fewer stickers, and improved steel quality.

Most of the steel companies are still trying to improve their methods and equipment for temperature control. Either improvement of present-day methods and equipment or new equipment will be the answer to this problem. A tungsten-molybdenum couple was used by H. T. Greenway, S. T. M. Johnstone, and Marion K. McQuillan at Aeronautical Research Laboratories at Melbourne, Australia, to measure temperatures up to 3,632° F.[10]

A serious defect in present-day steel technology is overspecification. Inadequate knowledge of the effect on steel properties of various elements when used individually or in various combinations is a cause of this grave defect. Increased research to include less common alloying elements would alleviate this problem. Proper distribution of such information would help steel users to buy the correct steel and save critical alloying elements.

WORLD PRODUCTION

World production of pig iron (including ferroalloys) and steel increased 1.3 and 0.5 percent, respectively, in 1952. This compares with a 12-percent increase for both materials in 1951. The Schuman Plan countries in total were second in both pig-iron and steel production, while Russia was third in both materials. United States steel production was 40 percent of world production, compared with 45 percent in 1951 and 46 percent in 1950.

[9] Metals Progress, vol. 61, No. 2, February 1952, p. 162.
[10] Industrial Heating, vol. 19, December 1952, pp. 2270–2280.

TABLE 21.—World production of pig iron (including ferroalloys), by countries,[1] 1948–52, in thousands of metric tons [2]

[Compiled by Lee S. Petersèn]

Country [1]	1948	1949	1950	1951	1952
North America:					
Canada	2,140	2,138	2,253	2,557	2,644
Mexico [3]	270	356	249	211	216
United States	56,214	49,775	60,210	65,745	57,507
South America:					
Argentina	(4)	(4)	20	28	27
Brazil	552	512	729	776	816
Chile	14	19	109	240	270
Europe:					
Austria	613	838	886	1,051	1,175
Belgium	3,929	3,749	3,695	4,847	4,774
Czechoslovakia [5]	1,660	1,875	2,052	2,200	3,000
Denmark	31	39	51	33	36
Finland	90	101	63	102	108
France	6,630	8,412	7,838	8,839	9,881
Germany:					
East Germany	182	293	335	340	(4)
West Germany	4,662	7,140	9,473	10,697	12,877
Hungary	403	428	[5] 500	[5] 410	(4)
Italy	526	445	573	1,049	1,206
Luxembourg	2,626	2,372	2,499	3,157	3,076
Netherlands	442	434	454	525	539
Norway	215	234	227	245	265
Poland	1,208	1,365	1,488	[5] 1,479	[5] 1,500
Rumania [5]	191	275	335	350	430
Saar	1,134	1,582	1,684	2,364	2,544
Spain	537	634	680	679	787
Sweden	804	860	837	838	1,040
Switzerland	[5] 30	[5] 32	34	40	(4)
Trieste	----------	61	65	40	87
U. S. S. R.[5]	14,100	16,700	19,500	22,500	25,000
United Kingdom	9,425	9,653	9,818	9,859	10,900
Yugoslavia	184	202	226	262	288
Asia:					
China [5]	147	317	1,022	1,300	1,800
India	1,494	1,637	1,706	1,853	1,843
Japan	836	1,602	2,299	3,228	3,585
Korea, North [5]	30	50	23	(4)	(4)
Taiwan (Formosa)	9	2	6	6	7
Thailand	----------	----------	8	9	[5] 2
Turkey	102	116	116	166	196
U. S. S. R.	(6)	(6)	(6)	(6)	(6)
Africa:					
Southern Rhodesia	17	28	34	32	(4)
Union of South Africa	651	708	733	805	1,129
Australia	1,158	1,046	1,336	1,357	1,560
Total (estimate)	113,000	116,000	134,000	150,000	152,000

1 Pig iron is also produced in Belgian Congo and Indonesia, but the quantity produced is believed insufficient to affect estimate of world total.
2 This table incorporates a number of revisions of data published in previous pig-iron chapters.
3 Excluding ferroalloy production, for which data are not yet available, but estimate has been included in total.
4 Data not available; estimate by author of chapter included in total.
5 Estimate.
6 U. S. S. R. in Asia included with U. S. S. R. in Europe.

Australia.—Australia planned to increase pig-iron and steel capacity from 1.6 and 2 million tons, respectively, to 1.9 and 2.4 million tons. Part of this increase was accomplished in 1952 in Port Kembla, New South Wales, works of the Australian Iron & Steel Co. when a new third blast furnace was blown in on August 27, 1952. A new open-hearth was to be producing early in 1953, with another open-hearth scheduled. When this construction is completed, steel production at this plant will be increased from 800,000 to 1,350,000 tons per year. Plans also call for a 66-inch continuous strip mill to be in operation in 1954. At New Castle, New South Wales, works, the fourth blast

TABLE 22.—World production of steel ingots and castings, by countries, 1948–52, in thousands of metric tons [1]

[Compiled by Lee S. Petersen]

Country	1948	1949	1950	1951	1952
North America:					
Canada	2,903	2,894	3,070	3,237	3,376
Mexico	264	332	333	453	[2] 548
United States [3]	80,413	70,740	87,848	95,435	84,520
South America:					
Argentina [2]	170	180	200	250	300
Brazil	483	615	789	843	894
Chile	30	32	56	190	245
Colombia [2]	10	10	10	10	10
Peru [2]	10	10	10	10	10
Europe:					
Austria	648	835	947	1,028	1,058
Belgium	3,920	3,849	3,777	5,069	5,051
Czechoslovakia [2]	2,650	2,762	3,011	3,312	4,200
Denmark	72	76	123	164	176
Finland	109	114	102	133	151
France	7,266	9,152	8,652	9,835	10,868
Germany:					
East Germany	332	603	995	1,552	[2] 1,800
West Germany	5,561	9,156	12,121	13,506	15,806
Greece [2]	17	23	26	30	45
Hungary	762	849	1,022	[2] 1,234	[2] 1,425
Ireland [2]	16	16	16	16	16
Italy	2,101	2,026	2,323	3,007	3,474
Luxembourg	2,453	2,272	2,451	3,077	3,002
Netherlands	334	428	490	554	685
Norway	71	74	81	88	98
Poland	1,955	2,305	2,515	2,792	3,180
Rumania [2]	340	459	558	646	700
Saar	1,228	1,757	1,898	2,603	2,820
Spain	673	684	807	831	1,008
Sweden	1,257	1,370	1,437	1,503	1,666
Switzerland	120	124	130	144	[2] 150
Trieste	24	29	39	56	61
U. S. S. R.[2]	18,300	23,000	27,000	31,500	35,000
United Kingdom	15,115	15,803	16,554	15,889	16,418
Yugoslavia	367	401	428	434	442
Asia:					
China [2]	30	100	550	800	1,000
India	1,276	1,374	1,461	1,524	1,608
Japan	1,714	3,111	4,838	6,502	6,984
Korea:					
Korea, Republic of	8	8	4	1	1
North Korea [2]	32	32	(4)	(4)	(4)
Pakistan	2	5	3	3	7
Thailand	(4)	(4)	5	6	[2] 4
Turkey	102	103	90	135	162
U. S. S. R	(5)	(5)	(5)	(5)	(5)
Africa:					
Egypt [2]	10	10	10	10	10
Southern Rhodesia	8	18	22	28	30
Union of South Africa	597	632	755	948	1,203
Australia	1,176	1,149	1,448	1,457	1,548
Total (estimate)	155,000	160,000	189,000	211,000	212,000

[1] This table incorporates a number of revisions of data published in previous steel chapters.
[2] Estimate.
[3] Data from American Iron and Steel Institute. Excludes production of castings by companies that do not produce steel ingots.
[4] Data not available; estimate in total.
[5] U. S. S. R. in Asia included with U. S. S. R. in Europe.

furnace of 300 tons capacity will be completed by 1955, and a new rolling mill is also planned.[11]

Brazil.—Brazil is the largest steel producer in South America—894,000 metric tons in 1952. Definite plans are in existence or under discussion for production levels of 1.5 to 2.5 million tons. Of the

[11] United Nations, European Steel Exports and Demands in Non-European Countries: Geneva, 1953, p. 170.
Metal Bulletin (London), No. 3720, Sept. 16, 1952, p. 21.
American Metal Market, vol. 59, No. 238, Dec. 12, 1952, pp. 1, 3.

total output for 1952, National Steel Co. (Volta Redonda) produced 40 percent of the pig iron, about 48 percent of the steel ingots, and 45 percent of the finished steel. Volta Redonda plans to install a new blast furnace in 1953 with a daily capacity of 1,100 metric tons of pig iron. The company anticipates an 8.5-percent increase in steel capacity to 467,000 metric tons for 1953. Cia. Siderurgica Belgo Mineira is planning to install two new blast furnaces and to increase steel production from 104,000 metric tons to 127,000. Mineracão Geral do Brasil has a third blast furnace now under construction. Two Siemens-Martin (basic open-hearth) furnaces are planned, and a blooming mill and equipment for seamless steel tubing have been ordered. Metalurgica São Francisco has a 900-ton monthly electric furnace under construction. Usina de Honorio Gurgel is installing an additional electric reduction furnace.

Construction of the new Mannesman plant at Belo Horizonte was begun in 1952, and the plant is scheduled to begin production toward the end of 1954. The plant will use the direct-reduction process, and its principal product will be seamless steel tubing at the initial rate of 40,000 tons annually.

The Governor of the State of Espirito Santo announced that construction of a new steel mill, Cia. Ferro e Aco de Vitoria, will begin soon at Vitoria. The company is financed jointly by Brazilian and German capital. Output of finished steel products is estimated at 50,000 tons in the first year. Iron ore from Itabira and electric power from the Rio Bonito power station will be used.[12]

Cia. Acos Especiais Itabira (Acesita) started production in June 1952. This company operates a charcoal blast furnace with a capacity of 75,000 tons a year, together with a Bessemer converter and electric furnaces for the production of alloy steels. The company owns a hydro-electric plant and is considering installation of an electric reducing furnace. This would increase pig-iron production to about 125,000 tons a year.[13]

Canada.—Pig-iron and steel production increased in Canada because of new furnaces. The Steel Co. of Canada in Hamilton, Ontario, added a new blast furnace with a daily capacity of 1,400 tons and four 275-ton open-hearth furnaces the last of the year. This will increase pig-iron output to 1.04 million tons and steel production to 1.7 million tons per year. Another blast furnace was also added by Dominion Foundries & Steel at Hamilton, with a daily capacity of some 800 tons.

The Algoma Steel Corp. at Sault Ste. Marie, with a million tons per year output of both pig iron and steel, is in the midst of an expansion program costing 50 million dollars which calls for new blast furnaces and increasing open-hearth capacity to 1.34 million tons per year. The expansion also includes an increase in blooming-mill capacity to 1.2 million tons and doubling of the rail and structural steel mill output.

The Dominion Steel Corp.'s main plant in Sydney, Nova Scotia, has new open-hearth furnaces under construction which will increase present capacity by 200,000 tons.

[12] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 6, June 1953, pp. 14-16.
[13] United Nations, European Steel Exports and Steel Demands in Non-European Countries: Geneva, 1953, p. 185.

Steel production in Canada is expanding steadily, and when present plans are carried out steel production should reach 4.5 million tons a year in 1954.[14]

India.—India produces about a million tons of finished steel annually, against a current demand of 2½ million tons. An expansion program was under consideration in 1945 by the Indian Government and the private steel companies; however, because of financial limitations and the difficulties of obtaining capital, equipment, and technical personnel, this program had to be modified. The Indian Planning Commission has fixed a target of 2.15 million tons of pig iron and 1.5 million tons of steel a year by 1955–56. A World Bank (International Bank for Reconstruction and Development) mission visited India in June 1952 to discuss with the Indian Government a proposal for a loan to increase production of iron and steel. The mission recommended that the two largest steel companies in India—the Indian Iron & Steel Co. and Steel Corp. of Bengal—be merged to aid in the expansion of iron and steel capacity. This was done late in 1952, and a loan of some 30 million dollars was announced to the above integrated company by the World Bank. The following new facilities will be added: Blast-furnace capacity will be increased to 1.4 million tons by the installation of two new blast furnaces with a daily capacity of 1,200 tons, 2 new batteries of coke ovens will be added, and a third 25-ton Bessemer converter will be installed. The iron mines at Gua will be mechanized, and the rolling mills will be expanded and foundry equipment modernized. This expansion will double the quantity of foundry iron and increase finished-steel output by one-third.[15]

Japan.—During 1952 Japanese pig-iron production increased 11 percent and crude-steel production 7.4 percent compared with 1951. The high rate of iron and steel production was maintained despite difficulties on the world export markets and the high cost of imported raw materials. The price of rounds fell from $135 a metric ton at the beginning of the year to below $100 at the end (this compares with a Belgian price change from $140 to $85–$90). Japan's normal source of supply for coal and iron ore was China and Manchuria, but this source has been cut off because of the Korean War and the ban on trade with Communist countries. This caused Japan to obtain these materials at higher cost from the United States and India. During the year coking coal sold for $20 per ton, and the home scrap price was $55 to $60 a ton, which was much higher than in the United States. In 1951 Japan started a Three-Year Rationalization Plan, with an estimated cost of 250 million dollars. To date 83.5 million dollars has been spent to modernize the Japanese steel industry. The anticipated capacity at the end of the plan is as follows, in thousands of metric tons: Blast furnace, 4,550; open-hearth, 6,845; and hot-finished steel, 11,957.[16]

---

[14] United Nations, European Steel Exports and Steel Demand in Non-European Countries: Geneva, 1953, pp. 223–224.
Canadian Mining Journal Annual Review of Canada's Mineral Industries, 1952: Vol. 74, No. 2, February 1953, p. 98.
Financial Post, Toronto, Canada, Feb. 21, 1953.

[15] Journal of Metals, March 1952, vol. 4, No. 3, p. 252. Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 6, December 1952, p. 9.
United Nations, European Steel Exports and Steel Demand in Non-European Countries: 1953, p. 139.

[16] Metal Bulletin No. 3764 (London), Jan. 30, 1953, p. 14.
Metal Progress, vol. 63, No. 1, January 1953, p. 113.

EUROPEAN COAL AND STEEL COMMUNITY

To obviate old differences among the countries of western Europe, representatives of France, West Germany, Belgium, Italy, Luxembourg, and the Netherlands signed a treaty on April 18, 1951, to put into effect the so-called Schuman Plan or the European Coal and Steel Community. The treaty became effective on July 23, 1952, after it had been ratified by the legislative bodies of the participating nations. The treaty provided for elimination of all tariffs, differences in transportation rates, and subsidies that have hampered the production and distribution of coal and steel in Western Europe or which discriminated against producers in one country by assisting its competitors in another. The treaty also prohibits price-fixing and other cartel arrangements among coal and steel companies. This is intended to force the mines and mills to pass along to their customers the savings made possible by eliminating tariffs and other artificial trade barriers. The treaty calls for a governing body to insure equal treatment for producers, regardless of country. This body is composed of the High Authority, the Consultative Committee, the Committee of Ministers, the Common Assembly, and the Court. The functions and composition of the component parts of this body are as follows:

The chief powers of the High Authority are to insure maintenance of free competition by prohibiting companies from engaging in restrictive practices that fix prices, control production, or allocate markets; oversee investments and make and guarantee loans for investments; obtain funds by levies on production, by borrowing, and through grants; enforce its decisions through the assessment and collection of fines and penalty payments; regulate production and distribution and fix prices and wages in certain prescribed instances where a serious imbalance between supply and demand exists; and conduct technical research, promote workers' safety, and exchange patents among the various countries. Where technological advances or the closing of uneconomic enterprises creates unemployment, the High Authority can assist in reeducating the employees to other work and in moving them to areas where labor is needed. In this connection, the participating nations agreed to ease passport restrictions to facilitate the free movement of workers in these industries from one country to another.

The Consultative Committee consists of not fewer than 30 and not more than 51 members and includes producers, workers, and consumers in equal numbers. Its functions are to assist the High Authority when deemed necessary by the High Authority and as prescribed by the treaty.

The Common Assembly is composed of 78 representatives selected from the parliaments of each country (18 each from Germany, France, and Italy; 10 each from Belgium and the Netherlands; and 4 from Luxembourg). Its chief functions are to conduct an annual review of the High Authority's work; approve the proposed budget of the Authority; and, on a motion of censure by a two-thirds vote, compel members of the Authority to resign as a body.

TABLE 23.—European production of pig iron and ferroalloys, 1946–52, in thousands of metric tons

	1946	Percent of total	1947	Percent of total	1948	Percent of total	1949	Percent of total	1950	Percent of total	1951	Percent of total	1952	Percent of total
Schuman Plan countries [1]	9,988	31.7	13,365	35.9	19,949	40.2	24,134	41.8	26,216	41.4	31,478	43.8	34,897	43.4
England	7,886	25.0	7,910	21.2	9,425	19.0	9,653	16.7	9,818	15.5	9,859	13.7	10,900	13.6
Russia	10,000	31.7	11,200	30.1	14,100	28.4	16,700	28.9	19,500	30.8	22,500	31.3	25,000	31.1
All other countries	3,639	11.6	4,780	12.8	6,148	12.4	7,237	12.6	7,779	12.3	8,069	11.2	9,596	11.9
Total	31,513	100.0	37,255	100.0	49,622	100.0	57,724	100.0	63,313	100.0	71,906	100.0	80,393	100.0

[1] Schuman Plan countries—Belgium, France, West Germany, Italy, Luxembourg, Netherlands, Saar.

TABLE 24.—European production of steel ingots and castings, 1946–52, in thousands of metric tons

	1946	Percent of total	1947	Percent of total	1948	Percent of total	1949	Percent of total	1950	Percent of total	1951	Percent of total	1952	Percent of total
Schuman Plan countries [1]	12,427	28.1	16,691	32.5	22,863	34.8	28,640	36.7	31,712	36.2	37,651	38.0	41,706	38.2
England	12,899	29.1	12,929	25.2	15,115	23.0	15,803	20.2	16,554	18.9	15,889	16.1	16,418	15.0
Russia	13,000	29.3	14,000	27.3	18,300	27.9	23,000	29.4	27,000	30.9	31,500	31.8	35,000	32.0
All other countries	5,984	13.5	7,668	15.0	9,413	14.3	10,724	13.7	12,237	14.0	13,963	14.1	16,176	14.8
Total	44,310	100.0	51,288	100.0	65,691	100.0	78,167	100.0	87,503	100.0	99,003	100.0	109,300	100.0

[1] Schuman Plan countries—Belgium, France, West Germany, Italy, Luxembourg, Netherlands ,Saar.

The Council of Ministers consists of a member from each of the signatory countries. Its chief functions are to insure coordination between actions of the High Authority and policies of the member governments; have a voice in the decisions of the High Authority whenever a question of market control is involved; request the High Authority to examine all proposals on measures that the council considers necessary; and concur in fixing levies exceeding 1 percent of the output.

The Community provides for its own Court of Justice to handle problems arising out of the relations among the Community institutions and complaints of governments, companies, or individuals. The court is composed of seven judges, appointed by the member countries. The court will render judgment in cases in which the Authority is alleged to have exceeded its powers by procedual violations or violations of the treaty, and nullify acts of the Council of Ministers or the Common Assembly when they exceed their powers. The court was installed on December 12, 1952, at a formal ceremony in Luxembourg.[17]

[17] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 1, January 1953, pp. 14–15.

Iron and Steel Scrap

By James E. Larkin [1]

SCRAP and pig iron consumed during 1952 decreased from the record year 1951, owing in part to the major steel strike of 54 days during June and July, preceded by work stoppages earlier in the year. Despite the adverse conditions during 1952, several records were established in the use of ferrous materials. Home-scrap use set a new record month in October (3,572,789 short tons), followed by December (3,490,020 tons), which also exceeded the previous record month (March 1951). The use of pig iron in each of these 2 months of 1952 was also larger than in the earlier record month (October 1951). The 6,509,866 short tons used in October 1952 established a new record. Purchased-scrap stocks held by consumers accumulated during the strike months to 5,291,340 short tons at the end of July and continued to increase to a high for the year of 5,657,615 tons on September 30, after which they began to decline and reached 5,580,424 tons December 31. Despite the tendency of these stocks to drop during the last 3 months of the year, they were 76 percent greater on December 31 than at the beginning of the year—equivalent to a 60-day supply at the 1952 average daily consumption rate of 93,405 short tons.

CONSUMPTION

Of the 1952 consumption of ferrous scrap and pig iron, 69,023,000 short tons was scrap (home and purchase), which represented 53 percent of the total charge. The home scrap was consumed in 1952 at an average monthly rate of 2,903,000 short tons, 10 percent less than the average monthly rate for 1951. Purchased scrap was consumed at a monthly average rate of 2,849,000 short tons, which was also 10 percent less than the average monthly rate for 1951. The drop in the use of ferrous scrap was accompanied by a lesser demand for pig iron during 1952, the total for the year being 12 percent below the total used during the previous year.

The 11-percent drop in the output of steel ingots and castings during 1952 was accompanied by an 11-percent decrease from 1951 in the use of ferrous scrap and pig iron charged to steelmaking furnaces. This drop in steel output resulted, in part, from a shortage of scrap during the early months of the year, which caused the closing of some open-hearth furnaces; however, a general shutdown of the steel mills was averted through the allocation program of the National Production Authority and the scrap industry's ability to prepare and deliver scrap to the mills. The shortage of scrap in the earlier months of the year did not have as devastating an effect upon the production of steel as did the strikes in the steel industry. Steel operations were reduced to 18.4 percent of capacity in June and to 17.7 percent in July. Consequently, the total charge of ferrous scrap and pig iron in steelmaking furnaces was at a greatly reduced rate during these 2 months, totaling 6,551,913 short tons, compared with other strike months of January and February 1946 (8,202,000 short tons) and October 1949 (2,417,000 short tons).

[1] Commodity-industry analyst.

TABLE 1.—Salient statistics of ferrous scrap and pig iron in the United States 1951–52

	1951 (short tons)	1952 (short tons)	Change from 1951 (percent)
Stocks, December 31:			
Ferrous scrap and pig iron at consumers' plants:			
Home scrap	1, 198, 556	1, 321, 890	+10
Purchased scrap	3, 167, 501	5, 580, 424	+76
Pig iron	1, 750, 986	1, 964, 087	+12
Total	6, 117, 043	8, 866, 401	+45
Consumption:			
Ferrous scrap and pig iron charged to—			
Steel furnaces: [1]			
Home scrap	30, 100, 917	27, 389, 744	−9
Purchased scrap	26, 986, 412	24, 827, 316	−8
Pig iron	61, 750, 383	53, 491, 734	−13
Total	118, 837, 712	105, 708, 794	−11
Iron furnaces: [2]			
Home scrap	8, 707, 235	7, 403, 025	−15
Purchased scrap	9, 521, 028	8, 239, 006	−13
Pig iron	9, 663, 934	8, 059, 227	−17
Total	27, 892, 197	23, 701, 258	−15
Miscellaneous uses [3] and ferroalloy production:			
Home scrap	48, 592	44, 025	−9
Purchased scrap	1, 363, 915	1, 120, 008	−18
Total	1, 412, 507	1, 164, 033	−18
All uses:			
Home scrap	38, 856, 744	34, 836, 794	−10
Purchased scrap	37, 871, 355	34, 186, 330	−10
Total ferrous scrap	76, 728, 099	69, 023, 124	−10
Pig iron	71, 414, 317	61, 550, 961	−14
Grand total	148, 142, 416	130, 574, 085	−12
Imports of scrap (including tin plate scrap)	416, 858	153, 674	−63
Exports of scrap:			
Iron and steel	229, 718	336, 593	+47
Tin plate, circles, strips, cobbles, etc	15, 622	15, 137	−3
Average prices per gross ton:			
Scrap:			
No. 1 Heavy-Melting, Pittsburgh [5]	$44. 21	$42. 78	−3
No. 1 Cast Cupola, Chicago [5]	[4] $52. 92	$45. 18	−15
For export	$41. 52	$39. 64	−5
Pig iron, f. o. b. Valley furnaces: [5]			
Basic	$52. 00	$53. 08	+2
No. 2 Foundry	$52. 50	$53. 75	+2

[1] Includes open-hearth, Bessemer and electric furnaces.
[2] Includes cupola, air, Brackelsberg, crucible, and blast furnaces; also direct castings.
[3] Includes rerolling, reforging, copper precipitation, nonferrous, and chemical uses.
[4] Revised figure.
[5] Iron Age.

The proportions of scrap and pig iron used in steel furnaces in 1952 were 49 percent scrap and 51 percent pig iron, compared with 48 and 52 percent, respectively, in 1951. The charge of scrap and pig iron used in iron foundries, mainly cupola furnaces, comprised 65 percent scrap and 35 percent pig iron, the same as 1949–51.

The use of scrap and pig iron decreased 10 and 14 percent, respectively, in 1952, compared to 1951, with decreases in all but 2 districts. Consumption of scrap increased slightly in the South Atlantic district and pig iron in the Pacific Coast district. There was a noticeably greater quantity of scrap than pig iron used in the New England, West North Central, West South Central, and Pacific Coast districts. These districts together used 11 percent of the total scrap and 4 percent of the pig iron consumed in 1952, the same percentages as in 1951. The United States as a whole used 12 percent more scrap than pig iron in 1952, compared with 7 percent in 1951. The average ratio of scrap to pig iron in these 4 districts was 2.8:1, whereas the United States average was 1.12:1.

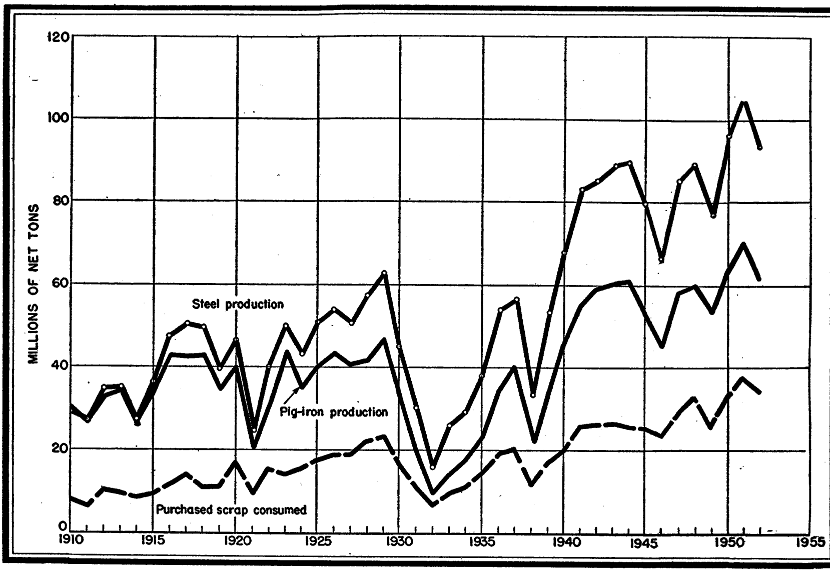

FIGURE 1.—Consumption of purchased scrap and output of pig iron and steel in the United States 1910–52. Figures on consumption of purchased scrap for 1910–32 are from State of Minnesota vs. Oliver Iron Mining Co., et al., Exhibits, vol. 5, 1935, p. 328; those for 1933–34 are estimated by authors; and those for 1935–52 are based on Bureau of Mines records. Data on steel output from the American Iron and Steel Institute.

Open-hearth furnaces continued to be the largest consumers of ferrous scrap and pig iron; however, their consumption decreased from that of 1951 by 4,418,319 tons of scrap and 6,680,788 tons of pig iron. Open-hearth consumption accounted for 62 percent of the total scrap in 1952 and 1951, 69 percent of the home scrap in 1952 compared with 68 percent in 1951, and 56 percent of the purchased scrap in 1952 and 55 percent in 1951. Pig-iron consumption in open hearths accounted for 80 percent of the total pig iron consumed, compared with 78 percent in 1951.

Cupola-furnace consumption in 1952 was as follows: Home scrap 14 percent of the total, compared with 15 percent in 1951; purchased scrap 16 percent, compared with 17 percent in 1951; pig iron 9 percent, the same as for the 5 previous years.

Bessemer converters consumed 6 percent of the pig iron during 1952, compared with 8 percent during 1951 and 1950, and 0.4 percent of the scrap, the same as for 1951 and 1950.

Electric furnaces consumed 13 percent of the total scrap, or 1 percent more than in 1951 and 1950, and 0.2 percent of the pig iron, unchanged from 1950–51.

TABLE 2.—Ferrous scrap and pig iron consumed in the United States and percent of total derived from home scrap, purchased scrap, and pig iron, 1951–52, by districts

District	1951					1952				
	Total consumed (short tons)	Percent of total consumed				Total consumed (short tons)	Percent of total consumed			
		Scrap			Pig iron		Scrap			Pig iron
		Home	Purchased	Total			Home	Purchased	Total	
New England	1, 584, 510	31. 8	42. 7	74. 5	25. 5	1, 236, 665	31. 4	44. 7	76. 1	23. 9
Middle Atlantic [1]	47, 075, 594	25. 9	23. 0	48. 9	51. 1	41, 041, 327	26. 4	23. 9	50. 3	49. 7
East North Central [1]	66, 266, 770	26. 7	25. 8	52. 5	47. 5	58, 421, 271	27. 2	26. 3	53. 5	46. 5
West North Central	3, 531, 848	25. 7	49. 2	74. 9	25. 1	3, 015, 357	26. 6	50. 3	76. 9	23. 1
South Atlantic [1]	10, 520, 272	24. 4	19. 2	43. 6	56. 4	9, 697, 148	24. 4	22. 9	47. 3	52. 7
East South Central [1]	9, 042, 798	26. 5	18. 8	45. 3	54. 7	7, 862, 325	27. 4	17. 0	44. 4	55. 6
West South Central	1, 894, 015	24. 6	44. 1	68. 7	31. 3	1, 624, 508	25. 3	48. 2	73. 5	26. 5
Rocky Mountain	3, 556, 812	26. 6	20. 9	47. 5	52. 5	3, 230, 628	26. 7	18. 3	45. 0	55. 0
Pacific Coast [1]	4, 588, 400	25. 3	46. 4	71. 7	28. 3	4, 369, 445	25. 2	44. 9	70. 1	29. 9
Undistributed [1]	81, 397	(2)	100. 0	100. 0	------	75, 411	-------	100. 0	100. 0	------
Total	148, 142, 416	26. 2	25. 6	51. 8	48. 2	130, 574, 085	26. 7	26. 2	52. 9	47. 1

[1] Some scrap consumed in the Middle Atlantic, East North Central, South Atlantic, East South Central, and Pacific Coast districts (not separable) is included with "Undistributed."
[2] Less than 0.05 percent.

TABLE 3.—Consumption of ferrous scrap and pig iron in the United States, 1951–52, by type of furnace, in short tons

Type of furnace or equipment	Scrap			Pig iron	Total scrap and pig iron
	Home	Purchased	Total		
1951					
Open-hearth	26, 610, 109	20, 805, 677	47, 415, 786	56, 055, 103	103, 470, 889
Bessemer	253, 782	45, 973	299, 755	5, 551, 149	5, 850, 904
Electric	3, 237, 026	6, 134, 762	9, 371, 788	144, 131	9, 515, 919
Cupola	5, 794, 969	6, 523, 688	12, 318, 657	6, 559, 800	18, 878, 457
Air [1]	906, 437	525, 128	1, 431, 565	400, 267	1, 831, 832
Crucible	94	78	172	243	415
Blast	2, 005, 735	2, 472, 134	4, 477, 869	------------	4, 477, 869
Direct castings	------------	------------	------------	2, 703, 624	2, 703, 624
Ferroalloy	13, 547	401, 402	414, 949	------------	414, 949
Miscellaneous	35, 045	962, 513	997, 558	------------	997, 558
Total	38, 856, 744	37, 871, 355	76, 728, 099	71, 414, 317	148, 142, 416
1952					
Open-hearth	24, 023, 910	18, 973, 557	42, 997, 467	49, 374, 315	92, 371, 782
Bessemer	203, 865	42, 905	246, 770	3, 998, 751	4, 245, 521
Electric	3, 161, 969	5, 810, 854	8, 972, 823	118, 668	9, 091, 491
Cupola	4, 847, 993	5, 320, 742	10, 168, 735	5, 438, 294	15, 607, 029
Air	749, 373	449, 646	1, 199, 019	317, 500	1, 516, 519
Crucible	72	54	126	152	278
Blast	1, 805, 587	2, 468, 564	4, 274, 151	------------	4, 274, 151
Direct castings	------------	------------	------------	2, 303, 281	2, 303, 281
Ferroalloy	12, 149	327, 610	339, 759	------------	339, 759
Miscellaneous	31, 876	792, 398	824, 274	------------	824, 274
Total	34, 836, 794	34, 186, 330	69, 023, 124	61, 550, 961	130, 574, 085

[1] Includes data for 2 Brackelsberg furnaces.

TABLE 4.—Proportion of home and purchased scrap and pig iron used in furnace charges in the United States, 1951–52, in percent

Type of furnace	1951				1952			
	Scrap			Pig iron	Scrap			Pig iron
	Home	Purchased	Total		Home	Purchased	Total	
Open-hearth	25.7	20.1	45.8	54.2	26.0	20.5	46.5	53.5
Bessemer	4.3	.8	5.1	94.9	4.8	1.0	5.8	94.2
Electric	34.0	64.5	98.5	1.5	34.8	63.9	98.7	1.3
Cupola	30.7	34.6	65.3	34.7	31.1	34.1	65.2	34.8
Air [1]	49.5	28.6	78.1	21.9	49.4	29.6	79.0	21.0
Crucible	22.6	18.8	41.4	58.6	25.9	19.4	45.3	54.7
Blast	44.8	55.2	100.0	----------	42.2	57.8	100.0	----------

[1] Includes data for 2 Brackelsberg furnaces during 1951.

TABLE 5.—Consumption of ferrous scrap and pig iron in the United States in 1952, by type of consumer and type of furnace, in short tons

Type of consumer and type of furnace or equipment	Scrap			Pig iron	Total scrap and pig iron
	Home	Purchased	Total		
Manufacturers of steel ingots and castings: [1]					
Open-hearth	23,517,537	18,155,777	41,673,314	49,142,925	90,816,239
Bessemer	189,465	15,124	204,589	3,995,248	4,199,837
Electric	2,240,160	4,751,059	6,991,219	75,349	7,066,568
Cupola	210,233	133,776	344,009	488,757	832,766
Air	19,971	16,511	36,482	15,218	51,700
Crucible	22	----------	22	11	33
Blast [2]	1,805,587	2,468,564	4,274,151	----------	4,274,151
Direct castings	----------	----------	----------	1,422,078	1,422,078
Miscellaneous	25,187	240,361	265,548	----------	265,548
Total: 1952	28,008,162	25,781,172	53,789,334	55,139,586	108,928,920
1951	31,035,896	27,778,878	58,814,774	63,845,469	122,660,243
Manufacturers of steel castings: [3]					
Open-hearth	506,373	817,780	1,324,153	231,390	1,555,543
Bessemer	12,955	22,134	35,089	3,055	38,144
Electric	762,825	939,187	1,702,012	26,301	1,728,313
Cupola	193,722	487,542	681,264	187,119	868,383
Air	168,267	126,539	294,806	66,419	361,225
Total: 1952	1,644,142	2,393,182	4,037,324	514,284	4,551,608
1951	1,750,711	2,769,422	4,520,133	555,280	5,075,413
Iron foundries and miscellaneous users:					
Bessemer	1,445	5,647	7,092	448	7,540
Electric	158,984	120,608	279,592	17,018	296,610
Cupola	4,444,038	4,699,424	9,143,462	4,762,418	13,905,880
Air	561,135	306,596	867,731	235,863	1,103,594
Crucible	50	54	104	141	245
Direct castings	----------	----------	----------	881,203	881,203
Ferroalloy	12,149	327,610	339,759	----------	339,759
Miscellaneous	6,689	552,037	558,726	----------	558,726
Total: 1952	5,184,490	6,011,976	11,196,466	5,897,091	17,093,557
1951	6,070,137	7,323,055	13,393,192	7,013,568	20,406,760

[1] Includes only those castings made by companies producing steel ingots.
[2] Includes consumption in blast furnaces by both integrated and nonintegrated mills.
[3] Excludes companies that produce both steel castings and steel ingots.

CONSUMPTION BY DISTRICTS AND STATES

During 1952 iron and steel scrap consumed showed a decrease in all but the South Atlantic district, where the increase was slight. The use of pig iron in all but the Pacific Coast district was less during 1952 than during 1951. The largest consuming districts were East North Central, Middle Atlantic, and South Atlantic. The States having the

TABLE 6.—Consumption of ferrous scrap and pig iron in the United States, 1948–52, by districts

District and year	Scrap: Home, Short tons	Scrap: Home, Change from previous year (percent)	Scrap: Purchased, Short tons	Scrap: Purchased, Change from previous year (percent)	Scrap: Total, Short tons	Scrap: Total, Change from previous year (percent)	Pig iron, Short tons	Pig iron, Change from previous year (percent)
New England:								
1948	442, 821	−3. 7	648, 418	+15. 5	1, 091, 239	+6. 8	342, 893	−2. 7
1949	345, 288	−22. 0	420, 160	−35. 2	765, 448	−29. 9	283, 337	−17. 4
1950	417, 689	+21. 0	551, 282	+31. 2	968, 971	+26. 6	358, 652	+26. 6
1951	504, 157	+20. 7	675, 823	+22. 6	1, 179, 980	+21. 8	404, 530	+12. 8
1952	387, 751	−23. 1	552, 828	−18. 2	940, 579	−20. 3	296, 086	−26. 8
Middle Atlantic:								
1948	10, 416, 428	+4. 5	9, 240, 074	+9. 4	19, 656, 502	+6. 7	20, 895, 487	+2. 0
1949	8, 899, 441	−14. 6	7, 147, 852	−22. 6	16, 047, 293	−18. 4	17, 731, 194	−15. 1
1950	10, 585, 951	+19. 0	9, 771, 756	+36. 7	20, 357, 707	+26. 9	21, 649, 125	+22. 1
1951 [1]	12, 210, 369	+15. 3	10, 839, 307	+10. 9	23, 049, 676	+13. 2	24, 025, 918	+11. 0
1952 [1]	10, 837, 200	−11. 2	9, 805, 388	−9. 5	20, 642, 588	−10. 4	20, 398, 739	−15. 1
East North Central:								
1948	15, 048, 785	+. 8	14, 486, 835	+11. 9	29, 535, 620	+5. 9	26, 498, 691	+1. 9
1949	13, 821, 486	−8. 2	11, 035, 315	−23. 8	24, 856, 801	−15. 8	23, 869, 383	−9. 9
1950	16, 921, 000	+22. 4	15, 137, 680	+37. 2	32, 058, 680	+29. 0	28, 597, 252	+19. 8
1951 [1]	17, 693, 909	+4. 6	17, 107, 798	+13. 0	34, 801, 707	+8. 6	31, 465, 063	+10. 0
1952 [1]	15, 918, 704	−10. 0	15, 340, 156	−10. 3	31, 258, 860	−10. 2	27, 162, 411	−13. 7
West North Central:								
1948	660, 035	+6. 2	1, 404, 212	+7. 3	2, 064, 247	+7. 0	661, 729	+3. 6
1949	576, 147	−12. 7	1, 175, 904	−16. 3	1, 752, 051	−15. 1	571, 453	−13. 6
1950	659, 059	+14. 4	1, 452, 653	+23. 5	2, 111, 712	+20. 5	747, 629	+30. 8
1951	908, 344	+37. 8	1, 737, 553	+19. 6	2, 645, 897	+25. 3	885, 951	+18. 5
1952	803, 932	−11. 5	1, 515, 831	−12. 8	2, 319, 763	−12. 3	695, 594	−21. 5
South Atlantic:								
1948	2, 130, 399	+11. 5	2, 078, 125	+. 1	4, 208, 524	+5. 6	4, 733, 573	+14. 8
1949	2, 154, 561	+1. 1	1, 704, 767	−18. 0	3, 859, 328	−8. 3	4, 818, 855	+1. 8
1950	2, 491, 182	+15. 6	1, 899, 328	+11. 4	4, 390, 510	+13. 8	5, 747, 111	+19. 3
1951 [1]	2, 570, 140	+3. 2	2, 017, 421	+6. 2	4, 587, 561	+4. 5	5, 932, 711	+3. 2
1952 [1]	2, 364, 735	−8. 0	2, 224, 227	+9. 3	4, 588, 962	([2])	5, 108, 186	−13. 9
East South Central:								
1948	1, 964, 069	+5. 5	1, 542, 245	+32. 9	3, 506, 314	+16. 0	4, 424, 654	+6. 2
1949	1, 740, 298	−11. 4	1, 184, 021	−23. 2	2, 924, 319	−16. 6	3, 913, 460	−11. 6
1950	2, 221, 577	+27. 7	1, 576, 898	+33. 2	3, 798, 475	+29. 9	4, 751, 371	+21. 4
1951 [1]	2, 395, 012	+7. 8	1, 703, 677	+8. 0	4, 098, 689	+7. 9	4, 944, 109	+4. 1
1952 [1]	2, 151, 837	−10. 2	1, 336, 961	−21. 5	3, 488, 798	−14. 9	4, 373, 527	−11. 5
West South Central:								
1948	233, 904	+9. 3	573, 557	+7. 7	807, 461	+8. 1	237, 972	+89. 1
1949	196, 586	−16. 0	488, 576	−14. 8	685, 162	−15. 1	204, 333	−14. 1
1950	345, 371	+75. 7	658, 095	+34. 7	1, 003, 466	+46. 5	364, 004	+78. 1
1951 [1]	465, 411	+34. 8	836, 030	+27. 0	1, 301, 441	+29. 7	592, 574	+62. 8
1952 [1]	411, 023	−11. 7	782, 560	−6. 4	1, 193, 583	−8. 3	430, 925	−27. 3
Rocky Mountain:								
1948	753, 167	−1. 5	583, 453	+17. 1	1, 336, 620	+5. 9	1, 585, 327	+4. 6
1949	676, 327	−10. 2	548, 626	−6. 0	1, 224, 953	−8. 4	1, 365, 795	−13. 8
1950	903, 368	+33. 6	637, 410	+16. 2	1, 540, 778	+25. 8	1, 768, 772	+29. 5
1951	946, 741	+4. 8	743, 392	+16. 6	1, 690, 133	+9. 7	1, 866, 679	+5. 5
1952	861, 476	−9. 0	591, 926	−20. 4	1, 453, 402	−14. 0	1, 777, 226	−4. 8
Pacific Coast:								
1948	770, 035	+14. 6	1, 987, 313	+15. 2	2, 757, 348	+15. 1	646, 078	−1. 1
1949	756, 359	−1. 8	1, 466, 509	−26. 2	2, 222, 868	−19. 4	688, 955	−6. 6
1950	979, 910	+29. 6	1, 691, 066	+15. 3	2, 670, 976	+20. 2	959, 202	+39. 2
1951 [1]	1, 162, 622	+18. 6	2, 128, 996	+25. 9	3, 291, 618	+23. 2	1, 296, 782	+35. 2
1952 [1]	1, 100, 136	−5. 4	1, 961, 042	−7. 9	3, 061, 178	−7. 0	1, 308, 267	+. 9
Undistributed:								
1951 [1]	39		81, 358		81, 397			
1952 [1]			75, 411		75, 411			
United States 1943–47 (average)	31, 827, 449		26, 080, 494		57, 907, 943		55, 563, 268	
1948	32, 419, 643	+2. 7	32, 544, 232	+11. 1	64, 963, 875	+6. 7	60, 026, 404	+3. 0
1949	29, 166, 493	−10. 0	25, 171, 730	−22. 7	54, 338, 223	−16. 4	53, 446, 765	−11. 0
1950	35, 525, 107	+21. 8	33, 376, 168	+32. 6	68, 901, 275	+26. 8	64, 943, 118	+21. 5
1951 [1]	38, 856, 744	+9. 4	37, 871, 355	+13. 5	76, 728, 099	+11. 4	71, 414, 317	+10. 0
1952 [1]	34, 836, 794	−10. 3	34, 186, 330	−9. 7	69, 023, 124	−10. 0	61, 550, 961	−13. 8

[1] Some scrap consumed in East North Central, East South Central, Middle Atlantic, Pacific Coast, and South Atlantic districts—not separable— is included with "Undistributed."
[2] Less than 0.05 percent.

largest consumption of scrap, with the percentages consumed, were: Pennsylvania 24, Ohio 18, Illinois 10, and Indiana 9. These States have consumed the same percentages of scrap for 3 consecutive years.

TABLE 7.—Consumption of ferrous scrap and pig iron in the United States in 1952, by districts and States

District and State	Scrap						Pig iron	
	Home		Purchased		Total			
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Connecticut	118,383	0.3	198,271	0.6	316,654	0.5	60,598	0.1
Maine	4,728	(2)	6,256	(2)	10,984	(2)	4,072	(2)
Massachusetts	202,852	.6	264,791	.8	467,643	.7	165,324	.3
New Hampshire	8,493	(2)	9,635	(2)	18,128	(2)	4,607	(2)
Rhode Island	35,661	.1	53,979	.1	89,640	.1	46,842	.1
Vermont	17,634	.1	19,896	.1	37,530	.1	14,643	(2)
Total New England	387,751	1.1	552,828	1.6	940,579	1.4	296,086	.5
New Jersey	220,612	.6	454,208	1.3	674,820	1.0	244,320	.4
New York [1]	1,470,589	4.2	1,597,892	4.7	3,068,481	4.4	3,128,013	5.1
Pennsylvania	9,145,999	26.3	7,753,288	22.7	16,899,287	24.5	17,026,406	27.7
Total Middle Atlantic	10,837,200	31.1	9,805,388	28.7	20,642,588	29.9	20,398,739	33.2
Illinois	3,012,234	8.7	3,661,443	10.7	6,673,677	9.7	4,893,725	7.9
Indiana	3,729,651	10.7	2,167,920	6.4	5,897,571	8.5	7,044,738	11.4
Michigan	2,522,966	7.2	3,037,180	8.9	5,560,146	8.1	3,294,753	5.4
Ohio [1]	6,139,541	17.6	6,029,379	17.6	12,168,920	17.6	11,650,525	18.9
Wisconsin	514,312	1.5	444,234	1.3	958,546	1.4	278,670	.5
Total East North Central	15,918,704	45.7	15,340,156	44.9	31,258,860	45.3	27,162,411	44.1
Iowa	218,224	.6	325,845	.9	544,069	.8	101,833	.2
Kansas and Nebraska	30,094	.1	67,656	.2	97,750	.1	6,682	(2)
Minnesota, North Dakota, and South Dakota	357,567	1.0	382,490	1.1	740,057	1.1	506,084	.8
Missouri	198,047	.6	739,840	2.2	937,887	1.4	80,995	.1
Total West North Central	803,932	2.3	1,515,831	4.4	2,319,763	3.4	695,594	1.1
Delaware, District of Columbia, and Maryland	1,498,137	4.3	942,056	2.7	2,440,193	3.5	3,144,907	5.1
Florida and Georgia	73,039	.2	167,255	.5	240,294	.3	60,528	.1
North Carolina	27,593	.1	21,572	.1	49,165	.1	27,194	.1
South Carolina	13,253	(2)	9,133	(2)	22,386	(2)	12,911	(2)
Virginia and West Virginia [1]	752,713	2.2	1,084,211	3.2	1,836,924	2.7	1,862,646	3.0
Total South Atlantic	2,364,735	6.8	2,224,227	6.5	4,588,962	6.6	5,108,186	8.3
Alabama [1]	1,549,747	4.5	757,445	2.2	2,307,192	3.4	3,527,809	5.7
Kentucky, Mississippi and Tennessee	602,090	1.7	579,516	1.7	1,181,606	1.7	845,718	1.4
Total East South Central	2,151,837	6.2	1,336,961	3.9	3,488,798	5.1	4,373,527	7.1

See footnotes at end of table.

TABLE 7.—Consumption of ferrous scrap and pig iron in the United States in 1952, by districts and States—Continued

District and State	Scrap						Pig iron	
	Home		Purchased		Total			
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Arkansas, Louisiana, and Oklahoma	45,984	0.1	117,109	0.3	163,093	0.2	11,961	(2)
Texas	365,039	1.1	665,451	2.0	1,030,490	1.5	418,964	0.7
Total West South Central	411,023	1.2	782,560	2.3	1,193,583	1.7	430,925	.7
Arizona, Nevada, and New Mexico	19,699	.1	57,032	.2	76,731	.1	144	(2)
Colorado and Utah	833,717	2.4	514,250	1.5	1,347,967	2.0	1,776,397	2.9
Montana	6,103	(2)	11,520	(2)	17,623	(2)	181	(2)
Idaho and Wyoming	1,957	(2)	9,124	(2)	11,081	(2)	504	(2)
Total Rocky Mountain	861,476	2.5	591,926	1.7	1,453,402	2.1	1,777,226	2.9
California	992,475	2.8	1,477,694	4.4	2,470,169	3.6	1,288,561	2.1
Oregon [1] and Washington	107,661	.3	483,348	1.4	591,009	.8	19,706	(2)
Total Pacific Coast	1,100,136	3.1	1,961,042	5.8	3,061,178	4.4	1,308,267	2.1
Undistributed [1]			75,411	.2	75,411	.1		
Total United States: 1952	34,836,794	100.0	34,186,330	100.0	69,023,124	100.0	61,550,961	100.0
Total United States: 1951	38,856,744	100.0	37,871,355	100.0	76,728,099	100.0	71,414,317	100.0

[1] Some scrap consumption in Alabama, New York, Ohio, Oregon, and West Virginia—not separable—is included with "Undistributed."
[2] Less than 0.05 percent.

CONSUMPTION BY TYPE OF FURNACE

Open-Hearth Furnaces.—Ferrous scrap and pig-iron consumption in open-hearth furnaces in 1952 was the third highest total on record of these materials consumed in this type of furnace, despite the various work stoppages. The consumption of ferrous materials (scrap and pig iron) and the production of ingots and steel for castings in the open-hearth furnaces during 1952 decreased 11 percent each from 1951. The use of home scrap decreased 10 percent, purchased scrap 9 percent total scrap 9 percent, and pig iron 12 percent. The open-hearth furnace melt in 1952 consisted of 47 percent scrap and 53 percent pig iron, compared with 46 and 54 percent, respectively, in 1951. Of the total scrap consumed, 44 percent was purchased, the same as in 1951.

Pennsylvania again led in the use of scrap in the open-hearth in 1952, followed, in order, by Ohio, Indiana, and Illinois, maintaining the same order since 1936.

TABLE 8.—Consumption of ferrous scrap and pig iron in open-hearth furnaces in the United States in 1952, by districts and States, in short tons

District and State	Scrap			Pig iron	Total scrap and pig iron
	Home	Purchased	Total		
New England: Connecticut, Massachusetts, and Rhode Island	111,006	283,134	394,140	104,314	498,454
Total: 1952	111,006	283,134	394,140	104,314	498,454
1951	142,327	330,257	472,584	132,368	604,952
Middle Atlantic:					
New Jersey and New York	1,213,944	952,365	2,166,309	2,890,376	5,056,685
Pennsylvania	7,206,952	5,481,996	12,688,948	14,529,565	27,218,513
Total: 1952	8,420,896	6,434,361	14,855,257	17,419,941	32,275,198
1951	9,261,603	6,926,335	16,187,938	19,933,496	36,121,434
East North Central:					
Illinois	1,876,439	1,860,184	3,736,623	3,666,160	7,402,783
Indiana	3,242,161	1,748,103	4,990,264	6,620,983	11,611,247
Michigan and Wisconsin	1,008,243	771,498	1,779,741	2,253,261	4,033,002
Ohio	4,306,817	3,490,742	7,797,559	8,560,706	16,358,265
Total: 1952	10,433,660	7,870,527	18,304,187	21,101,110	39,405,297
1951	11,606,676	8,641,811	20,248,487	24,106,405	44,354,892
West North Central: Minnesota and Missouri	290,277	670,465	960,742	478,633	1,439,375
Total: 1952	290,277	670,465	960,742	478,633	1,439,375
1951	325,469	812,135	1,137,604	605,852	1,743,456
South Atlantic:					
Delaware and Maryland	1,312,298	646,110	1,958,408	2,761,201	4,719,609
Georgia and West Virginia	632,017	907,775	1,539,792	1,474,983	3,014,775
Total: 1952	1,944,315	1,553,885	3,498,200	4,236,184	7,734,384
1951	2,090,825	1,436,476	3,527,301	4,833,215	8,360,516
East South Central: Alabama and Kentucky	1,217,000	405,927	1,622,927	3,051,990	4,674,917
Total: 1952	1,217,000	405,927	1,622,927	3,051,990	4,674,917
1951	1,373,955	529,640	1,903,595	3,363,738	5,267,333
West South Central: Oklahoma and Texas	158,699	403,009	561,708	249,569	811,277
Total: 1952	158,699	403,009	561,708	249,569	811,277
1951	207,925	467,335	675,260	311,769	987,029
Rocky Mountain: Colorado and Utah	751,637	394,536	1,146,173	1,619,938	2,766,111
Total: 1952	751,637	394,536	1,146,173	1,619,938	2,766,111
1951	849,248	513,306	1,362,554	1,660,574	3,023,128
Pacific Coast: California and Washington	696,420	957,713	1,654,133	1,112,636	2,766,769
Total: 1952	696,420	957,713	1,654,133	1,112,636	2,766,769
1951	752,081	1,148,382	1,900,463	1,107,686	3,008,149
Total United States: 1952	24,023,910	18,973,557	42,997,467	49,374,315	92,371,782
1951	26,610,109	20,805,677	47,415,786	56,055,103	103,470,889

Bessemer Converters.—The ferrous raw materials used in Bessemer Converters in 1952 represented a decrease of 27 percent from the 1951 use of these materials, with the production of ingots in these furnaces showing a 28-percent decrease from the previous year. The greatest decrease in the metallic charge in the Bessemer furnaces occurred in pig iron, which decreased 28 percent from 1951. The ratio of scrap to total metal charge was 1:17, compared with 1:20 during 1951. Of the scrap used, 83 percent was home scrap.

For the first time since 1940, Ohio was the principal consumer of converter scrap, and following the usual pattern, was the largest consumer of pig iron in this type of furnace, using 53 percent of the total.

TABLE 9.—Consumption of ferrous scrap and pig iron in Bessemer converters in the United States in 1952, by districts and States, in short tons

District and State	Scrap			Pig iron	Total scrap and pig iron
	Home	Purchased	Total		
New England and Middle Atlantic:					
Connecticut and New Jersey	2, 736	3, 241	5, 977	928	6, 905
Pennsylvania	65, 935	19, 523	85, 458	932, 761	1, 018, 219
Total: 1952	68, 671	22, 764	91, 435	933, 689	1, 025, 124
1951	99, 772	22, 231	122, 003	1, 614, 977	1, 736, 980
East North Central and West North Central:					
Illinois	2, 718	4, 882	7, 600	204, 933	212, 533
Indiana and Minnesota	4, 510	4, 635	9, 145	108, 768	117, 913
Ohio	98, 013	317	98, 330	2, 114, 522	2, 212, 852
Total: 1952	105, 241	9, 834	115, 075	2, 428, 223	2, 543, 298
1951	111, 225	11, 422	122, 647	3, 123, 433	3, 246, 080
South Atlantic: Delaware, Maryland, and West Virginia	29, 340	5, 358	34, 698	636, 630	671, 328
Total: 1952	29, 340	5, 358	34, 698	636, 630	671, 328
1951	41, 888	8, 441	50, 329	811, 697	862, 026
East South Central and West South Central: Alabama, Louisiana, and Texas	541	4, 538	5, 079	190	5, 269
Total: 1952	541	4, 538	5, 079	190	5, 269
1951	878	3, 758	4, 636	1, 036	5, 672
Rocky Mountain and Pacific Coast: Colorado and Washington	72	411	483	19	502
Total: 1952	72	411	483	19	502
1951	19	121	140	6	146
Total United States: 1952	203, 865	42, 905	246, 770	3, 998, 751	4, 245, 521
1951	253, 782	45, 973	299, 755	5, 551, 149	5, 850, 904

Electric Steel Furnaces.—The metallic charge of ferrous scrap and pig iron consumed in the electric furnace in 1952 totaled 9,091,491 short tons, a 4-percent decrease from the alltime record year 1951. The ratio of scrap to pig iron used in the electric furnace was 76 : 1 for 1952, the highest ratio on record. This compares with 65 : 1 in 1951 and 48 : 1 in 1950. In the New England, South Atlantic, and Pacific Coast districts, consumption of scrap increased whereas consumption of pig iron decreased. The East North Central and Middle Atlantic districts, which consumed 77 percent of the total scrap and pig iron, showed the largest decrease in consumption.

Cupolas.—Figures released by the Bureau of the Census, United States Department of Commerce, indicate that shipments of gray-iron castings in 1952 decreased 14 percent from 1951. Accordingly, requirements for scrap and pig-iron cupola consumption decreased 17 percent from 1951. The use of home scrap decreased 16 percent, purchased scrap 18 percent, total scrap 17 percent, and pig iron 17 percent.

Charges to cupolas consisted of 31 percent home scrap, 34 percent purchased scrap, and 35 percent pig iron, the same percentages as in 1951.

TABLE 10.—Consumption of ferrous scrap and pig iron in electric steel furnaces in the United States in 1952, by districts and States, in short tons

District and State	Scrap			Pig iron	Total scrap and pig iron
	Home	Purchased	Total		
New England:					
Connecticut and New Hampshire	11,139	11,195	22,334	581	22,915
Massachusetts	21,057	11,515	32,572	1,022	33,594
Total: 1952	32,196	22,710	54,906	1,603	56,509
1951	27,028	21,084	48,112	1,653	49,765
Middle Atlantic:					
New Jersey	17,543	22,432	39,975	775	40,750
New York	71,558	79,379	150,937	4,186	155,123
Pennsylvania	767,441	1,011,772	1,779,213	18,197	1,797,410
Total: 1952	856,542	1,113,583	1,970,125	23,158	1,993,283
1951	943,702	1,422,453	2,366,155	30,848	2,397,003
East North Central:					
Illinois	400,423	911,733	1,312,156	50,275	1,362,431
Indiana	43,149	43,784	86,933	1,259	88,192
Michigan	344,766	962,078	1,306,844	7,006	1,313,850
Ohio	764,093	1,292,033	2,056,126	14,525	2,070,651
Wisconsin	90,101	101,057	191,158	3,616	194,774
Total: 1952	1,642,532	3,310,685	4,953,217	76,681	5,029,898
1951	1,755,156	3,534,996	5,290,152	95,571	5,385,723
West North Central:					
Iowa, Kansas, and Nebraska	62,489	60,499	122,988	1,221	124,209
Minnesota	4,547	6,849	11,396	288	11,684
Missouri	15,387	61,233	76,620	3,270	79,890
Total: 1952	82,423	128,581	211,004	4,779	215,783
1951	48,244	71,209	119,453	999	120,452
South Atlantic:					
Delaware, District of Columbia, and Maryland	35,646	59,707	95,353	1,983	97,336
Florida and Georgia	23,254	53,097	76,351	210	76,561
North Carolina, Virginia, and West Virginia	22,881	20,714	43,595	1,043	44,638
Total: 1952	81,781	133,518	215,299	3,236	218,535
1951	63,637	80,354	143,991	4,561	148,552
East South Central:					
Alabama	28,600	67,690	96,290	731	97,021
Kentucky	50,923	168,291	219,214	424	219,638
Tennessee	11,105	30,850	41,955	895	42,850
Total: 1952	90,628	266,831	357,459	2,050	359,509
1951	82,510	309,023	391,533	2,091	393,624
West South Central:					
Arkansas, Louisiana, and Oklahoma	24,206	31,456	55,662	977	56,639
Texas	98,082	130,322	228,404	3,448	231,852
Total: 1952	122,288	161,778	284,066	4,425	288,491
1951	67,495	103,631	171,126	4,231	175,357
Rocky Mountain: Arizona, Colorado, Nevada, and Utah	18,384	19,930	38,314	649	38,963
Total: 1952	18,384	19,930	38,314	649	38,963
1951	19,820	23,038	42,858	902	43,760
Pacific Coast:					
California	183,348	411,996	595,344	1,689	597,033
Oregon	26,495	115,522	142,017	121	142,138
Washington	25,352	125,720	151,072	277	151,349
Total: 1952	235,195	653,238	888,433	2,087	890,520
1951	229,434	568,974	798,408	3,275	801,683
Total United States: 1952	3,161,969	5,810,854	8,972,823	118,668	9,091,491
1951	3,237,026	6,134,762	9,371,788	144,131	9,515,919

Michigan was the leading State in consumption of scrap in cupola furnaces.

TABLE 11.—Consumption of ferrous scrap and pig iron in cupola furnaces in the United States in 1952, by districts and States, in short tons

District and State	Scrap			Pig iron	Total scrap and pig iron
	Home	Purchased	Total		
New England:					
Connecticut	55,531	42,128	97,659	50,912	148,571
Maine	4,728	6,256	10,984	4,072	15,056
Massachusetts	100,537	120,436	220,973	81,238	302,211
New Hampshire	3,323	8,495	11,818	2,461	14,279
Rhode Island	18,934	15,555	34,489	21,383	55,872
Vermont	17,634	19,896	37,530	14,643	52,173
Total: 1952	200,687	212,766	413,453	174,709	588,162
1951	267,760	268,485	536,245	249,131	785,376
Middle Atlantic:					
New Jersey	130,046	246,247	376,293	197,026	573,319
New York	186,308	170,497	356,805	192,465	549,270
Pennsylvania	345,131	468,636	813,767	433,106	1,246,873
Total: 1952	661,485	885,380	1,546,865	822,597	2,369,462
1951	881,657	1,100,285	1,981,942	1,061,015	3,042,957
East North Central:					
Illinois	515,852	408,819	924,671	342,182	1,266,853
Indiana	277,433	242,187	519,620	268,976	788,596
Michigan	1,086,813	1,007,302	2,094,115	1,023,945	3,118,060
Ohio	440,995	563,259	1,004,254	441,444	1,445,698
Wisconsin	338,576	258,910	597,486	239,467	836,953
Total: 1952	2,659,669	2,480,477	5,140,146	2,316,014	7,456,160
1951	3,039,088	2,993,020	6,032,108	2,630,353	8,662,461
West North Central:					
Iowa	157,985	128,808	286,793	97,847	384,640
Kansas	11,133	33,464	44,597	6,315	50,912
Nebraska	1,661	12,141	13,802	260	14,062
Minnesota, North Dakota and South Dakota	72,760	120,369	193,129	55,712	248,841
Missouri	64,999	149,261	214,260	42,905	257,165
Total: 1952	308,538	444,043	752,581	203,039	955,620
1951	419,557	553,400	972,957	268,893	1,241,850
South Atlantic:					
Maryland	37,359	39,544	76,903	59,158	136,061
Florida	1,430	3,550	4,980	2,406	7,386
Georgia	11,647	18,318	29,965	13,028	42,993
North Carolina	21,030	21,104	42,134	26,376	68,510
South Carolina	13,253	8,735	21,988	12,911	34,899
Virginia	67,837	150,876	218,713	65,206	283,919
West Virginia	5,557	17,705	23,262	41,325	64,587
Total: 1952	158,113	259,832	417,945	220,410	638,355
1951	179,898	278,191	458,089	272,083	730,172
East South Central:					
Alabama	324,802	300,021	624,823	954,256	1,579,079
Kentucky and Mississippi	85,375	38,422	123,797	173,590	297,387
Tennessee	140,479	122,791	263,270	190,292	453,562
Total: 1952	550,656	461,234	1,011,890	1,318,138	2,330,028
1951	651,082	645,047	1,296,129	1,577,653	2,873,782
West South Central:					
Arkansas	174	----------	174	246	420
Louisiana	2,709	10,498	13,207	401	13,608
Oklahoma	14,967	21,482	36,449	9,476	45,925
Texas	68,687	131,599	200,286	163,666	363,952
Total: 1952	86,537	163,579	250,116	173,789	423,905
1951	118,517	211,832	330,349	272,133	602,482
Rocky Mountain:					
Arizona and New Mexico	10,771	23,288	34,059	----------	34,059
Colorado	17,876	52,318	70,194	26,984	97,178
Utah	29,987	42,346	72,333	53,212	125,545
Idaho and Wyoming	1,650	7,379	9,029	504	9,533
Montana	6,103	4,878	10,981	181	11,162
Total: 1952	66,387	130,209	196,596	80,881	277,477
1951	65,278	144,611	209,889	116,268	326,157

TABLE 11.—Consumption of ferrous scrap and pig iron in cupola furnaces in the United States in 1952, by districts and States, in short tons—Continued

District and State	Scrap			Pig iron	Total scrap and pig iron
	Home	Purchased	Total		
Pacific Coast:					
California	141,220	224,276	365,496	124,597	490,093
Oregon	7,087	23,270	30,357	1,770	32,127
Washington	7,614	35,676	43,290	2,350	45,640
Total: 1952	155,921	283,222	439,143	128,717	567,860
1951	172,132	328,817	500,949	112,271	613,220
Total United States: 1952	4,847,993	5,320,742	10,168,735	5,438,294	15,607,029
1951	5,794,969	6,523,688	12,318,657	6,559,800	18,878,457

Air Furnaces.—The total charge of scrap and pig iron in air furnaces in 1952 was 17 percent less than in 1951. There was no consumption in Brackelsberg furnaces during the year. The use of home scrap, purchased scrap, and pig iron decreased 17, 14, and 21 percent, respectively, from 1951.

The East North Central district led in the use of scrap in air furnaces. Ohio was the principal consumer of scrap in this type of furnace.

TABLE 12.—Consumption of ferrous scrap and pig iron in air furnaces in the United States in 1952, by districts and States, in short tons

District and State	Scrap			Pig iron	Total scrap and pig iron
	Home	Purchased	Total		
New England:					
Connecticut	21,283	6,852	28,135	8,015	36,150
Massachusetts and New Hampshire	14,376	2,938	17,314	7,262	24,576
Total: 1952	35,659	9,790	45,449	15,277	60,726
1951	48,151	19,038	67,189	21,057	88,246
Middle Atlantic:					
New Jersey	4,705	548	5,253	3,396	9,189
New York	35,728	17,545	53,273	19,813	73,086
Pennsylvania	93,706	58,013	151,719	54,303	206,022
Total: 1952	134,139	76,106	210,245	78,052	288,297
1951	178,005	99,296	277,301	97,568	374,869
East North Central:					
Illinois	120,534	69,289	189,823	50,712	240,535
Indiana	89,695	46,699	136,394	39,864	176,258
Michigan	57,488	46,257	103,745	17,606	121,351
Ohio	209,206	135,028	344,234	62,477	406,711
Wisconsin	60,502	41,011	101,513	28,522	130,035
Total: 1952	537,425	338,284	875,709	199,181	1,074,890
1951	633,612	378,953	1,012,565	252,942	1,265,507
West North Central: Iowa, Minnesota, and Missouri	10,975	3,497	14,472	9,141	23,613
Total: 1952	10,975	3,497	14,472	9,141	23,613
1951	12,380	4,519	16,899	10,179	27,078
South Atlantic and West South Central:					
Delaware, North Carolina, and West Virginia	11,919	7,611	19,530	9,279	28,809
Oklahoma and Texas	10,134	7,015	17,149	2,955	20,104
Total: 1952	22,053	14,626	36,679	12,234	48,913
1951	26,629	16,275	42,904	14,407	57,311
Pacific Coast: California	9,122	7,343	16,465	3,615	20,080
Total: 1952	9,122	7,343	16,465	3,615	20,080
1951 [1]	7,660	7,047	14,707	4,114	18,821
Total United States: 1952	749,373	449,646	1,199,019	317,500	1,516,519
1951	906,437	525,128	1,431,565	400,267	1,831,832

[1] Includes California and Colorado. Not listed separately.

Crucible and Puddling Furnaces.—The consumption of scrap and pig iron in crucible furnaces was virtually negligible during 1952. There was no tonnage of iron and steel scrap reported as being melted in puddling furnaces during 1952.

Blast Furnaces.—Materials other than scrap constitute by far the largest proportion of the blast furnace charge and in 1952 consisted of 110,168,932 short tons of iron ore, sinter, and manganiferous ore; 3,182,218 tons of mill cinder and roll scale; 3,391,402 tons of open-hearth and Bessemer slag; and 95,899 tons of miscellaneous materials.

The consumption of scrap in blast furnaces during 1952 was 5 percent less than in 1951. The scrap charged to blast furnaces was 42 percent home and 58 percent purchased, compared with 45 and 55 percent, respectively, in 1951. The proportion of scrap used to pig iron produced was 6.9 percent (home scrap 2.9 percent and purchased scrap 4.0 percent), compared with 6.4 percent in 1951.

TABLE 13.—Consumption of ferrous scrap in blast furnaces in the United States in 1952, by districts and States, in short tons

District and State	Home	Purchased	Total
New England and Middle Atlantic:			
Massachusetts and New York	34,229	347,667	381,896
Pennsylvania	659,159	646,624	1,305,783
Total: 1952	693,388	994,291	1,687,679
1951	851,178	907,538	1,758,716
East North Central and West North Central:			
Illinois	94,244	219,461	313,705
Indiana	63,420	73,975	137,395
Michigan and Minnesota	143,837	321,989	465,826
Ohio	320,367	472,066	792,433
Total: 1952	621,868	1,087,491	1,709,359
1951	619,292	1,246,509	1,865,801
South Atlantic and East South Central:			
Alabama	273,944	120,749	394,693
Kentucky, Maryland, Tennessee, Texas, and West Virginia	190,749	264,498	455,247
Total: 1952	464,693	385,247	849,940
1951	524,039	317,445	841,484
Rocky Mountain and Pacific Coast: California, Colorado, and Utah	25,638	1,535	27,173
Total: 1952	25,638	1,535	27,173
1951	11,226	642	11,868
Total United States: 1952	1,805,587	2,468,564	4,274,151
1951	2,005,735	2,472,134	4,477,869

USE OF SCRAP IN FERROALLOY PRODUCTION

The ferroalloy plants operating electric furnaces or aluminothermic units during 1952 used 18 percent less scrap than in 1951.

Purchased scrap accounted for 96 percent of the quantity used and home scrap 4 percent; in 1951, these percentages were 97 and 3, respectively.

Scrap used in blast furnaces in the manufacture of ferroalloys is included in this chapter with blast furnaces.

TABLE 14.—Consumption of ferrous scrap by ferroalloy producers in the United States in 1952, by districts and States, in short tons

District and State	Home	Purchased	Total
Middle Atlantic:			
New York [1]	69	43,527	43,596
Pennsylvania		1,626	1,626
Total: 1952	69	45,153	45,222
1951	76	76,663	76,739
East North Central and West North Central: Iowa and Ohio [1]	12,080	174,859	186,939
Total: 1952	12,080	174,859	186,939
1951	13,432	201,767	215,199
South Atlantic and East South Central: Alabama,[1] Kentucky, South Carolina, Tennessee and West Virginia		27,374	27,374
Total: 1952		27,374	27,374
1951		35,698	35,698
Pacific Coast: Oregon [1] and Washington		4,813	4,813
Total: 1952		4,813	4,813
1951		5,916	5,916
Undistributed:[1] 1952		75,411	75,411
1951	39	81,358	81,397
Total United States: 1952	12,149	327,610	339,759
1951	13,547	401,402	414,949

[1] Some scrap consumption in Alabama, New York, Ohio, Oregon, and West Virginia—not separable—is included with "Undistributed."

MISCELLANEOUS USES

Scrap consumed in 1952 for miscellaneous purposes, such as rerolling, nonferrous metallurgy, and as a chemical agent amouted to 1.2 percent of the total consumption, compared with 1.3 percent during the previous year. The quantity so used decreased 17 percent from that used for these purposes in 1951. Of the quantity used, 96 percent was purchased scrap and 4 percent home scrap.

TABLE 15.—Consumption of ferrous scrap in miscellaneous uses in the United States in 1952, by districts and States, in short tons

District and State	Home	Purchased	Total
New England: Connecticut and Massachusetts	65	15,795	15,860
Total: 1952	65	15,795	15,860
1951	500	16,657	17,157
Middle Atlantic:			
New Jersey	2,464	96,820	99,284
New York	9	80,465	80,474
Pennsylvania	7,653	65,098	72,751
Total: 1952	10,126	242,383	252,509
1951	12,719	304,769	317,488
East North Central:			
Illinois	2,024	187,075	189,099
Indiana	13,038	12,692	25,730
Michigan and Wisconsin	2,489	17,895	20,384
Ohio		59,520	59,520
Total: 1952	17,551	277,182	294,733
1951	17,833	316,008	333,841
West North Central:			
Minnesota	347	396	743
Missouri		59,612	59,612
Total: 1952	347	60,008	60,355
1951	243	79,563	79,806
South Atlantic:			
Georgia	400	899	1,299
Virginia and West Virginia	384	39,695	40,079
Total: 1952	784	40,594	41,378
1951	837	57,218	58,055
East South Central and West South Central: Alabama and Texas	167	56,418	56,585
Total: 1952	167	56,418	56,585
1951	448	56,764	57,212
Rocky Mountain:			
Arizona		31,154	31,154
Colorado, Idaho, and Montana	1,428	10,308	11,736
Utah	1,296	5,049	6,345
Total: 1952	2,724	46,511	49,235
1951	2,356	62,028	64,384
Pacific Coast:			
California		52,003	52,003
Washington	112	1,504	1,616
Total: 1952	112	53,507	53,619
1951	109	69,506	69,615
Total United States: 1952	31,876	792,398	824,274
1951	35,045	962,513	997,558

STOCKS

For the first time since December 31, 1944, complete data on stocks of ferrous scrap in the hands of consumers, suppliers, and producers were made available to the Bureau of Mines and totaled 8,425,312 short tons on December 31, 1952.

Data on manufacturers' and railroads' stocks were made available through a canvass by the Bureau of the Census, for the National Production Authority on Form NPAF–33. Data on the dealers', automobile wreckers', and shipbreakers' stocks were collected by the same bureau on Form NPAF–32, a questionnaire for use by the National Production Authority and the Bureau of Mines.

Consumers' Stocks.—Consumers' total home and purchased stocks on December 31, 1952, increased 58 percent over the stocks held at the beginning of the year. Stocks of home scrap had increased 10 percent and purchased scrap 76 percent.

Stocks of pig iron on December 31, 1952, increased 12 percent over the stocks on hand December 31, 1951.

Suppliers' and Producers' Stocks.—Stocks of iron and steel scrap in the hands of a combined total of 2,084 dealers, automobile wreckers, and shipbreakers, as reported to the Bureau of Mines, totaled 1,343,478 short tons on December 31, 1952.

A total of 1,303 manufacturers and railroads reported having 179,520 short tons of iron and steel scrap on hand December 31, 1952.

Government Control.—During 1952, the two NPA orders in effect that dealt with controls of stocks of iron and steel scrap were M–20 and M–92. M–20 established inventory limitations for iron and steel scrap and subjected such scrap to allocations to assure its distribution in the interest of national defense. On January 30, 1952, M–20 was amended, deleting the words "or automobile wreckers" because controls covering automobile wreckers were covered specifically by M–92. M–92 required an inventory report from automobile wreckers covering the number of motor vehicles and the poundage of loose scrap. This order limited automobile wreckers in their acceptance of delivery of motor vehicles or car units and required them to comply with NPA allocation directives at any time. On March 26, 1952, M–92 was amended to permit automobile wreckers to retain cars built in 1940 and subsequent years, but they were required to scrap 1939 and older cars on the same basis as set forth in the original order. Motor buses (16,000 pounds and heavier) were excluded. M–92 was again amended on April 14, 1952, exempting auto wreckers in Washington, Oregon, Idaho, and Montana from complying with this order. This action was taken owing to the slow movement of scrap in these areas.

On July 2, 1952, M–92 was revoked, and on July 18, 1952, M–20 was amended, requiring auto wreckers to report in the same manner in which they did when operating under M–92.

Direction 1 to NPA Order M–20 (alloy scrap) was issued August 14, 1952, requiring persons who generate alloy scrap as a result of a production operation to sort their scrap into groups on the basis of nickel and other alloy content. NPA estimated that 20 percent of low-alloy steel scrap was being lost to the alloy mills, causing drains on the mills' supplies of prime nickel. To stop this loss the segregation direction was issued. The direction ordered that low-alloy scrap be melted only for the production of alloy, stainless, and low-alloy, high-strength steel. It prohibited mingling such scrap except by melters. There was a minor amendment to this direction on October 15, 1952, dealing with reporting and classification of one type of stainless steel scrap.

TABLE 16.—Consumers' stocks of ferrous scrap and pig iron on hand in the United States on Dec. 31, 1951, and Dec. 31, 1952, by States and districts, in short tons

District and State	Dec. 31, 1951				Dec. 31, 1952			
	Scrap			Pig iron	Scrap			Pig iron
	Home	Purchased	Total		Home	Purchased	Total	
Connecticut	4,745	17,736	22,481	9,951	6,407	20,371	26,778	10,101
Maine	110	3,344	3,454	2,363	48	1,894	1,942	756
Massachusetts	8,071	43,061	51,132	46,698	7,307	79,569	86,876	54,484
New Hampshire	267	2,540	2,807	264	228	2,650	2,878	281
Rhode Island	765	7,175	7,940	19,838	2,808	7,773	10,581	8,153
Vermont	85	8,365	8,450	2,033	262	8,689	8,951	1,338
Total New England	14,043	82,221	96,264	81,147	17,060	120,946	138,006	75,113
New Jersey	9,228	65,633	74,861	46,595	8,478	66,845	75,323	38,440
New York [1]	66,317	146,158	212,475	76,361	123,404	351,229	474,633	116,435
Pennsylvania	390,588	582,846	973,434	340,638	362,801	1,277,845	1,640,646	337,459
Total Middle Atlantic	466,133	794,637	1,260,770	463,594	494,683	1,695,919	2,190,602	492,334
Illinois	58,937	369,863	428,800	106,920	115,431	622,138	737,569	127,164
Indiana	48,427	230,693	279,120	139,956	60,779	459,338	520,117	130,191
Michigan	48,730	219,247	267,977	198,752	44,690	327,722	372,412	367,231
Ohio [1]	230,319	490,701	721,020	216,654	306,651	817,744	1,124,395	228,170
Wisconsin	31,199	71,568	102,767	32,866	19,668	65,992	85,660	36,854
Total East North Central	417,612	1,382,072	1,799,684	695,148	547,219	2,292,934	2,840,153	889,610
Iowa	7,951	48,241	56,192	24,104	6,355	53,859	60,214	23,700
Kansas and Nebraska	180	15,587	15,767	1,656	185	13,888	14,073	1,090
Minnesota, North Dakota, and South Dakota	17,453	62,300	79,753	17,583	16,913	169,486	186,399	21,803
Missouri	3,168	73,540	76,708	18,844	4,129	128,483	132,612	35,671
Total West North Central	28,752	199,668	228,420	62,187	27,582	365,716	393,298	82,264
Delaware, District of Columbia, and Maryland	30,004	26,169	56,173	23,178	32,135	69,570	101,705	12,061
Florida and Georgia	1,104	13,496	14,600	7,295	1,598	18,825	20,423	6,540
North Carolina	1,138	2,706	3,844	5,340	824	1,386	2,210	2,675
South Carolina	82	4,929	5,011	2,012	76	3,904	3,980	2,477
Virginia and West Virginia [1]	11,156	84,500	95,656	51,152	16,380	136,557	152,937	24,237
Total South Atlantic	43,484	131,800	175,284	88,977	51,013	230,242	281,255	47,990
Alabama [1]	85,757	99,969	185,726	162,490	52,287	84,079	136,366	225,371
Kentucky, Mississippi, and Tennessee	13,672	48,564	62,236	54,849	16,167	50,819	66,986	55,763
Total East South Central	99,429	148,533	247,962	217,339	68,454	134,898	203,352	281,134
Arkansas, Louisiana, and Oklahoma	1,126	12,962	14,088	5,607	595	11,675	12,270	4,764
Texas	38,379	69,844	108,223	58,410	33,132	139,566	172,698	29,983
Total West South Central	39,505	82,806	122,311	64,017	33,727	151,241	184,968	34,747
Arizona, Nevada, and New Mexico	7,167	7,012	14,179	282	9,663	13,501	23,164	309
Colorado and Utah	30,176	60,885	91,061	26,354	29,678	118,733	148,411	18,650
Montana	793	2,989	3,782	26	659	4,724	5,383	10
Idaho and Wyoming	15	5,202	5,217	454		3,418	3,418	289
Total Rocky Mountain	38,151	76,088	114,239	27,116	40,000	140,376	180,376	19,258
Alaska, Washington, and Oregon [1]	1,634	65,273	66,907	2,556	2,536	100,007	102,543	3,724
California	49,802	189,156	238,958	48,905	39,581	323,820	363,401	37,913
Total Pacific Coast	51,436	254,429	305,865	51,461	42,117	423,827	465,944	41,637
Undistributed [1]	11	15,247	15,258		35	24,325	24,360	
Total United States	1,198,556	3,167,501	4,366,057	1,750,986	1,321,890	5,580,424	6,902,314	1,964,087

[1] Some scrap stocks in Alabama, New York, Ohio, Oregon, and West Virginia—not separable—are included with "Undistributed."

PRICES

During 1952, all iron and steel scrap prices were under Federal control.

The price of No. 1 Heavy-Melting scrap at Pittsburgh, as reported in the Iron Age Annual Review, January 1, 1953, was at an average of $42.78 per gross ton for 1952. The basing-point price ceiling of $43 per ton, as set by the Office of Price Stabilization, remained firm during 10 months of the year, being affected during the steel-strike months of June and July, when it dropped to $42.90 and $40.45, per gross ton, respectively. Cast-iron scrap remained at the ceiling price of $49 throughout the year.

The composite price of iron and steel scrap, as reported in the Iron Age Annual Review, was $42 per gross ton in January 1952, a drop of $4.15 per ton from the price quoted at the same time for the previous year. With price regulations effective throughout the year, this price prevailed until June and July, when it decreased to $41.37 and $40.10 per gross ton, respectively. The No. 1 Cast scrap composite price at Chicago was quoted at $52, the OPS ceiling, shipping-point price, during January and February; this price per ton had held since February 1951. In March, the price per ton for this grade of scrap dropped from the $52 ceiling price to $46.63 per ton; from this point it continued to drop to a low during the year of $39.10 per ton during July. It rose again during the following 3 months, reaching $45.90 per ton in October, but by the end of the year had dropped to $43.30 per gross ton. The average price for the year for No. 1 Cast at Chicago was $45.18 per ton. No. 1 Heavy Melting at Chicago was quoted at $41.50 per gross ton in January, remaining firm for each month other than June and July, when it dropped to $40.75 and $39.30 per ton, respectively. The average price for this grade of scrap for the year was $41.25.

OPS issued a supplemental regulation 1 to Ceiling Price Regulation 5, effective June 6, 1952, permitting dealers to unload, store, and reload scrap for consumers at not over $1.50 per gross ton. The consumer was required to request this service in writing; the unloading must have taken place after June 1 and ended not later than 24 hours after official termination of the strike at the mill for which the service was being performed; intransit scrap or a dealer's own scrap could not be stored under this arrangement; no charge was allowed to be made for weighing.

The OPS issued Amendment 11, Ceiling Price Regulation, effective October 22, 1952. This provision was designed to recognize that, under certain circumstances, some minor deviation from precise specifications might be permitted. The regulation stated that all grades of scrap must be free of dirt, nonferrous metals, or foreign material of any kind and free of excessive rust and corrosion. Where any shipment failed to meet the exact specifications set forth in the regulation, the burden was on the shipper to prove that the offgrade materials were of a negligible quantity and failed only to a minor extent to meet the specifications, and that its inclusion was accidental and unavoidable in the customary preparation and handling of a particular grade.

FOREIGN TRADE [2]

Imports.—Imports of iron and steel scrap, including tin-plate scrap, decreased 63 percent from imports of the previous year, with the value decreasing 64 percent. Of the scrap imported, the largest quantity was received from Canada (36 percent of the total imports), followed by Cuba (15 percent), and India (9 percent); 40 percent was imported from other countries. Of the total imports, 31 percent was tin-plate scrap, mostly from Canada, compared with 14 percent during the previous year.

Exports.—Exports of ferrous scrap from the United States in 1952 showed an increase in tonnage of 43 percent, and a 37-percent increase in value over 1951. Exports exceeded imports by 129 percent; 1952 was the first year since 1947 when exports were greater than imports. The tonnage exported amounted to 11 percent of the 5-year prewar average (1935–39) of 3,298,326 tons a year; the percentage in 1951 was 7. Tin-plate scrap, tin-plate circles, strips, cobbles, and terneplate clippings and scrap exported during 1952 was 4 percent of the total exports, with a value of $1,387,717. The same materials in 1951 were 6 percent of the 1951 exports, with a value of $2,279,258.

TABLE 17.—Ferrous scrap imported for consumption in the United States, by countries, 1948–52, in short tons

[U. S. Department of Commerce]

Country	1948	1949	1950	1951	1952
Algeria	481	548	15,401	22,863	799
Australia	18,168	12,469	16,635	12,512	8,755
Belgium-Luxembourg	7,614	5,731	39,527	1,676	328
Canada	34,547	71,199	87,981	69,799	55,101
Canal Zone	6,957	1,824	1,163	10,525	1,141
Colombia	-	-	-	1,119	2,444
Cuba	33,026	10,337	21,242	43,870	22,800
Denmark	5,808	146	5,006	475	128
France	1,113	213	162,090	27,844	258
French Morocco	3,384	1,682	6,586	3,042	2,187
French West Indies	-	4,693	-	-	1,596
Germany	227,805	532,850	185,839	63,912	-
Hong Kong	-	-	8,915	-	-
India	3,694	1,186	325	21,519	13,251
Iraq	-	-	7,466	-	-
Italy	3,963	16	-	-	-
Japan	65,856	209,519	113,436	31,648	1,259
Korea	-	-	-	8,516	5,741
Netherlands	9,863	200,486	70,001	19,402	12
Netherlands Antilles	5,411	2,128	3,609	4,328	951
New Zealand	664	1,634	175	7,477	431
Norway	112	28	18	35	2,576
Panama	646	1	-	65	1,913
Peru	-	-	-	-	2,722
Philippines	25,399	75,955	14,253	26,336	-
Switzerland	-	-	3	6,709	-
Union of South Africa	4,284	4,461	5,893	6,930	4,748
United Kingdom	1,251	3,257	8,529	6,225	23
Venezuela	138	647	-	55	8,385
Western Pacific Islands	-	101	-	-	6,720
Other countries	20,540	10,183	11,137	19,976	9,405
Total: Short tons	480,724	1,151,294	785,230	416,858	153,674
Value	$12,180,222	$29,937,798	$18,718,895	[1] $15,013,148	$5,398,570

[1] Revised figure.

[2] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 18.—Ferrous scrap exported from the United States, 1948–52, by countries of destination, in short tons

[U. S. Department of Commerce]

Destination	1948	1949	1950	1951	1952
Argentina	1,187	3,866	1,112	2,597	741
Brazil	602	12	3,225	1,018	296
British Malaya			863	2,487	1,044
Canada	168,119	[1] 162,631	81,000	89,632	[1] 195,439
Chile	48			6	
China	434	33	230		
Colombia	4		217		2
Egypt		315			25
Hong Kong	1,131	1,558	2,547	14	
India	850	808	160	797	1,763
Italy			115	473	1,300
Japan			1,605	3,105	4,362
Malta, Gozo, and Cyprus				1,000	
Mexico	39,291	[1] 123,624	124,537	[1] 140,304	[1] 136,271
Netherlands			355	1,212	34
Norway	34	4,120			
Sweden	95			51	
Turkey		503	95	420	846
Union of South Africa	58	25	236	709	28
United Kingdom		38			8,654
Uruguay				230	
Other countries	341	[1] 1,061	667	1,285	925
Total: Short tons	212,194	[1] 298,594	216,964	[1] 245,340	[1] 351,730
Value	$7,156,105	[1] $7,342,886	$6,013,719	[1] $9,094,473	[1] $12,450,309

[1] Includes rerolling material as follows: 1949, Canada, 37 tons; Mexico, 1,095 tons; other countries, 74 tons; total, 1,206 tons ($50,086): 1951, Mexico, 9,813 tons ($358,146): and 1952, Canada, 69 tons; Mexico, 1,217 tons; total, 1,286 tons ($77,287).

TABLE 19.—Ferrous scrap imported into and exported from the United States, 1948–52, by classes

[U. S. Department of Commerce]

Year	Imports			Exports				
	Iron and steel scrap	Tinplate scrap	Total	Iron and steel scrap	Tinplate scrap	Tinplate circles, strips, cobbles, etc.	Terneplate clippings and scrap	Total
				SHORT TONS				
1948	434,710	46,014	480,724	208,246		3,637	311	212,194
1949	1,105,343	45,951	1,151,294	[1] 294,960		3,380	254	[1] 298,594
1950	737,749	47,481	785,230	208,355	629	7,819	161	216,964
1951	359,099	57,759	416,858	[1] 229,718	907	14,554	161	[1] 245,340
1952	105,896	47,778	153,674	[1] 336,593	3,998	11,139		[1] 351,730
				VALUE				
1948	$11,149,265	$1,030,957	$12,180,222	$6,738,977		$391,421	$25,707	$7,156,105
1949	28,890,519	1,047,279	29,937,798	[1] 6,947,516		370,568	24,802	[1] 7,342,886
1950	17,834,543	884,352	18,718,895	5,254,747	$39,237	697,755	21,980	6,013,719
1951	13,181,093	[2] 1,832,055	[2] 15,013,148	[1] 6,815,215	33,498	2,227,549	18,211	[1] 9,094,473
1952	4,053,529	1,345,041	5,398,570	[1] 11,062,592	85,828	1,301,889		[1] 12,450,309

[1] Includes rerolling materials as follows: 1949, 1,206 tons valued at $50,086; 1951, 9,813 tons valued at $358,146; and 1952, 1,286 tons valued at $77,287.
[2] Revised figure.

TECHNOLOGY

By proper scrap preparation, plus close coordination of plant transportation methods, furnace charging time can be decreased materially, with a corresponding increase in steel production.

Following World War II, the Fontana open-hearth plant of Kaiser Steel Corp. faced serious problems in connection with scrap. The greater portion was light-gage, poorly prepared, and contaminated with nonferrous metals. It was impossible to charge the furnaces quickly; therefore, to get heavier and better prepared scrap, the company developed two scrap-preparation yards. Home scrap (with the exception of heavy structurals and plate) is prepared in one yard and purchased unprepared scrap in the other yard. No attempt is made to separate the light-gage scrap from the heavier gage scrap in the home scrap yard. The length of the cut is controlled to not exceed 15 inches for light-gage and 20 inches for heavy-gage. This maintains a good mixture of light and heavy scrap and provides a good scrap-buggy (charging box car) weight of 10,000 to 12,000 pounds.

In the purchased-scrap yard, a few simple rules are followed in preparing the scrap. The burners are instructed to cut the light material small (about 15 by 30 inches) and the heavy material larger (24 by 60 inches, maximum). Special attention is given to cross bracings and projections so that the finished material will be flat in a charging box and give maximum weight. By careful preparation, good weights can be provided in the boxes. The recovery of nonferrous metals in this yard is a small but important part of the operations. Nonferrous metals are stripped from the scrap and removed to a cleaning area for classification and storage. Approximately 20 tons is recovered and sold each month. The scrap-preparation personnel participates in a nonferrous bonus each time this metal is sold. The payment of this bonus creates an incentive for removing nonferrous metals and decreases contamination of undesirable elements in the steel furnace. A larger charging box is being tried in an effort to charge furnaces faster, shorten drags (trains for delivery of scrap to furnace charging floor), and eliminate congestion with adjacent furnaces. This box has a capacity of 65 cubic feet, compared to the regular box of 32 cubic feet.

As a result of the above-mentioned preparation and transportation methods, the average charging time has been reduced. In 1945 the average charging time for the year was 3 hours 21 minutes, using approximately 40.8 percent hot metal, on an average charge of 420,000 pounds exclusive of ore. The steel-production rate during 1945 was 15.2 tons per hour. In comparison, 1951, owing to the improved methods, reduced the charging time to 1 hour 42 minutes, using approximately 60 percent hot metal in a total charge averaging 465,000 pounds exclusive of ore. The steel-production rate was increased during 1951 to 21.8 tons per hour.[3]

In the past, many sources of scrap had to be passed by because of the high cost of cutting large pieces to furnace-charging size. The C–600 heavy-duty oxyacetylene cutting blowpipe mounted on an adjustable positioning rig supplied by Linde Air Products Co., a division of Union Carbide & Carbon Corp., now makes it possible to reduce large shapes

[3] Bowers, William F., Open-Hearth Proceedings: Am. Inst. Min. and Met. Eng., Pittsburgh, vol. 35, 1952, pp. 72–74.

easily and economically. Cast-iron scrap, as well as other scrap, can also be cut rapidly by using the C–60 cutting blowpipe and the powder cutting process.[4]

One large steel company has reduced its preparation time by approximately one half the time necessary when a lance was used.[5]

Late in 1952, an effective and efficient method for opening hydraulically compressed bundles for inspection by dynamite blasting was developed by the Bethlehem Steel Co.[6] The previous methods used, such as friction sawing, drilling, band sawing, torch cutting, and cold shearing, proved to be impractical for reasons of low production, expense, or distortion and destruction of the bundles' contents.

The trends in recent years has been to lighter and lighter scrap, caused partly by an increase in steel production without corresponding increases in the supplies of Heavy-Melting scrap, and partly by an increase in the proportion of steel production going into sheet and other flat-rolled products, which is reflected in scrap returning to the mills. This has necessitated scrap preparation by baling or hydraulic bundling light-gage scrap and by torch-cutting or shearing plate trimmings and other irregular shapes into smaller pieces, which load more compactly into charging boxes. It may be noted that light-gage is not entirely a liability if the weight per charging box is reasonable.

WORLD REVIEW

Dominican Republic.—According to Embassy Despatch 331, dated October 31, 1952, from Ciudad Trujillo, the export of old iron from the Dominican Republic in any form was prohibited by Presidential Decree on October 24, 1952. The decree specifically included steel scrap and other iron alloys, according to an official of the Ministry of Economics.

The purpose of the degree was to protect the supply of metal needed by the small local foundry industry. The heavy demand for scrap had forced prices up to such an extent that local foundries had difficulty obtaining adequate supplies.

Germany, West [7].—During the first quarter 1952 the German Minister of Economics, Professor Erhard, introduced the expected decontrol of scrap prices. Since the middle of 1951, unsettled market conditions, such as barter transactions, have caused great confusion, and prices could no longer be regulated by Government decrees, so that abolition of the system of controlled prices became necessary. The new measure is the result of long and difficult discussions between the Ministry of Economics, the scrap industry, and consumers.

According to Embassy Despatch 101, dated September 10, 1952, from Duesseldorf, the price of scrap doubled and scrap collection picked up as a result of the removal of price controls on steel scrap. Scrap collection increased from 499,990 metric tons in June to 511,000 metric tons in July. Of this amount, 39,000 metric tons was exported, 400,000 tons was delivered to steel mills, and 72,000 metric tons went to foundries. The scrap agreement between the United States, Great Britain, and the Federal Republic, which terminated July 30,

[4] Blast Furnace and Steel Plant, vol. 40, No. 1, January 1952, p. 132.
[5] Work cited in footnote 4.
[6] Bethlehem Steel Co., Internal Inspection of Bundle Scrap: May 1953.
[7] The Metal Bulletin (London), No. 3687, Apr. 25, 1952, p. 28.

1952, also helped to increase the domestic supply. A contract between the dealers and consumers provided for 1,640,000 metric tons for the last 4 months of 1952.

India.[8]—Indian firms contracted to sell about 250,000 tons of scrap iron to the United States, the United Kingdom, Japan, and European continental countries, with Japan and the United States as the principal buyers. The Government of India decided to permit the export of scrap only when it was understood that steel manufacturers in India found it more economical to use iron ore, rather than go to the expense of crushing the huge blocks of scrap and processing them for further use.

Indonesia.—According to the Embassy Despatch 92, dated July 28, 1952, from Djakarta, the Ministry of Economic Affairs announced that the export of scrap would begin shortly after the date of this despatch. The first shipment was to go to Japan. It was reported that the total quantity of scrap iron in Indonesia was estimated at 400,000 to 600,000 metric tons. Negotiations were underway for export of scrap iron to Europe and the United States.

Japan.[9]—Japan is importing an annual supply of 225,000 to 330,000 tons of scrap iron from Korea and the southeast Asian area. Immediately after World War II, the supply of scrap iron from war-torn areas was estimated at around 10,000,000 tons, but this source is now nearly exhausted.

Sweden.[10]—It was reported from Stockholm that scrap iron supplies had increased in Sweden since the Scrap Committee began its campaign last autumn. The scrap industry delivered 124,000 metric tons between November 1951 and April 1952, inclusive.

United Kingdom.[11] [12]—In the early part of 1952 there was an acute shortage of all types of iron and steel scrap. However, by the end of the year the scrap situation had improved substantially.

Cast-iron scrap became scarce and brought high prices regardless of grade or size. The continued scrap drive was extended to include household and other light scrap. This helped to raise the supply of home scrap, bought, to a level appreciably above that of 1951. The supply of scrap was eked out by additional pig iron, with the ratio used in steelmaking increasing from 0.85 in 1951 to 0.95 in 1952. There was a 5-percent increase in 1952 over the previous year in steel production, whereas the consumption of scrap in steelmaking decreased from 9,124,000 tons to 9,080,000. Imports were also slightly higher than in the previous year. Some 275,000 tons of extra scrap from all sources was used to rebuild the industry's stocks, from which 323,000 tons had been taken in 1951.

---

[8] Mining Journal (London), vol. 239, No. 6101, July 25, 1952, p. 92.
[9] Metal Progress, vol. 63, No. 1, January 1953, p. 112.
[10] Metal Bulletin (London), No. 3697, May 30, 1952, p. 22.
[11] Metal Bulletin (London), No. 3692, May 13, 1952, p. 24.
[12] Monthly Statistical Bulletin, vol. 27, No. 12, December 1952, pp. 1–2.

Jewel Bearings

By Robert D. Thomson [1] and Eleanor V. Blankenbaker [2]

JEWEL BEARINGS are made from various substances, principally synthetic ruby and sapphire. Synthetic spinel and glass are used for jewel bearings where maximum hardness is not essential. Jewel bearings are used to reduce friction and to make a hard, smooth surface that will resist the wear caused by pivot action.

Most of the domestic supply of jewel bearings is obtained from Switzerland. Lack of labor skilled in making jewel bearings, and competition from Swiss bearings of high quality, lower cost, and plentiful supply have handicapped the domestic industry. However, the United States industry has made some progress in commercial production of industrial jewel bearings, which are larger and more amenable to mass-production methods.

The economics of the United States jewel-bearings industry was discussed in an article published in 1952.[3]

DOMESTIC PRODUCTION

Domestic production of blanks and finished jewel bearings in 1952 increased 59 percent and 77 percent, respectively, above the 1951 output. Nevertheless, production of blanks and finished jewels supplied only a small percentage of the total jewel-bearings consumption. A very small quantity of watch jewels was manufactured. Vees (synthetic corundum and glass), instrument rings, cups, and endstones were the principal varieties of industrial jewel bearings man-

TABLE 1.—Salient statistics of the jewel-bearings industry in the United States, 1948–52

[Number of jewel bearings]

	1948	1949	1950	1951	1952
Production:					
Blanks	680,400	249,600	795,400	1,200,503	1,907,301
Finished jewels [1]	2,576,095	2,725,103	3,327,206	9,876,654	10,637,206
Consumption:					
Blanks	7,503,199	6,678,922	7,008,289	11,415,514	9,062,893
Semifabricated jewels	1,729,100	1,603,900	3,331,500	7,884,500	1,892,000
Finished jewels [1]	66,212,629	68,322,111	71,126,700	85,030,037	77,311,999
Shipments:					
Blanks	125,400	29,100	85,400	75,503	5,391
Semifabricated jewels	2,069	1,771	2,414	561	1,439
Finished jewels [1]	28,816,351	24,645,548	6,976,608	14,031,386	28,795,001
Stocks on hand Dec. 31:					
Blanks	7,297,087	7,684,765	5,796,014	2,618,650	4,327,957
Semifabricated jewels	405,225	243,454	529,540	710,479	1,054,886
Finished jewels [1]	72,945,750	98,213,655	107,432,348	97,390,081	104,169,041

[1] Includes finished jewels made from glass.

[1] Commodity-industry analyst.
[2] Statistical clerk.
[3] Weart, S. A., The United States Jewel Bearing Industry: Ind. Diamond Rev., vol. 12, No. 135, February 1952, pp. 27–29.

ufactured domestically during the year. Plants producing jewel bearings are located at Newark, Perth Amboy, and Trenton, N. J.; Lancaster and Morrisville, Pa.; and Waltham, Mass.

CONSUMPTION AND USES

The jewel-bearings industry in 1952 showed an increase in quantity of raw material consumed for manufacturing jewel bearings but a decrease in the consumption of blanks, semifabricated jewels, and finished jewels.

About three times as much raw material was consumed in 1952 as in 1951. Synthetic sapphire and synthetic ruby were the principal materials used in manufacturing jewel bearings.

Consumption of blanks and finished jewels declined about 21 and 9 percent, respectively, whereas semifabricated jewel consumption decreased 76 percent. Consumption and shipments of finished jewels, by uses, are shown in table 3.

TABLE 2.—Consumption and shipments of raw materials by the jewel-bearings industry in the United States, 1949–52

Type of raw material	Consumption (carats)	Shipments	
		Carats	Value
1949:			
Synthetic sapphire	70,299	284	$602
Synthetic ruby	20,550		
Total	90,849	284	602
1950:			
Synthetic sapphire	37,845	10,000	100
Synthetic ruby	4,300		
Total	42,145	10,000	100
Synthetic sapphire rods (in inches)	1,152		
1951:			
Synthetic sapphire	[1] 88,135		
Synthetic ruby	[1] 18,651		
Total	106,786		
Synthetic sapphire rods (in inches)	[2] 210		
1952:			
Synthetic sapphire	162,600		
Synthetic ruby	149,500	300	120
Other	450		
Total	312,550	300	120

[1] Partly estimated.
[2] Estimated figure.

In watches, jewels are used on the parts that move the fastest and require the finest adjustments. The most common varieties of watch bearings are pallet stones (one on each prong of the Y-shaped lever), roller pin (on the roller table affixed to the shaft of the balance wheel), cap jewel (upper and lower ends of the balance wheel shaft), and hole jewels (at the end of the escapement wheel shaft, the shaft holding the lever, and at the end of the balance wheel). Usually, these are made from synthetic ruby.

TABLE 3.—Consumption and shipments of finished jewels in the United States, 1952, by uses

Use	Consumption		Shipments	
	Quantity (number of jewels)	Market value	Quantity (number of jewels)	Market value
Vees:				
Glass	6,468,022	$960,840	5,840,646	$192,080
Other	1,178,518	255,194	6,232,847	681,019
Instrument rings	26,159,954	1,678,596	6,537,557	1,073,390
Watch rings	11,510,601	652,235		
Cups	5,964,992	589,048	4,893,571	447,986
Endstones	8,254,461	220,707	2,987,955	98,030
Caps	4,403,626	56,102		
Holes	4,238,640	246,680	168,000	43,630
Pallet stones	6,110,379	106,623	14,000	3,850
Jewel pins	2,138,391	63,350	2,109,000	274,600
Roller pins	884,415	22,287		
Other			11,425	22,303
Total	77,311,999	4,851,662	28,795,001	2,836,888

The principal industrial jewel bearings are as follows: Cup (nonperforated disk in shape of cup which holds oil), vees (nonperforated circular disks with V-shape indenture in one side), ring (perforated disks or hole jewels), and cap (flat surface endstone). Virtually all industrial jewels are made of synthetic sapphire and require a larger quantity of raw material than the watch jewels.

Jewel bearings have a wide variety of uses. They are used for timekeeping devices; electric and water meters; aircraft, marine, and mechanical instruments; compasses; and other instrumentation.

In all, 22 companies in 9 States reported consumption of finished jewels in 1952 (table 4). The major portion of the consumption was in the Central Atlantic States and two of the New England States. About 44 percent of the number of jewels used in the manufacture of end-use products was consumed by 8 companies in New York, Ohio, and Pennsylvania and 4 companies in New Jersey.

TABLE 4.—Consumption of finished jewel bearings in the United States, 1952, by States

State	Number of consumers	Quantity (number of jewels)
Connecticut	2	861,924
Massachusetts	3	2,056,446
Michigan	1	59,926
New Jersey	4	5,858,517
New York, Ohio, Pennsylvania	8	28,007,916
Other States [1]	4	40,467,270
Total	22	77,311,999

[1] Includes Illinois, Indiana, and a quantity unspecified by State.

FOREIGN TRADE[4]

The major portion of the United States supply of jewel bearings is imported, principally from Switzerland. Some jewel bearings are produced intermittently in Italy, France, and Germany, and during World War II, Russia and England produced limited quantities. Statistics on imports of jewel bearings are shown for the first time in the Minerals Yearbook in table 5. Imports in 1952 increased 6 percent in quantity and 7 percent in value compared with 1951.

TABLE 5.—Jewel bearings imported for consumption in the United States, 1940–52

[U. S. Department of Commerce]

Year	Number	Value	Year	Number	Value
1940	98,771,042	$1,831,007	1947	114,089,168	$4,016,072
1941	92,547,236	2,007,012	1948	138,229,491	5,614,287
1942	88,650,286	2,770,866	1949	140,742,977	5,117,341
1943	65,166,357	2,601,256	1950	87,939,766	3,737,979
1944	38,324,422	1,376,675	1951	92,396,053	3,965,983
1945	36,340,820	1,467,547	1952	98,021,914	4,226,948
1946	58,896,065	2,076,391			

TECHNOLOGY

A contract to establish and operate a jewel-bearings plant at Rolla, N. Dak., near the Turtle Mountain Indian Reservation was awarded to Bulova Watch Co. by the Army Ordnance Corps. The plant will be known as Turtle Mountain Ordnance pilot plant and will utilize the skill of the Indians. It is anticipated that a portion of the Armed Forces requirements for jewel bearings in gunsights, tank range finders, bombsights, and other optical instruments will be met by this production.

A detailed description of jewel-bearings recessing (cupping) machines and their operation was presented in an article in which data on coolants, collets, lubrication, broche manufacturing, and inspection were summarized.[5]

Hardness tests were conducted on synthetic corundum.[6] Results showed that specimens are hardest on the faces and parallel to the optic axis and the hardness does not depend on the angle formed by the geometric axis and the optic axis as previously believed. Preliminary tests have shown that the direction of greatest abrasion resistance of synthetic corundum coincides with the direction of greatest indentation hardness.[7]

[4] Figures on imports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

[5] Weart, S. A., Jewel Bearing Recessing Machines: Ind. Diamond Rev., vol. 12, No. 141, August 1952, pp. 165–169.

[6] Attinger, C., Orientation and Hardness of Synthetic Corundum: Ind. Diamond Rev., vol. 12, No. 140, July 1952, pp. 136–137.

[7] Stern, W., Direction Hardness and Abrasion Resistance of Synthetic Corundum: Ind. Diamond Rev., vol. 12, No. 140, July 1952, pp. 137–140.

342070—55——38

Kyanite and Related Minerals

By Brooke L. Gunsallus [1] and Frances P. Uswald [2]

KYANITE, sillimanite, andalusite, dumortierite, topaz, and synthetic mullite are discussed under the heading "Kyanite and Related Minerals," because of similarities in properties and end use.

The mullite-containing materials constitute one of the most important types of refractories used in the metallurgical and glass industries. Smaller quantities are used for high-temperature boilers and in the cement and ceramic industries. Mullite ($3Al_2O_3.2SiO_2$) rarely is found in nature, but when any of the aluminum silicate minerals kyanite, andalusite, sillimanite, dumortierite, or topaz is heated to an appropriate temperature it converts to a mixture of mullite and a form of free silica. Mullite of any desired purity also may be produced by sintering or fusing mixtures of alumina and either kaolin or silica in the correct stoichiometric proportions. As with all refractories, however, correct chemical composition is not the only essential criterion; mineralogical constitution and grain structure are also vitally significant in their influence on the utility of the grain as the predominant raw material to produce a finished refractory.

Domestic kyanite production increased slightly in 1952 over 1951, but the Bureau of Mines is not at liberty to publish detailed figures.

Changing political and economic conditions and the uncertainty of obtaining high-grade material from India increased the demand for high-grade synthetic mullite. As a result, 1952 kyanite imports decreased 54 percent from 1951.

The development of synthetic mullite will insure domestic self-sufficiency in raw materials for mullite refractories in the future.

No production of other minerals in this group was reported in 1952.

DOMESTIC PRODUCTION

Kyanite provides most of the United States production of aluminum silicate minerals used in producing mullite.

All kyanite produced in the United States is recovered as fine-grained concentrates from disseminated ores. The mullite produced from these concentrates is not suitable for the highest grades of refractories because of small grain size and low density.

Only two companies produced kyanite in the United States in 1952: Commercialores, Inc., 39 Cortlandt St., New York, N. Y., from deposits at Henry Knob, near Clover, S. C.; and Kyanite Mining Corp., Cullen, Va., from a property on Baker Mountain near Farmville, Prince Edward County, Va. The total domestic production was slightly larger in 1952 than in 1951. The Bureau of Mines is not at liberty to publish figures on domestic production inasmuch as there were only two producers in 1952.

No production of andalusite, dumortierite, sillimanite, or topaz was reported to the Bureau of Mines in 1952.

[1] Commodity-industry analyst.
[2] Statistical clerk.

CONSUMPTION AND USES

Domestic consumption of kyanite from foreign and domestic sources and synthetic mullite during 1950, 1951, and 1952 was about 30,000, 38,000, and 40,000 short tons, respectively, exclusive of material purchased for the National Stockpile and electrocast mullite.

Mullite, whether obtained from natural ores or synthetically, is used almost entirely in the manufacture of superduty refractories. Although mullite refractories represent only a small percentage of the total tonnage of refractories used in the United States, they are important because of their relatively high softening points, resistance to loads at high temperatures, resistance to thermal shock due to low coefficient of expansion, and resistance to the corrosive action of certain fluxing agents. Mullite refractories are relatively expensive, but industry has found them profitable for many purposes.

Mullite refractories are used in the form of bricks and shapes, cements, mortars, plastics, and ramming mixtures. Mullite bricks and shapes are used chiefly by the refractory industry and require in their manufacture a material that converts, after calcining, to a coarse-grained dense material. Until recently, they have been made mostly from massive kyanite imported from India. In some instances, the relatively fine-grained mullite obtained from concentrates produced from domestic disseminated ores has been blended with coarse-grained mullite in producing refractory bricks and shapes. Domestic kyanite also is satisfactory for making refractory cements and for other uses where large grain size is not required; such applications consume most of the domestic variety.

About 90 percent of all mullite refractories are used for lining furnaces operated by the metallurgical (50 percent) and glass (40 percent) industries. The remaining refractories (10 percent) are used for numerous purposes, chiefly in the ceramic industry. In the metallurgical industry the principal application of mullite refractories is in lining electric furnaces, largely the induction type, used for melting brasses and bronzes, copper-nickel alloys, certain steels, and ferrous alloys. Other metallurgical applications are in zinc smelting and gold-refining furnaces. In the glass industry these refractories are used mainly in the construction of continuous tanks, especially the superstructure, and in making plungers, rings, and tubes for feeding molten glass to the forming machines. In the ceramic industry small quantities of mullite are used to manufacture kiln furniture for stacking ware in kilns, in saggers (open-top refractory boxes) for protecting ware during firing, and in kiln construction.

STOCKS

Stocks of imported kyanite at the end of 1952 totaled 2,844 short tons, compared with 1,891 short tons in 1951. Kyanite imported for consumption in 1952 totaled 9,057 short tons, compared with 19,570 in 1951, a decrease of 54 percent. This large decrease in imports for consumption resulted from the increased use of synthetic mullite produced from domestic raw materials.

Stockpile objectives for kyanite and mullite were contracted for and no further contracts were contemplated.

PRICES

As reported by E&MJ Metal and Mineral Markets for December 1952, quotations on kyanite were as follows: Per short ton, f. o. b. point of shipment, Virginia and South Carolina, 35-mesh, c. l., in bulk, $29, in bags, $32; 200-mesh, in bags, c. l., $40. Quotations on imported kyanite (55- to 59-percent grade) in bags were $60 to $65 per short ton, c. i. f. Atlantic ports.

FOREIGN TRADE

Imports and exports of kyanite and related minerals for 1952 are shown in table 1. India continued to lead as a source of supply with 53 percent, British East Africa supplied 29 percent, and the Union of South Africa supplied 16 percent. The total imports for 1952 decreased 54 percent compared with 1951. Competition from synthetic mullite produced in the United States partly explains this decline; other contributing factors were the unsettled political and economic conditions in India and the uncertainty of obtaining continuing supplies of high-grade massive kyanite. Imports have fluctuated considerably during recent years.

TABLE 1.—**Kyanite imported for consumption and kyanite and allied minerals exported from the United States, 1948–52**

[U. S. Department of Commerce]

Imports

Year and origin	Short tons	Value
1948	17,091	$259,055
1949	12,119	324,856
1950	17,417	587,819
1951 [1]		
Australia	57	507
British East Africa	[2] 8,254	[2] 439,171
India	10,370	339,437
Southern British Africa	[2] 341	[2] 16,111
Union of South Africa	548	17,060
United Kingdom	(3)	148
Total	19,570	[2] 812,434
1952		
Australia	84	1,999
British East Africa	2,595	101,173
Canada	57	4,598
India	4,835	217,908
Union of South Africa	1,486	64,879
Total	9,057	390,557

Exports

Year and destination	Short tons	Value
1948	462	$21,813
1949	1,039	46,725
1950	941	35,750
1951		
Argentina	106	12,000
Canada	523	18,474
Chile	15	510
France	93	4,395
Mexico	242	7,921
Switzerland	11	462
Total	990	43,762
1952		
Canada	575	22,348
France	60	3,443
Mexico	494	18,706
Total	1,129	44,497

[1] In the corresponding table in Minerals Yearbook, 1951, Mozambique, revised to none.
[2] Revised figure.
[3] Less than 1 ton.

TECHNOLOGY

Until recent years most of the mullite refractory material used in the United States was obtained by calcining high-grade massive Indian kyanite. During the last few years, however, research by the Bureau of Mines and private concerns utilizing Western Hemisphere raw materials has resulted in the development of synthetic-mullite products equal or superior to those derived from high-grade Indian kyanite. The highest qualities of synthetic mullite have been produced from Bayer-process alumina made from Caribbean bauxite by the fusing process. Mullite of excellent quality has been produced from certain low-iron, siliceous bauxites in the United States by the sintering process. Synthetic-mullite grain produced from these domestic materials is comparable in quality and cost to mullite grain processed from massive Indian kyanite. Size and density of the mullite grain are important.

RESERVES

Reserves of domestic kyanite having the favorable characteristics of high-grade Indian kyanite are negligible. High-grade fibrous kyanite occurs on the slopes of Willis Mountain in western Virginia. Estimates have placed the reserves of high-grade lump kyanite at approximately 5,000 short tons, equal to 1 month's supply at the present rate of consumption. Further exploration of this deposit may disclose additional reserves.

According to the Federal Geological Survey, the kyanite reserves in Virginia, North Carolina, South Carolina, and Georgia are of the order of tens of millions of tons of ore containing 20 to 30 percent kyanite.

The development of synthetic mullite appeared to offer the best means for future fulfillment of needs now being served by imported kyanite. Raw materials used in producing mullite synthetically by either the fusing or sintering method are sufficient to meet anticipated future demands.

WORLD REVIEW

A large deposit of kyanite was reported [3] to have been found in the Province of Ontario, Canada. The kyanite, associated with quartz, garnet, feldspar, and mica, occurs in bands of gneiss several hundred to a thousand feet thick. Beneficiation will be required to produce a salable product. During 1952 a small quantity of ore was mined.

In 1952 only 57 short tons of kyanite was exported from Canada to the United States.

A kyanite deposit [4] was being developed about 8 miles from Francistown in the Tati Territory of Bechuanaland Protectorate, Africa. Another was reported near the town of Brokoponda on the Surinam River in Surinam.[5] Exploration was in progress, but no development work had been started in 1952.

A company was formed to work the Assam sillimanite deposits in India.[6]

[3] Northern Miner, vol. 38, No. 28, October 1952, pp. 17–18.
[4] Mining World, vol. 14, No. 2, February 1952, p. 53.
[5] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 1, July 1952, pp. 37–38.
[6] Mining World, vol. 14, No. 12, November 1952, p. 77.

Lead

By O. M. Bishop [1] and Edith E. den Hartog [2]

THE OUTSTANDING feature of the United States lead industry in 1952 was the transition from scarcity to plenty. Imports, more than double the 1951 total, established a new record and were the determining factor in the change in the supply position. The great influx of foreign lead resulted from expanded free-world production and price drops in foreign markets, which stimulated shipments to the United States. The increased availability of lead was first indicated late in 1951 and became more apparent early in 1952. Foreign prices began a steady decline in February, and in April domestic prices dropped for the first time since June 1950. The United States selling price declined from the 19-cent-a-pound ceiling in effect since October 1951 to a low of 13.5 cents, but by the end of the year had risen to 14.75 cents. The National Production Authority revoked all controls on lead May 15 owing to abundant supplies. Free trading was established on the London Metal Exchange on October 1 for the first time in 13 years, and dealings in lead futures were resumed in the New York Commodity Exchange on May 26.

Lead supply totaled 1,477,000 tons in 1952, an increase of 28 percent over 1951, comprising 390,000 tons of recoverable mine production, 471,000 tons of secondary lead, and 616,000 tons of imports (exclusive of scrap). Consumption of lead, including the quantities consumed in pigments and chemicals, totaled 1,131,000 tons compared with 1,185,000 tons in 1951. Producers' stocks of primary refined lead increased from 19,000 tons on December 31, 1951, to 31,000 tons at the end of 1952, and antimonial lead stocks increased from 6,000 tons to 11,000 tons during the year. Consumers' stocks rose 19 percent to 123,000 tons.

In 1952 the five-volume report by the President's Materials Policy Commission, popularly known as the Paley report, was released. Volume II, Resources for Freedom, reviewed the lead supply and demand of the United States and evalued reserves, conservation practices, market demand, and position of the free world. Projected demand for lead in 1975 is estimated at 1,950,000 tons, or approximately 61 percent more than in 1950. Projected supply at that time is estimated at 300,000 tons of domestic mine production, 750,000 tons of secondary lead, and 900,000 tons of imports.

---

[1] Commodity-industry analyst.
[2] Statistical assistant.

GOVERNMENT REGULATIONS

Adequate supplies of lead resulted in an amendment to Order M–38 on March 3, 1952, whereby all restrictions on the use of lead were removed and consumers were permitted to carry a 60-day lead inventory instead of the 30-day supply previously permitted. On May 15 the National Production Authority completely revoked Orders M–38 and M–76, governing the use and distribution of lead, respectively, thus ending all domestic controls on lead. On June 5, 1952, the National Production Authority withdrew all forms of lead from list A, designating scarce materials, and on July 3 the Office of International Trade removed quota restrictions on the quantity of soft pig lead that might be exported. Export licenses were still required, however, for exports to all countries except Canada.

GOVERNMENT PROGRAMS UNDER THE DEFENSE PRODUCTION ACT OF 1950

The Defense Minerals Administration was established in 1950, under provisions of the Defense Production Act, to stimulate the production of critical minerals and metals needed for national defense. Late in 1951 this organization was terminated, being succeeded with respect to exploration activities by the Defense Minerals Exploration Administration and with respect to procurement by the Defense Materials Procurement Agency.

The objective of the Defense Minerals Exploration Administration was to encourage mineral exploration and thus to increase the production of strategic and critical minerals and metals. In connection with this program, the Government financed up to 50 percent of the total cost of approved exploration projects for lead and zinc. At the end of 1952, 151 exploration contracts involving lead or zinc were in force. Government participation in these 151 lead-zinc exploration contracts totaled $5,595,473 or approximately half of total Government participation in all defense-minerals exploration contracts.

The Defense Materials Procurement Agency in connection with its procurement function made purchase contracts (both foreign and domestic), granted floor-price contracts and subsidies, and made recommendations for production expansion loans, operating loans, and certificates of necessity for accelerated tax amortization programs. The Agency also certified the essentiality of specific access-road programs.

Table 2 in the Zinc chapter of this volume lists individual lead-zinc Defense Minerals Exploration Administration contracts through 1952, and tables 3, 4, and 5 list purchase contracts and certification of tax amortization programs and access roads as they pertain to lead or zinc.

TABLE 1.—Salient statistics of the lead industry in the United States, 1943–47 (average) and 1948–52, in short tons

	1943–47 (average)	1948	1949	1950	1951	1952
Production of refined primary lead:						
From domestic ores and base bullion	366,388	339,413	404,449	418,809	342,644	383,358
From foreign ores and base bullion	65,045	67,281	72,889	89,505	75,049	89,494
Total	431,433	406,694	477,338	508,314	417,693	472,852
Recovery of secondary lead	388,261	500,071	412,183	482,275	518,110	471,294
Imports (general):						
Lead in pigs, bars, and old	198,895	276,013	289,889	461,827	[2] 188,175	523,059
Lead in base bullion	1,271	7,186	2,373	3,488	2,281	389
Lead in ores and matte	65,712	63,907	107,279	76,520	[2] 67,471	104,515
Exports of refined pig lead	4,211	[2] 399	969	2,735	1,281	1,762
Consumption of primary and secondary lead	1,082,344	1,133,895	957,674	1,237,981	1,184,793	1,130,795
Prices (cents per pound):						
New York:						
Average for period	8.46	18.04	15.36	13.30	17.49	16.47
Quotation at end of period	9.41	21.50	12.00	17.00	19.00	14.12
London average for period	7.57	17.16	16.95	13.29	20.25	17.09
Mine production of recoverable lead [1]	396,140	390,476	409,908	430,827	388,164	390,162
World smelter production of lead	1,386,000	[2] 1,504,000	[2] 1,659,000	[2] 1,812,000	[2] 1,768,000	1,980,000

[1] Includes Alaska.
[2] Revised figure.

DOMESTIC PRODUCTION

Statistics on lead output may be prepared on a mine or smelter and refinery basis. Mine-production data, compiled on the basis of lead content in ores and concentrates, adjusted to account for average losses in smelting, are a better measure of domestic output from year to year and are more accurate for showing the geographic distribution of production. Pig-lead output, as reported by smelters and refiners, presents a more precise figure of actual lead recovery but indicates only in a general way the source of crude material treated. Smelter and refinery output usually differs from the mine figure owing to the lag between mine shipments and smelter treatment of ores and concentrates.

MINE PRODUCTION

Domestic mine output of recoverable lead increased slightly to 390,000 tons in 1952. Gains were made in the first half of the year, when higher prices stimulated production; during the latter half of the year, when lead and zinc prices were lower, lead was produced at a rate 4 percent below the 1951 rate. Missouri was by far the leading producing State, supplying 33 percent of the total United States output. Idaho and Utah ranked second and third in production, with 19 percent and 13 percent of the total, respectively. Production in 7 of the 16 principal States was higher than in 1951; the largest tonnage increases were in Missouri, Washington, and Virginia, and the largest decreases were in Kansas, Idaho, and California. Lead output in Kansas was the lowest since 1918, and in Arizona, Nevada, Idaho, and New York mine production was the smallest since 1943, 1945, 1946, and 1946, respectively. On the other hand, production in 1952 from Washington was larger than in any year, that from Wisconsin was the largest since 1927, and that of Illinois was the largest in more than 50 years.

Of the total lead produced in the United States in 1952, 69 percent came from 25 properties. Missouri continued to rank first among the States in the production of lead, and the Southeastern Missouri district continued to be the largest lead-producing region, supplying nearly 32 percent of the total domestic output. Production for the first 6 months from Southeast Missouri was only 2 percent more than the output in the last 6 months, indicating that the price declines, which began in April, had less effect on production than price changes had elsewhere in the lead-mining industry. Development work, however, was curtailed to some extent. The St. Joseph Lead Co. continued as the largest individual lead producer in the district and in the United States. The company operated its 4 mills, having a combined daily capacity of 26,800 tons, and its Bonne Terre, Desloge, Federal (including Doe Run), and Leadwood groups of mines in the Lead Belt throughout the year. It also began production from its Hayden Creek property in September and continued development of its Indian Creek property. In addition, the St. Joseph Lead Co. operated Mine La Motte and its 2,000-ton mill as a joint venture with the National Lead Co. The National Lead Co. (St. Louis Smelting & Refining Division) operated its Madison lead-copper mine and 1,200-ton mill throughout the year.

TABLE 2.—Mine production of recoverable lead in the United States, 1943–47 (average) and 1948–52, by States, in short tons

State	1943-47 (average)	1948	1949	1950	1951	1952
Western States and Alaska:						
Alaska	127	329	51	149	21	1
Arizona	21, 159	29, 899	33, 568	26, 383	17, 394	16, 520
California	7, 746	9, 110	10, 318	15, 831	13, 967	11, 199
Colorado	17, 701	25, 143	26, 853	27, 007	30, 336	30, 066
Idaho	77, 473	88, 544	79, 299	100, 025	76, 713	73, 719
Montana	12, 763	18, 411	17, 996	19, 617	21, 302	21, 279
Nevada	6, 401	9, 777	10, 626	9, 408	7, 148	6, 790
New Mexico	6, 386	7, 653	4, 652	4, 150	5, 846	7, 021
Oregon	5	7	12	17	2	1
South Dakota	17	16	4		2	2
Texas	28	170	132	129	43	56
Utah	47, 800	55, 950	53, 072	44, 753	50, 451	50, 210
Washington	4, 599	7, 147	6, 417	10, 334	8, 002	11, 744
Wyoming	1					
Total	202, 206	252, 156	243, 000	257, 803	231, 227	228, 608
West Central States:						
Arkansas	4	22	1	9	33	4
Kansas	7, 941	8, 386	9, 772	9, 487	8, 947	5, 916
Missouri	161, 505	102, 288	127, 522	134, 626	123, 702	129, 245
Oklahoma	14, 866	16, 918	19, 858	20, 724	16, 575	15, 137
Total	184, 316	127, 614	157, 153	164, 846	149, 257	150, 302
States east of the Mississippi River:						
Illinois	2, 642	3, 695	3, 824	2, 729	3, 160	4, 262
Kentucky	170	216	187	66	107	60
New York	1, 486	1, 231	1, 317	1, 484	1, 500	1, 120
Tennessee	80		257	113	14	18
Virginia	3, 867	4, 703	3, 313	3, 254	1, 508	3, 792
Wisconsin	1, 373	861	857	532	1, 391	2, 000
Total	9, 618	10, 706	9, 755	8, 178	7, 680	11, 252
Grand total	396, 140	390, 476	409, 908	430, 827	388, 164	390, 162

Lead production in the Tri-State district increased nearly 2 percent over the 1951 total. Output in Kansas and Oklahoma declined 34 percent and 9 percent, respectively, while output from southwestern Missouri increased markedly and accounted for the overall increase in the district. Production dropped 20 percent in the latter half of the year as compared with the first 6 months; many small mines curtailed production or were closed because of the sharp decline in the zinc price, as zinc constitutes the major values in most of the district. The Quick Seven pit (Brown & Root and American Zinc, Lead & Smelting Co.), the Kelsey Norman pit of the Wild Goose Mining Syndicate, and the Potter-Sims Snap open-pit mine were the major sources of lead and zinc produced in southwestern Missouri. The Eagle-Picher Co. remained by far the largest lead producer in the Tri-State district, followed by the American Zinc, Lead & Smelting Co. Other significant producers were the National Lead Co. (operations were shut down on account of a labor strike during the last 4 months of the year), Beck Mining Co., Potter-Sims Mines, Inc., Federal Mining & Smelting Co., and the Dines Mining Co.

Mine production of recoverable lead in the combined Western States decreased 1 percent in 1952. During the year mines in these States accounted for 59 percent of the total domestic output, or slightly less than in 1951.

Idaho continued to be the leading producer of lead in the Western States and second only to Missouri in the United States, despite a 4-percent decrease in output in 1952. Declining market prices for lead and zinc and a restriction on the use of electric power were the principal factors contributing to the reduced output. The Signal Mining Co. Hilarity mine and the Idaho Custer Mines, Inc., Livingston mine were shut down, and Day Mines, Inc., Spokane-Idaho Mining Co., and Sunset Minerals, Inc., curtailed operations because of low metal prices. Pacific Northwest consumers of power using more than 8,000 kw.-hr. per week were required to reduce their consumption to 90 percent of that in 1951, owing to the lack of rain during the summer and fall. More than 90 percent of the State total lead output in 1952 came from the Coeur d'Alene region. The remainder was produced chiefly in the Warm Springs, Bayhorse, and Texas districts. The Bunker Hill & Sullivan mine was again by far the largest producer in the State, followed by the Page, Star, Morning, and Triumph mines. Other important producers were the Sunshine, Golconda, Sidney group, and Constitution properties and the Dayrock mine of Day Mines, Inc. These 6 mines accounted for 65 percent of the State lead. Zinc-lead ore yielded about 79 percent of the State output.

Output of recoverable lead in Utah in 1952 was approximately the same as in 1951. Zinc-lead ore supplied 92 percent of the State total lead. About 68 percent of the output came from the West Mountain (Bingham) district, 15 percent from the Park City region, and 9 percent from the Tintic district. The United States & Lark property remained by far the largest producer in the State and was followed by the Chief Consolidated mine, New Park property, West Calumet, Park Utah property, Silver King Coalition mine, and the Butterfield group. In the Park City region the Park Utah Consolidated Mining

Co. property was shut down on June 25 because of a labor strike, and the Silver King Coalition Mining Co. property was closed August 16 because of low metal prices. The Chief Consolidated Mining Co. property in the Tintic district was shut down by a labor strike for nearly 3 months during the summer.

Mine production of lead in Colorado in 1952 was 1 percent less than that in 1951. Many mines could not operate profitably at the low metal prices in effect the latter part of the year, and a number of them, mostly small producers, shut down. The leading producers in order of output were the Resurrection group, Treasury Tunnel-Black Bear group, Eagle group, Smuggler Union group, and the Rico Argentine group. Zinc-lead and zinc-lead-copper ores yielded 78 percent of the State total lead, zinc ore 15 percent, and lead ore 7 percent.

Montana's production of lead in 1952 was substantially the same as in 1951. The bulk of the output came from the Anaconda Copper Mining Co. owned and leased operations at Butte. Smaller quantities of lead were obtained from the American Smelting & Refining Co. subsidiary, the Mike Horse mine (which was closed in November "due to low prices and a substantial exhaustion of reserves"), and from the Jack Waite and Iron Mountain mines. Nearly 87 percent of the State lead was recovered from zinc-lead ore; most of the rest came from lead ore.

Lead output in Arizona decreased 5 percent in 1952, the lowest since 1943. Reduced output resulted largely from the closing of the Eagle-Picher Co. San Xavier mine in August because of low metal prices. The chief producers in the State in 1952 in order of output were the Iron King mine, Mammoth-St. Anthony property, Flux group, San Xavier mine, Copper Queen mine and the Aravaipa group. Six districts—Aravaipa, Big Bug, Harshaw, Old Hat, Pima, and Warren—accounted for 88 percent of the State total lead. Zinc-lead ore yielded 93 percent of the total output.

Production of lead in Washington in 1952 set a new record, 47 percent above the 1951 output and 14 percent over 1950, the previous high. The leading producers in order of output were the Pend Oreille mine, Grandview mine, Bonanza mine, and the Deep Creek mine. These four properties accounted for virtually all of the State lead during the year. Over 88 percent of the total lead output was recovered from zinc-lead ore, and most of the remainder came from lead ore and old lead tailings.

California's lead output in 1952 was 20 percent below the 1951 total. The Anaconda Copper Mining Co. Darwin and Shoshone groups supplied the bulk of the State production. The Shoshone property curtailed production in June to explore for new sources of ore. Coronado Copper & Zinc Co., the only other large producer of lead in the State, terminated mining operations at its Afterthought mine in August owing to ore depletion. Many of the small, high-cost producers ceased operations after midyear owing to the reduced lead price. There was some exploration for new deposits in 1952, the activity centering mainly in Inyo, San Bernardino, and Shasta Counties. Zinc-lead ore provided about 60 percent of the lead yield and lead ore 36 percent.

Mine production of lead in New Mexico in 1952 increased 20 percent above the 1951 output. Most of the output came from mines in the Central and Magdalena districts; minor tonnages of lead and barite ores were mined in the Hansonberg district. The leading producers in order of output were the Ground Hog group, Bayard group, and the Lynchburg mine. Zinc ore yielded 64 percent of the State total lead, zinc-lead ore 21 percent, and lead ore 15 percent.

TABLE 3.—Mine production of recoverable lead in the United States, 1943–47 (average) and 1948–52, and by districts that produced 1,000 tons or more during any year, 1948–52, in short tons

District	State	1943–47 (average)	1948	1949	1950	1951	1952
Southeastern Missouri region.	Missouri	157,390	100,654	126,269	133,680	122,318	122,942
Coeur d'Alene region	Idaho	71,933	82,587	74,152	94,697	70,570	67,330
West Mountain (Bingham).	Utah	25,567	30,672	32,600	27,472	29,120	34,328
Tri-State (Joplin region)	Kansas, Southwestern Missouri, Oklahoma.	26,788	26,901	30,883	31,157	26,906	27,356
Summit Valley (Butte)	Montana	4,480	13,217	11,490	15,679	16,630	16,153
Upper San Miguel	Colorado	2,087	3,804	5,285	7,780	8,008	7,657
Park City region	Utah	11,192	12,670	8,583	7,538	11,719	7,494
California (Leadville)	Colorado	4,891	4,745	5,080	6,392	5,996	5,624
Pioche	Nevada	3,393	5,613	6,630	6,761	4,751	4,632
Central	New Mexico	4,005	3,740	2,479	2,315	3,133	4,486
Tintic	Utah	5,783	5,970	6,676	6,520	5,553	4,279
Big Bug	Arizona	1,770	2,676	3,330	4,357	4,035	4,135
Red Cliff	Colorado	1,078	1,120	1,600	2,110	4,274	3,980
Old Hat	Arizona	4,382	5,406	6,788	5,980	[1] 4,241	3,913
Austinville	Virginia	3,680	4,703	3,313	3,254	1,508	3,792
Upper Mississippi Valley	Iowa, Northern Illinois, Wisconsin.	1,690	1,807	2,046	1,801	1,923	3,532
Animas	Colorado	2,591	1,886	2,935	3,069	3,963	3,464
Warm Springs	Idaho	2,569	1,304	2,339	2,648	3,086	3,455
Kentucky-Southern Illinois.	Kentucky, Southern Illinois.	2,494	2,965	2,822	1,526	2,516	2,790
Rush Valley and Smelter (Tooele County).	Utah	3,451	4,185	2,953	1,393	2,674	2,595
Pioneer (Rico)	Colorado	2,410	2,430	1,388	1,138	2,231	2,230
Harshaw	Arizona	1,772	1,999	1,546	1,931	1,668	1,921
Pima (Sierritas, Papago, Twin Buttes).	do	2,058	3,917	4,232	2,996	2,834	1,864
Warren (Bisbee)	do	7,584	11,253	13,865	7,790	1,606	1,828
Creede	Colorado	387	451	1,162	1,422	1,167	1,513
Heddleston	Montana	2,539	1,946	2,335	930	1,398	1,251
St. Lawrence County	New York	1,486	1,231	1,317	1,484	1,497	1,120
Bayhorse	Idaho	1,489	1,880	1,073	1,679	1,732	1,091
Magdalena	New Mexico	1,489	2,826	1,162	926	1,004	1,046
Sneffels	Colorado	(2)	756	1,064	866	1,094	1,044
Ophir	Utah	613	791	1,089	948	712	999
Battle Mountain	Nevada	54	234	1,290	564	--------	907
Aravaipa	Arizona	355	1,142	1,271	1,498	1,294	865
Eureka	Colorado	215	1,107	578	323	569	759
Tomichi	do	563	1,788	1,221	645	761	739
Eagle	Montana	834	600	1,024	1,013	(2)	733
Modoc	California	266	1,061	729	87	317	111
Ten Mile	Colorado	625	4,177	3,671	910	6	8
Coso (Darwin)	California	4,906	6,078	4,928	8,479	7,191	(2)
Metaline [3]	Washington	3,808	4,297	4,030	7,445	5,234	(2)
Northport (Aladdin) [3]	do	198	1,426	342	237	937	(2)
Bossburg [3]	do	330	1,394	2,011	2,640	1,768	(2)
Resting Springs [3]	California	(2)	(2)	(2)	(2)	(2)	(2)

[1] Revised figure.
[2] Figure not shown to avoid disclosure of individual company operations.
[3] This district is not listed in order of 1952 output.

TABLE 4.—Twenty-five leading lead-producing mines in the United States in 1952, in order of output

Rank	Mine	District	State	Operator	Type of ore
1	Federal	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
2	United States & Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co	Zinc-lead.
3	Bunker Hill & Sullivan	Yreka	Idaho	Bunker Hill & Sullivan Mining & Concentrating Co	Do.
4	Leadwood	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
5	Butte Hill mines and dumps	Summit Valley (Butte)	Montana	Anaconda Copper Mining Co	Zinc-lead.
6	Mine La Motte	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
7	Bonne Terre	do	do	do	Do.
8	Darwin group	Coso	California	Anaconda Copper Mining Co	Do.
9	Madison	Southeastern Missouri	Missouri	St. Louis Smelting & Refining Co	Lead-copper.
10	Page	Yreka	Idaho	Federal Mining & Smelting Co	Zinc-lead.
11	Star	Hunter	do	Sullivan Mining Co	Do.
12	Desloge	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
13	Pend Oreille	Metaline	Washington	Pend Oreille Mines & Metals Co	Zinc-lead.
14	Resurrection	Leadville	Colorado	Resurrection Mining Co	Do.
15	Morning	Hunter	Idaho	Federal Mining & Smelting Co	Do.
16	Treasury Tunnel-Black Bear	Upper San Miguel	Colorado	Idarado Mining Co	Do.
17	Combined Metals group	Pioche	Nevada	Combined Metals Reduction Co	Do.
18	Grandview	Metaline	Washington	American Zinc-Lead Smelting Co	Do.
19	Iron King	Big Bug	Arizona	Shattuck-Denn Mining Co	Do.
20	Eagle	Red Cliff	Colorado	New Jersey Zinc Co	Silver-zinc.
21	Mammoth-Collins	Old Hat	Arizona	St. Anthony Mining & Development Co	Zinc-lead.
22	Chief	Tintic	Utah	Chief Consolidated Mining Co	Do.
23	Austinville	Austinville	Virginia	New Jersey Zinc Co	Do.
24	Triumph, North Star	Warm Springs	Idaho	Triumph Mining Co	Do.
25	Smuggler Union	Upper San Miguel	Colorado	Telluride Mines, Inc	Do.

Recoverable lead output in Nevada in 1952 decreased 5 percent below the 1951 tonnage, owing chiefly to the closing of the Copper Canyon Mining Co. Copper Canyon mine in October and the Ely Valley Mines, Inc., mine in August because of low metal prices. The Pioche group of mines was by far the largest producer in the State, followed by the Copper Canyon and Ely Valley properties. Zinc-lead ore supplied 76 percent of the State total lead and lead ore 20 percent.

Mines in States east of the Mississippi River produced 47 percent more lead in 1952 than in 1951. Lead is produced chiefly as a byproduct or coproduct of zinc and fluorspar mining in these States. Increased output was attributed in part to resumption of full-scale operations at the Austinville mine in Virginia and to greatly increased production from mines in Wisconsin and Illinois.

Small quantities of lead were also recovered in 1952 from ores mined in Oregon, South Dakota, Texas, and Arkansas.

The 25 leading lead-producing mines in the United States in 1952, listed in table 4, yielded 69 percent of the total domestic output; the 10 leading mines produced 51 percent and the 4 leading mines 37 percent.

Detailed information on the production of mines and mining districts in the United States may be found in Volume III of this Yearbook.

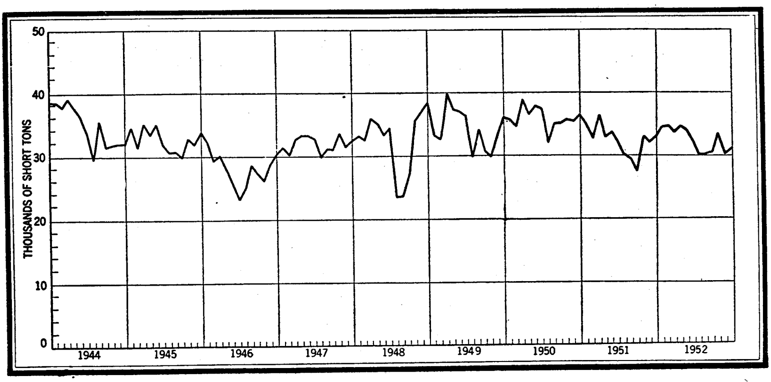

FIGURE 1.—Mine production of recoverable lead in the United States, 1944–52, by months.

TABLE 5.—Mine production of recoverable lead in the United States,[1] 1951–52, by months, in short tons

Month	1951	1952	Month	1951	1952
January	35, 102	34, 551	August	29, 487	30, 454
February	32, 864	34, 601	September	27, 494	30, 633
March	36, 474	33, 637	October	33, 058	33, 853
April	32, 972	34, 724	November	32, 060	30, 152
May	33, 537	34, 087	December	32, 928	31, 178
June	32, 148	32, 202			
July	30, 040	30, 090	Total	388, 164	390, 162

[1] Includes Alaska.

SMELTER AND REFINERY PRODUCTION

Pig (refined) lead produced in the United States is derived from three principal sources—domestic mine production, imports of foreign ores and base bullion, and scrap materials (treated largely at secondary smelters)—and is recovered at primary refineries that treat ore, base bullion, and small quantities of scrap and at secondary plants that process scrap exclusively. Of the 13 primary lead plants in the United States, 6 combine smelting and refining operations, 5 produce only base bullion (containing approximately 98 percent lead, plus gold and silver, and small quantities of other impurities recovered from the ores smelted), and 2 confine their activities to refining. Refined lead and antimonial or "hard" lead may be produced by both primary and secondary plants. Because of the large quantity of hard lead, such as battery scrap, melted at secondary smelters, the output from this type of operation is principally antimonial lead. Statistics on the production of refined lead and alloys at secondary plants are given in the Secondary Lead section of this chapter.

The 11 primary smelters in operation in 1952 consumed 498,000 short tons (lead content) of primary materials in the form of ores and concentrates, of which 81 percent was domestic and 19 percent was of foreign origin. Consumption was 14 percent greater than in 1951 but almost 3 percent below that of 1950.

ACTIVE LEAD SMELTERS AND REFINERIES

Primary lead smelters and refineries operating in the United States in 1952 were as follows:

California: Selby—Selby plant, American Smelting & Refining Co. (smelter and refinery).
Colorado: Leadville—Arkansas Valley plant, American Smelting & Refining Co. (smelter).
Idaho: Bradley—Bunker Hill Smelter, Bunker Hill & Sullivan Mining & Concentrating Co. (smelter and refinery).
Illinois: Alton—Federal plant, American Smelting & Refining Co. (smelter and refinery).
Indiana: East Chicago—U. S. S. Lead Refinery, Inc. (refinery).
Kansas: Galena—Galena plant, Eagle-Picher Co. (smelter and refinery).
Missouri: Herculaneum—Herculaneum plant, St. Joseph Lead Co. (smelter and refinery).
Montana: East Helena—East Helena plant, American Smelting & Refining Co. (smelter).
Nebraska: Omaha—Omaha plant, American Smelting & Refining Co. (refinery).
New Jersey: Barber—Perth Amboy plant, American Smelting & Refining Co. (smelter and refinery).
Texas: El Paso—El Paso plant, American Smelting & Refining Co. (smelter).
Utah:
- Midvale—Midvale plant, United States Smelting, Refining & Mining Co. (smelter).
- Tooele—Tooele plant, International Smelting & Refining Co. (smelter).

REFINED LEAD

Primary refineries in the United States produced 475,900 short tons of refined lead in 1952, an increase of 13 percent over 1951 production.

Of the 472,900 tons of refined lead produced from primary sources during the year, domestic ores and base bullion were the source of 81 percent and imported ores and bullion of 19 percent (82 and 18 percent, respectively, in 1951). Table 7 gives the production of refined lead by source material and by country of origin. Details of the sources of lead from domestic ores are given in the Mine Production section of this chapter.

TABLE 6.—Refined lead produced at primary refineries in the United States, 1943–47 (average) and 1948–52, by source material, in short tons

Source	1943–47 (average)	1948	1949	1950	1951	1952
Refined lead:						
From domestic ores and base bullion	366,388	339,413	404,449	418,809	342,644	383,358
From foreign ores	64,944	60,829	71,413	86,241	71,984	89,092
From foreign base bullion	101	6,452	1,476	3,264	3,065	402
Total from primary sources	431,433	406,694	477,338	508,314	417,693	472,852
From scrap	11,086	4,952	23,230	5,455	3,893	3,070
Total refined lead	442,519	411,646	500,568	513,769	421,586	475,922
Average sales price per pound	$0.084	$0.179	$0.158	$0.135	$0.173	$0.161
Total calculated value of primary refined lead [1]	$71,866,000	$145,600,000	$150,840,000	$137,245,000	$144,522,000	$153,246,884

[1] Excludes value of refined lead produced from scrap at primary refineries.

TABLE 7.—Refined primary lead produced in the United States, 1943–47 (average) and 1948–52, by source material and country of origin, in short tons

Source	1943–47 (average)	1948	1949	1950	1951	1952
Domestic ore and base bullion	366,388	339,413	404,449	418,809	342,644	383,358
Foreign ore:						
Australia	14,793	6,729	6,465	6,984	9,056	5,888
Canada	6,344	3,608	3,317	7,892	7,986	7,113
Europe		43	30		17	454
Mexico	3,628	4,427	8,477	5,992	3,620	2,344
South America	15,437	24,589	29,163	38,770	36,849	48,625
Other foreign	24,742	21,433	23,961	26,603	14,456	24,668
Total	64,944	60,829	71,413	86,241	71,984	89,092
Foreign base bullion:						
Australia		466	1,382	2,427	2,815	
Mexico	44	5,637	36	435	27	70
South America	57	52	58	402	75	177
Other foreign		297			148	155
Total	101	6,452	1,476	3,264	3,065	402
Total foreign	65,045	67,281	72,889	89,505	75,049	89,494
Grand total	431,433	406,694	477,338	508,314	417,693	472,852

ANTIMONIAL LEAD

Production of antimonial lead at primary refineries in 1952 dropped 11 percent below the 1951 output. Production increased at 2 of the alloy-producing plants but declined at the other 4. Distribution of antimonial lead production at primary refineries in 1948–52 by source material is shown in table 8, as is also the average antimony content.

Although antimonial lead is an important byproduct of the refining of base bullion, the quantity derived from this source is only a small part of total domestic output. The major production is recovered from the smelting of antimonial lead scrap at secondary smelters. Production data from lead-smelting plants treating scrap materials exclusively are summarized in the following section.

TABLE 8.—Antimonial lead produced at primary lead refineries in the United States, 1943–47 (average) and 1948–52

Year	Production (short tons)	Antimony content		Lead content by difference (short tons)			
		Short tons	Percent	From domestic ore	From foreign ore	From scrap	Total
1943–47 (average)	62,893	4,081	6.6	12,654	6,151	40,007	58,812
1948	100,764	5,760	5.7	29,561	15,918	49,525	95,004
1949	41,402	3,385	8.2	692	4,620	32,705	38,017
1950	57,959	4,504	7.8	10,728	4,344	38,383	53,455
1951	65,309	4,416	6.7	17,372	9,218	34,303	60,893
1952	58,203	4,392	7.5	12,993	5,673	35,145	53,811

SECONDARY LEAD

Some scrap lead is treated at primary smelters, but the greater part is processed at a large number of plants that specialize in the treatment of secondary materials. Secondary lead is recovered in the form of refined lead, antimonial lead, and other alloys.

Secondary lead recovered in 1952 fell 9 percent below the peak established in 1951 to a total of 471,294 tons and exceeded domestic mine production for the seventh consecutive year. Data on recovery, by type of plant, in 1948–52 are shown in table 9. Detailed information on secondary lead appears in the Secondary Metals—Nonferrous chapter of this volume.

TABLE 9.—Secondary lead recovered in the United States, 1943–47 (average) and 1948–52, in short tons

	1943–47 (average)	1948	1949	1950	1951	1952
As refined metal:						
At primary plants	11,086	4,952	23,230	5,455	3,893	3,070
At other plants	60,854	126,951	129,396	123,858	165,023	137,032
Total	71,940	131,903	152,626	129,313	168,916	140,102
In antimonial lead:						
At primary plants	40,007	49,525	32,705	38,383	34,303	35,145
At other plants	162,282	194,027	140,037	187,257	195,660	187,806
Total	202,289	243,552	172,742	225,640	229,963	222,951
In other alloys	114,032	124,616	86,815	127,322	119,231	108,241
Grand total:						
Short tons	388,261	500,071	412,183	482,275	518,110	471,294
Value	$69,017,982	$179,025,418	$130,249,828	$130,214,250	$179,266,060	$151,756,668

LEAD PIGMENTS

The principal lead pigments are litharge, white lead, red lead, sublimed lead, leaded zinc oxide, and orange mineral. These products are manufactured for the most part from metal, but some ore and concentrates are converted directly into pigments. Details of the production of lead pigments are given in the Lead and Zinc Pigments and Zinc Salts chapter of this volume.

342070—55——39

CONSUMPTION AND USES

Domestic lead consumption (including lead in lead ore consumed directly in the manufacture of lead pigments and salts) totaled 1,131,000 tons in 1952—a 5-percent decline from 1951. Of the total consumed, 726,000 tons was refined soft lead, 275,000 tons was contained in antimonial lead, 29,000 tons in white metal scrap, 43,000 tons in percentage metals, 26,000 tons in copper-base scrap, and 22,000 tons in residues and drosses; and 10,000 tons was recovered from ore in leaded zinc oxide. About 42 percent of all lead consumed was used in metal products, 31 percent in storage batteries, 11 percent in pigments, 13 percent in chemicals, including tetraethyl lead, and 3 percent for miscellaneous and other purposes. Cable covering took about 13 percent (12.6 percent) of the total and tetraethyl lead almost 13 percent (12.9 percent).

In June 1952 Chemical Engineering[3] reported that the Ethyl Corp. had completed a new tetraethyl lead plant with a capacity of 40,000 tons per year on the Houston, Tex., ship channel and noted that the E. I. du Pont de Nemours & Co., was completing new facilities at Deepwater, N. J., that would increase the capacity to 25,000 tons of tetraethyl lead per year. These new plants give the United States a total tetraethyl lead capacity of about 270,000 tons per year. Current trends point to higher octane gasoline requirements, which can be met most economically by the use of ethyl fluid.

TABLE 10.—Consumption of lead in the United States in 1951–52 by products, in short tons

	1951	1952		1951	1952
Metal products:			Pigments:		
Ammunition	40,242	36,182	White lead	25,578	22,943
Bearing metals	35,410	36,545	Red lead and litharge	88,031	76,742
Brass and bronze	29,858	25,807	Pigment colors	12,796	12,839
Cable covering	131,863	142,571	Other [1]	13,099	9,775
Calking lead	46,544	45,150			
Casting metals	22,497	18,017	Total pigments	139,504	122,299
Collapsible tubes	13,657	10,095			
Foil	2,881	2,124	Chemicals:		
Pipes, traps, and bends	33,095	29,465	Tetraethyl lead	128,407	146,723
Sheet lead	31,210	28,697	Miscellaneous chemicals	6,949	3,996
Solder	82,465	72,664			
Terne metal	2,051	1,812	Total chemicals	135,356	150,719
Type metal	28,236	27,413			
			Miscellaneous uses:		
Total metal products	500,009	476,542	Annealing	6,656	5,084
			Galvanizing	2,173	2,002
Storage batteries:			Lead plating	1,444	1,037
Antimonial lead	199,838	187,506	Weights and ballast	7,913	7,660
Lead oxides	175,546	163,424			
			Total miscellaneous uses	18,186	15,783
Total storage batteries	375,384	350,930	Other, unclassified uses	16,354	14,522
			Grand total	1,184,793	1,130,795

[1] Includes lead content of leaded zinc oxide production.

[3] Chemical Engineering, Big Jump for TEL Vol. 59, No. 6, June 1952, p. 274.

TABLE 11.—Consumption of lead in the United States 1951–52, by months, in short tons [1]

Month	1951	1952	Month	1951	1952
January	126, 022	97, 503	August	97, 622	105, 729
February	101, 603	92, 527	September	78, 999	107, 728
March	120, 826	88, 664	October	88, 527	108, 841
April	118, 372	83, 719	November	88, 106	96, 509
May	102, 524	82, 714	December	86, 307	93, 614
June	94, 458	87, 679			
July	81, 427	85, 568	Total	1, 184, 793	1, 130, 795

[1] Includes lead content of leaded zinc oxide production.

TABLE 12.—Consumption of lead in the United States in 1952, by class of product and type of material, in short tons

	Soft and antimonial lead	Scrap, percentage metal, drosses, etc.	Total
Metal products	364, 047	112, 495	476, 542
Storage batteries	345, 001	5, 929	350, 930
Pigments	112, 604	62	112, 666
Chemicals	150, 719		150, 719
Miscellaneous	15, 420	363	15, 783
Unclassified	12, 950	1, 572	14, 522
Total	1, 000, 741	120, 421	[1] 1, 121, 162

[1] Excludes 9,633 tons of lead contained in leaded zinc oxide.

STOCKS

Producers' Stocks.—Lead stocks, as reported by the American Bureau of Metal Statistics, are shown in table 13. Stocks of refined and antimonial lead include metal held by all primary refiners and by some of the refiners of secondary metal who produce soft lead. According to reports released by the American Bureau of Metal Statistics, total lead stocks increased during the year from 124,080 to 149.778 tons (21 percent) and refined and antimonial stocks from 25,339 to 43,560 tons (72 percent).

TABLE 13.—Stocks of lead at smelters and refineries in the United States at end of year, 1943–47 (average) and 1948–52, in short tons

[American Bureau of Metal Statistics]

	1943–47 (average)	1948	1949	1950	1951	1952
Refined pig lead	27, 302	29, 050	61, 329	28, 894	18, 518	31, 405
Antimonial lead	5, 980	9, 594	9, 095	6, 725	6, 821	12, 155
Total	33, 282	38, 644	70, 424	35, 619	25, 339	43, 560
Lead in base bullion:						
At smelters and refineries	8, 139	9, 697	16, 364	11, 993	11, 315	17, 583
In transit to refineries	4, 338	4, 101	3, 696	4, 959	3, 909	3, 105
In process at refineries	15, 592	17, 939	15, 561	15, 341	15, 700	19, 759
Total	28, 069	31, 737	35, 621	32, 293	30, 924	40, 447
Lead in ore and matte and in process at smelters	85, 527	76, 373	95, 481	69, 757	67, 817	65, 771
Grand total	146, 878	146, 754	201, 526	137, 669	124, 080	149, 778

The Bureau of Mines annual survey of primary smelters and refiners indicated stocks of 31,400 tons of refined soft lead at these plants on December 31, 1952, compared with 18,500 tons on January 1. Stocks of primary antimonial lead (lead content) at these plants increased from 6,400 to 11,000 tons during the year. Stocks of ore and concentrates (in terms of lead content) decreased in 1952 from 44,400 to 34,000 tons, and inventories of base bullion at refineries that receive bullion and smelters that produce bullion for shipment to refineries increased from 12,700 to 13,500 tons. Stocks of in-process base bullion or work lead at four combination smelter-refinery plants are not included in reports to the Bureau of Mines. No direct comparison can be made between these data and the figures of the American Bureau of Metal Statistics. Figures reported to the Bureau of Mines represent physical inventory at the plants, irrespective of ownership, and do not include material in process or in transit.

Consumers' Stocks.—Consumers' stocks of lead increased 19 percent in 1952. On January 1 they totaled 103,000 tons, increased to 132,000 tons at the end of July, dropped to 105,000 tons by October 31, and rose again in November and December to total 123,000 tons on December 31. Stocks of refined soft lead, white metal scrap, lead in copper-base scrap and in the drosses increased 43, 23, 60, and 45 percent, respectively; decreases were reported in antimonial lead and percentage metals.

TABLE 14.—Consumers' stocks of lead in the United States at end of year, 1948–52, by type of material, in short tons, lead content

Year	Refined soft lead	Antimonial lead	Unmelted white scrap	Percentage metals	Copper-base scrap	Drosses, residues, etc.	Total
1948	62,077	35,088	4,828	7,932	2,301	6,972	119,198
1949	64,542	16,837	2,957	5,405	2,087	5,439	97,267
1950	87,285	27,737	5,406	6,446	1,558	11,452	139,884
1951	56,731	28,221	3,140	7,054	1,429	6,185	102,760
1952	80,888	20,309	3,877	6,191	2,282	8,983	122,530

PRICES

The two major markets for lead in the United States are New York and St. Louis. The bulk of the lead produced domestically is sold at prices normally based upon quotation in these markets. The differential between St. Louis and New York prices is about 0.2 cent a pound, an amount approximating the freight charges between the two cities, the St. Louis price being the lower. The London market has had no direct influence on New York quotations since suspension of trading on the London Metal Exchange in September 1939; however, on October 1, 1952, free trading in lead on the Exchange was resumed, and United States prices declined to the lowest point of the year, following sharp reductions in the London quotations.

The market price for common lead, New York, held at the ceiling of 19 cents per pound set by the Office of Price Stabilization on October 2, 1951, until April 29, 1952, when increased supplies and lower consumption caused a decline to 18 cents. Later drops brought the price to 15 cents a pound on May 12. The quoted price advanced to 16 cents on June 24, where it remained until October 7, when it again dropped to 15 cents. Limited buying caused further declines in the following weeks, and on October 22 the price was down to 13.5 cents, the low point of the year. In November and December the market improved, and on December 30 the quotation for lead was 14.75 cents a pound.

TABLE 15.—Average monthly and yearly quoted prices of lead at St. Louis, New York, and London, 1950–52, in cents per pound [1]

Month	1950			1951			1952		
	St. Louis	New York	London [2]	St. Louis	New York	London [2]	St. Louis	New York	London [2]
January	11.80	12.00	12.11	16.80	17.00	17.00	18.80	19.00	21.86
February	11.80	12.00	12.11	16.80	17.00	17.00	18.80	19.00	21.23
March	10.76	10.96	11.06	16.80	17.00	17.00	18.80	19.00	20.87
April	10.43	10.63	10.57	16.80	17.00	20.00	18.72	18.92	20.36
May	11.52	11.72	11.61	16.80	17.00	20.00	15.53	15.73	17.29
June	11.61	11.81	11.84	16.80	17.00	20.00	15.06	15.26	16.29
July	11.46	11.66	11.58	16.80	17.00	21.45	15.80	16.00	16.60
August	12.73	12.93	12.84	16.80	17.00	22.49	15.80	16.00	16.36
September	15.60	15.80	15.70	16.80	17.00	22.49	15.80	16.00	16.36
October	15.84	16.04	16.00	18.72	18.92	21.87	14.20	14.40	[3] 11.84
November	16.80	17.00	17.00	18.80	19.00	21.88	13.98	14.18	[3] 11.23
December	16.80	17.00	17.00	18.80	19.00	21.84	13.92	14.12	[3] 12.10
Average	13.10	13.30	13.29	17.29	17.49	20.25	16.27	16.47	17.09

[1] St. Louis: Metal Statistics, 1953, p. 533. New York: Metal Statistics, 1953, p. 527. London: E&MJ Metal and Mineral Markets.
[2] Conversion of English quotations into American money based on average rates of exchange recorded by Federal Reserve Board.
[3] Free trade in lead on London market resumed October 1. Quoted price based on monthly average o bids as quoted in E&MJ Metal and Mineral Markets.

The official London price of £175 per long ton of lead (equivalent to 21.86 cents per pound computed on the 279.75-cent base) fixed on October 1, 1951, was lowered to £170 (21.23 cents) on February 1, 1952. Thereafter subsequent drops reduced the price to £131 (16.36 cents) on July 10, where it remained until October. On October 1 the London free lead market was opened, marking the first time thc exchanged functioned since August 31, 1939. During the first few weeks of free trading the price ranged from £111 (13.86 cents) to £80 (9.99 cents). At the close of the year the selling price was £102 15s (12.83 cents).

FOREIGN TRADE [4]

Imports.—Imports of lead reached an all-time high in 1952; the total, including 12,000 tons of scrap, was 628,000 tons or about 2½ times greater than the quantity imported in 1951 and 16 percent above the previous record established in 1950. The buyer's market in lead in 1952 was brought about chiefly by this huge increase in imports, which in turn reflected increased world production of lead considerably in excess of foreign demand.

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 16.—Total lead imported into the United States in ore, matte, base bullion, pigs, bars, and reclaimed, 1948–52, by countries, in short tons [1]

[U. S. Department of Commerce]

Country	1948	1949	1950	1951 [2]	1952 [2]
Ore and matte:					
Africa	10,142	31,373	19,713	10,673	22,656
Australia	9,017	8,983	9,792	7,423	8,932
Bolivia	20,369	24,098	13,336	15,989	18,473
Canada	8,288	10,326	9,452	[3] 7,239	11,937
Chile	3,430	3,395	2,605	1,945	3,197
El Salvador	250	333	417	286	126
Guatemala	23	2,827	325	3,169	4,721
Honduras	61	465	412	381	595
Mexico	2,702	8,388	2,846	[3] 2,525	2,487
Peru	8,548	14,970	16,010	16,946	28,210
Philippines	16	279	949	789	2,446
Other countries	1,061	1,842	663	106	735
Total ore and matte	63,907	107,279	76,520	[3] 67,471	104,515
Base bullion:					
Australia		2,246	2,263	2,234	
Guatemala			232		266
Japan			921		
Korea	82				
Mexico	6,455	25			
Peru	619	102	72	47	123
Other countries	30				(4)
Total base bullion	7,186	2,373	3,488	2,281	389
Pigs and bars:					
Africa	507	280		2,279	6,670
Australia	30,469	17,192	22,009	13,598	82,800
Belgium-Luxembourg	8,911	212	166	331	1,785
Bolivia					635
Burma	2,343	1,414			
Canada	53,978	56,432	107,673	56,959	104,531
Germany		8,333	8,643	738	[5] 6,052
Italy	21,349	3,419			
Japan		2,108	5,712		
Korea	39	51			
Mexico	98,460	126,398	220,767	[3] 36,987	198,872
Netherlands	1,826	219	484		2,747
Peru	23,559	34,626	31,988	31,528	42,169
Spain	1,653		440		5,509
United Kingdom	422	341	49	299	4,216
Yugoslavia	2,889	23,436	43,855	[3] 36,311	53,997
Other countries	711	779	2	2	737
Total pigs and bars	247,116	275,240	441,788	[3] 179,032	510,720
Reclaimed, scrap, etc.:					
Africa	344	479			
Australia	3,690	2,971	1,061	2,175	924
Belgium-Luxembourg	986	329	13		
Burma		205			203
Canada	11,687	1,856	1,317	[3] 1,730	6,047
Canal Zone	447	384	319	228	858
Chile				84	
France	(4)	289		88	
Germany		663	290		
Italy	2,304	346			
Jamaica	1	89	51	252	101
Japan		2,765	14,769	[3] 470	345
Malta, Gozo, and Cyprus	155				
Mexico	1,644	845	934	2,089	872
Netherlands	2,460	599	4	18	454
Panama	223	92	80	234	300
Peru				159	297
Philippines	2,341	1,144	99	114	96
Venezuela	2	8	106	668	196
Western Pacific Islands			6	81	282
Yugoslavia	652				345
Other countries	1,961	1,585	990	753	1,019
Total reclaimed, scrap, etc	28,897	14,649	20,039	[3] 9,143	12,339
Grand total	347,106	399,541	541,835	[3] 257,927	627,963

[1] Data are "general imports," that is, include lead imported for immediate consumption plus material entering the country under bond.

[2] In addition to data shown, "flue dust or fume containing lead and zinc, and other minerals or metals (lead content)," imported as follows—1951: 13 tons (revised figure), 1952: 40 tons.

[3] Revised figure. [4] Less than 1 ton. [5] West Germany.

Of the total lead imported, 511,000 tons or 81 percent was in the form of pigs and bars, 105,000 tons or 17 percent in ore and matte, 12,000 tons or 2 percent as reclaimed, scrap, etc., and less than 500 tons in base bullion. Mexico supplied 39 percent of the pigs and bars, Canada 20 percent, Australia 16 percent, Yugoslavia 11 percent, and Peru 8 percent. Of the ore and matte imported, 27 percent came from Peru, 22 percent from the Union of South Africa, 18 percent from Bolivia, 11 percent from Canada, and 9 percent from Australia. Canada provided 49 percent of the imports of scrap.

TABLE 17.—Lead imported for consumption in the United States, 1948–52, by classes [1]

[U. S. Department of Commerce]

Year	Lead in ores, flue dust, and mattes, n. s. p. f.		Lead in base bullion		Pigs and bars		Sheets, pipe, and shot		Not otherwise specified (value)	Total value
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value		
1948	33, 932	$8, 350, 507	10, 922	$3, 239, 135	244, 692	$80, 922, 779	181	$100, 519	$35, 554	$100, 968, 922
1949	121, 848	34, 397, 026	1, 133	374, 954	272, 437	80, 148, 110	178	101, 084	29, 830	119, 054, 978
1950	95, 068	21, 045, 414	1, 148	193, 356	434, 410	104, 340, 645	207	78, 111	78, 690	129, 613, 215
1951	[2] 31, 359	[2] 8, 278, 266			[2] 179, 021	[2] 63, 682, 071	255	123, 377	174, 265	[2] 74, 528, 528
1952	107, 581	32, 755, 497	2, 951	1, 137, 813	510, 718	165, 018, 991	11	8, 446	221, 779	202, 353, 559

[1] In addition to quantities shown (value included in total values), "reclaimed, scrap, etc.," imported as follows—1948: 28,897 tons, $8,320,428; 1949: 14,076 tons, $4,003,974; 1950: 22,524 tons, $3,876,999; 1951: Revised figures, 8,020 tons, $2,183,240; 1952: 11,361 tons, $3,197,621; and "flue dust or fume containing lead and zinc and other minerals or metals (lead content)," imported as follows—1951: Revised figures, 13 tons, $87,309; 1952: 40 tons, $13,412. Figures include lead received by the Government and held in stockpiles but exclude imports for manufacture in bond and export, which are classified as "imports for consumption" by the U. S. Department of Commerce.

[2] Revised figure.

TABLE 18.—Miscellaneous products containing lead, imported for consumption in the United States, 1948–52

[U. S. Department of Commerce]

Year	Babbitt metal, solder, white metal, and other combinations containing lead			Type metal and antimonial lead		
	Gross weight (short tons)	Lead content (short tons)	Value	Gross weight (short tons)	Lead content (short tons)	Value
1948	257	184	$213, 614	14, 732	13, 163	$5, 279, 080
1949	281	127	459, 236	5, 861	5, 207	2, 255, 909
1950	4, 345	2, 744	2, 814, 264	12, 518	10, 582	3, 431, 650
1951	1, 533	988	1, 494, 792	[1] 9, 128	[1] 8, 663	3, 845, 671
1952	1, 282	847	1, 102, 717	10, 909	9, 415	4, 153, 960

[1] Revised figure.

Exports.—Total exports of pig lead in 1952 were 1,800 tons compared with 1,300 tons in 1951. Exports of scrap increased from 2,400 to 2,700 tons in 1952. Export restrictions imposed under the Export Control Act of 1940 remained in force throughout 1952.

TABLE 19.—Total lead exported from the United States in ores, matte, base bullion, pigs, bars, and scrap, by destinations, 1948–52, in short tons [1]

[U. S. Department of Commerce]

Destination	1948	1949	1950	1951	1952
Ore, matte, base bullion:					
Belgium-Luxembourg			132		
Canada	9	1,616	1	557	836
Total ore, matte, base bullion	9	1,616	133	557	836
Pigs and bars:					
Belgium-Luxembourg		76		37	
Brazil	1	126	47	62	433
Canada	[2] 7	14	306	138	40
Canal Zone		15	19	24	18
Chile	42	40	35	107	193
Colombia	16	60	123	42	10
Cuba	40	68	61	48	52
Denmark		131			
Ecuador		15	15		84
El Salvador		34	96	35	23
Honduras	[2] 8	29	6	14	10
India	121	4		11	4
Israel		1	174	112	34
Pakistan			569		
Philippines	1	53	306	17	78
Saudi Arabia	24	7	1	3	19
Turkey	11	7			280
United Kingdom			67		
Uruguay		69	734	424	231
Venezuela	[2] 63	148	95	62	67
Other countries	65	72	81	145	186
Total pigs and bars	[2] 399	969	2,735	1,281	1,762
Scrap:					
Belgium-Luxembourg		362		31	
Canada		95	41	203	20
Germany			264	145	
Japan				195	
Lebanon		11			
United Kingdom		279	1,271	20	55
Total scrap		747	1,576	594	75
Grand total	408	3,332	4,444	2,432	2,673

[1] In addition, 86 tons of foreign lead in pigs and bars was reexported in 1949, 53 tons in 1950, none in 1948 and 1951, and 2 tons in 1952.
[2] Revised figure.

Tariff.—Owing to the shortage of lead in the United States in 1951 and early 1952, import duties were suspended on February 12, 1952, until March 31, 1953, or until the end of the existing emergency. The congressional act suspending the duty stipulated that the rates of June 6, 1951, which were in effect until February 12 ($1\frac{1}{16}$ cents and $\frac{3}{4}$ cent on pig lead and lead in ores and concentrates, respectively) were to be reimposed if the average market price of lead fell to 18 cents a pound for a calendar month. The Tariff Commission informed the President on June 6 that the average price of lead for May was below 18 cents a pound, and on June 26 the President signed the order ending the duty suspension.

TECHNOLOGY

During 1952 the Bureau of Mines published the following Reports of Investigation which relate in whole or in part to lead:

4876. Separation of Lead, Cadmium, and Germanium Sulfides From Zinc Sulfide Concentrates.
4900. Recovery of Thallium From Smelter Products.
4907. Lead-Zinc Deposits of Southwestern St. Lawrence County, N. Y.
4908. Beneficiation of Sherman Pyromorphite Lead Ore.
4909. Guymard Lead-Zinc Deposit, Orange County, N. Y.
4927. Concentration Tests on Various Base-Metal Ores.

Other Bureau of Mines publications giving technologic information on lead include the lead chapters in the Materials Survey (MS 5) made in cooperation with the United States Geological Survey for the National Security Resources Board; Bulletin 503, which deals with the limits of flammability of gases and vapors and gives such data on lead tetramethyl; and Information Circular 7627, Control of Metallurgical and Mineral Dusts and Fumes in Los Angeles County, Calif.

Publications of the United States Geological Survey published in 1952 and relating to lead include:

Circular 131. Exploratory Drilling in the Prairie du Chien Group of the Wisconsin Zinc and Lead District.
Circular 168. Geochemical Studies in the Coeur d'Alene Mining District, Idaho.
Bulletin 978–d. Zinc-Lead Deposits at Shawangunk Mine, Sullivan County, N. Y.
Bulletin 978–e. The Wallapai Mining District, Mohave County, Ariz.

Several excellent articles on lead-ore deposits and their exploration appeared in the technical press, among which were:

Huff, Lyman C. Abnormal Copper, Lead, and Zinc Content of Soil Near Metalliferous Veins. Econ. Geol., vol. 47, No. 5, August 1952, pp. 517–542.
Triplett, W. H. Geology of the Silver-Lead-Zinc Deposits of the Avalos Providencia District of Mexico. Min. Eng., vol. 4, No. 6, June 1952, pp. 583–593.
Claveau, Jacques, and Others. The Lead and Zinc Deposits of the Bou Beker-Touissit Area, Eastern French Morocco. Econ. Geol., vol. 47, No. 5, August 1952, pp. 481–493.
Creasey, S. C. Geology of the Iron King Mine, Yavapai County, Ariz. Econ. Geol., vol. 47, No. 1, January-February 1952, pp. 24–55.
Ohle, Ernest L. Geology of the Hayden Creek Lead Mine, Southeast Missouri. Min. Eng., vol 4, No. 5, May 1952, pp. 477–483.
Powers, Harold, and Others. Geophysical Case History, Fredericktown Lead District, Missouri. Min. Eng., vol 5, No. 3, March 1953. Presented as Tech. Paper 3507L, February 1952.

Several articles on new applications or developments in metallurgy were published. One describes a slag-fuming [5] plant erected in 1951–52 at the American Smelting & Refining Co. lead smelter, Chihuahua, Mexico, to process monthly 19,000 tons of lead slags containing about 12 percent zinc and 1 percent lead. The American Smelting & Refining Co. was also constructing a slag-fuming plant at its Selby, Calif., smelter during 1952.

Vacuum dezincing of desilverized lead bullion was discussed by Davey [6] in some detail in an article based on the theoretical aspects of vacuum distillation.

Production of high-purity (99.995) lead by the sulfamate [7] method,

---

[5] MacDonald, V. R., Chihuahua Slag Fuming Plant to Process 19,000 Tons per Month: Jour. Metals, vol. 5, No. 6, June 1953, pp. 789–790.
[6] Davey, T. R. A., Vacuum Dezincing of Desilverized Lead Bullion: Jour. Metals, vol. 5, No. 8, August 1953, pp. 991–997.
[7] Chemical Age, Production of High Purity Lead: Vol. 68, No. 1752, Feb. 7, 1953, pp. 251–252.

evolved by R. Piontelli and coworkers, was 10,000 tons in 1952. Chemical Age, which describes some of the technology of the process, includes a list of references.

During 1951 and 1952, when the price of metals was high, interest in the recovery of flue dusts, grindings, and metal fumes increased. Principles of dust collectors and their application in mining and metallurgical industries was the subject of a technical paper [8] presented before the American Institute of Mining and Metallurgical Engineers.

Several valuable papers dealing with the ore dressing of lead were published in 1952. A recent paper [9] describes the method by which complex copper-lead-zinc ores are treated at the Santa Barbara and Parral mills of Cia. Minera Asarco, Chihuahua, Mexico. At each mill usual flotation practice is followed, but the zinc concentrate is later deleaded with considerable success, using cyanide and zinc sulfate as depressants of the zinc and refloating the lead as a lead concentrate. Another paper [10] presents evidence to disprove the general theory of alkali depression and shows that alkalinity depends upon the nature of the mineral-collector system involved. An interesting development is the use of radiotracers [11] to study the action of dithiophosphate in selective flotation of galena and sphalerite. In 1950 the radiogenic concentration [12] of uranium ores at Port Hope, Canada, was described. More recently, the Atomic Energy Commission has contracted with the Massachusetts Institute of Technology for research on the measurement of artificially induced gamma radiation in ores. Some of the results of that research and an indication of how such radioactivity might be used effectively in separating minerals were reviewed in an article [13] in the November 1952 issue of the Engineering and Mining Journal.

WORLD REVIEW

Lead ores are mined in many countries (approximately 47 in 1952), but four—United States, Mexico, Australia, and Canada—have accounted for about three-fifths of the world output in recent years. On a smelter basis there are about 30 lead-producing countries, the same principal producers accounting for virtually the same percentage of the total world output. Mine and smelter production by countries for 1948–52, insofar as statistics are available, is given in tables 20 and 21.

[8] Kane, J. M., and Walpole, R. H., Principles of Present-Day Dust Collectors and Their Application to Mining and Metallurgical Industries: Am. Inst. Min. and Met. Eng., Tech. Pub. 3427B, Feb. 20, 1952; Min. Eng., vol. 5, No. 1, January 1953, pp. 85–88.

[9] Boeke, C. L., and Gunther, G. G., Deleading Zinc Concentrate at the Parral and Santa Barbara Mills: Min. Eng., vol. 4, No. 5, May 1952, pp. 495–498.

[10] Fleming, Marston G., Effects of Alkalinity on the Flotation of Lead Minerals: Min. Eng., vol. 4, No 12, December 1952, pp. 1231–1236.

[11] Judson, C. M., Lerew, A. A., and others, Radiotracer Studies of the Action of Dithiophosphate in the Selective Flotation of Galena and Sphalerite Using $CuSO_4$ and NaCN: Min. Eng., vol. 4, No. 4, April 1952, pp. 375–380.

[12] Kaufman, L. A., The Radiogenic Concentration of Uranium Ores: Canadian Min. and Met. Bull. 43, 1950, pp. 450–453.

[13] Gaudin, A. M., Senftle, F. E., and Fryberger, W. L., How Induced Radioactivity May Help Separate Minerals: Eng. and Min. Jour., vol. 153, No. 11, November 1952, pp. 95–99, 174, 176.

TABLE 20.—World mine production of lead, by countries,[1] 1948–52, in metric tons [2]

[Compiled by Pauline Roberts]

Country [1]	1948	1949	1950	1951	1952
North America:					
Canada	151,727	144,945	150,317	143,544	149,575
Guatemala	(3)	3,154	3,000	3,300	4,200
Honduras	143	449	279	454	538
Mexico	193,317	220,763	238,078	225,468	246,027
Salvador [4]	200	530	530	470	100
United States [5]	354,232	371,860	390,838	352,135	353,947
South America:					
Argentina	21,800	16,000	[4] 20,000	[4] 20,000	18,000
Bolivia (exports) [5]	25,610	26,311	31,176	30,558	28,291
Brazil	(3)	2,000	4,000	3,500	(3)
Chile	6,223	2,859	3,318	7,801	[4] 4,000
Ecuador	269	380	229	30	116
Peru	48,538	65,357	62,118	82,350	98,069
Europe:					
Austria	3,482	4,297	4,440	4,522	5,503
Finland	72	130	142	216	216
France	7,645	9,936	11,459	10,605	11,815
Germany, West	22,344	40,944	44,830	50,377	51,597
Greece	1,280	[6] 1,200	[6] 5,800	[6] 3,800	[6] 6,000
Hungary	----------	(3)	300	(3)	(3)
Italy	30,400	35,800	40,100	40,200	40,100
Norway	265	301	234	414	435
Poland [7]	16,874	17,850	18,000	18,000	20,000
Portugal	635	746	1,311	1,621	(3)
Spain	27,073	29,685	39,266	40,500	[8] 43,116
Sweden	23,579	23,900	22,673	19,693	20,593
U. S. S. R. [4] [7]	75,000	90,000	111,600	128,400	154,200
United Kingdom	2,432	2,505	3,336	4,925	3,987
Yugoslavia	62,861	72,144	86,039	78,750	78,968
Asia:					
Burma	36	(3)	[4] 1,000	[4] 2,000	[4] 2,000
Hong Kong	----------	----------	----------	179	300
Iran	----------	----------	2,000	1,100	17,500
Japan	6,672	9,132	10,896	12,876	17,484
Korea, Republic of	260	87	40	----------	142
Philippines	72	550	879	571	2,300
Thailand (Siam)	(3)	183	691	1,321	1,048
Turkey	2,756	200	260	600	[4] 1,000
Africa:					
Algeria	1,047	1,121	1,408	2,838	4,220
Belgian Congo	400	180	----------	----------	----------
French Equatorial Africa	2,603	731	1,814	2,504	3,551
French Morocco	28,600	37,200	48,200	68,134	83,608
Nigeria	273	29	12	4	27
Northern Rhodesia [7]	13,229	14,169	13,905	14,194	12,802
Southern Rhodesia	----------	83	----------	----------	----------
South-West Africa	33,600	38,400	33,680	39,230	52,842
Spanish Morocco	215	159	178	[4] 300	(9)
Tanganyika	----------	----------	652	1,561	2,833
Tunisia	13,219	14,860	19,260	21,250	23,270
Uganda (exports)	14	39	44	9	8
Union of South Africa	156	166	600	900	575
Australia	220,437	216,918	222,694	228,407	231,821
Total (estimate)	1,425,000	1,535,000	1,670,000	1,685,000	1,820,000

[1] Lead may be produced in China, Cuba, Czechoslovakia, East Germany, North Korea, and Rumania, but accurate data on production are not available and estimates by the senior author of the chapter have been included in the total.
[2] This table incorporates a number of revisions of data published in previous lead chapters.
[3] Data not available; estimate by senior author of chapter included in total.
[4] Estimate.
[5] Tonnage recoverable from ore.
[6] Includes lead content of zinc-lead concentrates.
[7] Smelter production.
[8] Includes Spanish Morocco.
[9] Included with Spain.

TABLE 21.—World smelter production of lead, by countries where smelted,[1] 1948–52 in metric tons [2] [3]

[Compiled by Pauline Roberts]

Country	1948	1949	1950	1951	1952
North America:					
Canada	145,246	132,608	154,551	147,609	166,367
Guatemala	(4)	68	271	60	316
Mexico	187,067	212,004	230,831	219,107	237,443
United States (refined) [5]	363,092	431,692	458,171	376,142	428,597
South America:					
Argentina	20,404	18,037	18,960	24,000	20,000
Brazil	(4)	1,172	4,200	[6] 3,000	(4)
Peru	34,297	36,017	31,693	44,247	48,622
Europe:					
Austria [7]	9,350	9,841	10,910	11,147	10,316
Belgium [7]	66,035	79,304	62,094	70,646	75,423
Czechoslovakia	5,770	(4)	(4)	(4)	(4)
France	38,288	57,541	61,236	47,970	51,538
Germany, West	[7] [8] 49,382	54,551	66,619	76,063	92,682
Greece	1,166	2,389	2,125	3,890	2,460
Italy	26,734	26,346	37,469	36,000	34,931
Poland	16,874	17,850	18,000	18,000	20,000
Portugal	233	304	591	724	(4)
Spain	25,313	33,021	40,568	44,711	46,543
Sweden	6,228	10,757	16,681	9,435	11,340
U. S. S. R.[6]	75,000	90,000	111,600	128,400	154,200
United Kingdom [6]	2,312	2,134	3,048	4,158	3,986
Yugoslavia	49,214	56,760	57,204	60,068	67,180
Asia:					
Burma	7,570	230	11	4,966	2,675
China	834	[7] 2,062	[6] [7] 4,000	[6] [7] 5,000	[6] [7] 6,000
India	554	603	639	878	1,150
Japan	6,900	7,716	9,984	10,740	15,156
Korea, Republic of	299	100	(4)	(4)	126
Africa:					
French Morocco	2,818	7,073	12,097	22,322	30,088
Northern Rhodesia	13,229	14,169	13,905	14,194	12,802
South-West Africa	82				
Tunisia	17,957	19,429	23,536	22,906	25,506
Australia	162,057	152,464	163,102	168,418	197,447
Total (estimate)	1,364,000	1,505,000	1,644,000	1,604,000	1,796,000

[1] In addition to countries listed, East Germany, Hungary, North Korea, and Rumania produce lead, but production data are not available; estimates by senior author of chapter included in total.
[2] Data derived in part from Monthly Bulletin of the United Nations, Statistical Summary of the Mineral Industry (Colonial Geological Surveys, London), and the Yearbook of the American Bureau of Metal Statistics.
[3] This table incorporates a number of revisions of data published in previous lead chapters.
[4] Data not available; estimate by senior author of chapter included in total.
[5] Figures cover lead refined from domestic and foreign ores; refined lead produced from foreign base bullion not included.
[6] Estimate.
[7] Includes scrap.
[8] American and British zones only.

NORTH AMERICA

Canada.—Mine output of lead in Canada in 1952 exceeded that of 1951 by 4 percent, while smelter output increased almost 13 percent. British Columbia was the most important lead-producing province, and the Consolidated Mining & Smelting Co. in British Columbia was the major producing company. During 1953 this company mined 2,700,000 tons of lead-zinc ore (2,530,000 in 1951) from its Sullivan mine; 136,000 tons of ore from the Bluebell lead-zinc mine, which was put into production in April; and 96,000 tons of zinc-copper-lead ore from its Tulsequah mines in northern British Columbia. In 1952 the company sold 183,000 tons of lead, including metal sold in unrefined form, as against 163,000 tons in 1951. The increase was due wholly to larger custom receipts (269,000 tons of ores and concentrates in 1952 as compared with 190,000 tons in 1951). The Consolidated

Mining & Smelting Co. annual report for 1952 stated that exploration at its zinc-lead property at Pine Point, Northwest Territory, totaled 41,000 feet of drilling and results continued to be encouraging. A shaft site was chosen, and the shaft collar, headframe, and power and change house were completed.

In New Brunswick the Anacon Lead Mines milled 226,000 tons of ore (219,000 tons in 1951) to recover 4,100 tons of lead (2,200 tons in 1951) and 8,500 tons of zinc (6,100 in 1951). Better recoveries and a substantial increase in the grade of ore accounted for the increased mine output. Ore reserves at the end of 1952 were 1,050,000 tons compared with 1,100,000 tons at the end of 1951. In 1952 a major zinc-lead ore deposit was discovered [14] a few miles south of Bathhurst by a prospecting syndicate which has been incorporated as the Brunswick Mining & Smelting Co. As a result of diamond drilling and geologic study, the ore body was estimated, as of January 1953, to contain 28,800 tons of ore per vertical foot of depth. The ore averages approximately 5.2 percent zinc, 1.6 percent lead, and 2.0 ounces of silver per ton. The accessibility of the area, ore bodies amenable to open-pit mining, and the financial strength of principal claim owners suggest development and exploitation would shortly follow exploration.

Greenland.—Active development of the lead-zinc deposit at Blykippen, Mesters Vig, on the eastern shore of Greenland continued throughout 1952. During the summer a year-round camp and landing strip were built, and a new adit was started 325 feet below the exploration adit. Work on the upper level was reported to have indicated an ore shoot 900 feet long and 30 feet wide assaying about 22 percent combined lead and zinc.

Guatemala.—Compañia Minera de Huehuetenango, S. A., in early 1952 contracted with the Defense Materials Procurement Agency to produce, sell, and ship up to 26,250 tons of lead, beginning in 1954 and ending June 30, 1959; work was begun on a $400,000 expansion program, including a 75-ton-per-day rotation mill. Compañia Minera de Guatemala operated its Caquipec mine near Coban to produce about 4,000 tons of lead in 1952.

Mexico.—Mexican mine output of lead increased 9 percent in 1952, and smelter output was up 8 percent as compared to 1951. An important factor in the economics of lead and zinc mining in Mexico was the construction of a slag-fuming plant [15] at the American Smelting & Refining Co. Chihuahua lead smelter. Plant construction was begun February 1951 and completed July 1952. The plant was in operation during the last 2 months of 1952, processing about 19,000 tons of hot slag monthly to recover about 2,000 tons of zinc oxide fumes, which contained 67 percent zinc and about 8 percent lead. Although the lower price of lead and zinc reduced mine income, no large mines were closed. The American Smelting & Refining Co. lead smelters at Chihuahua and San Luis Potosi and the Monterrey refinery operated almost continuously. Operating mines, owned or leased by the American Smelting & Refining Co., that produced lead during the year included the Charcas unit in the State of San

[14] Engineering and Mining Journal, Huge New Brunswick Metal Find Sets Off Exploration Boom: Vol. 154, No. 5, May 1953, pp. 101–104, 202, 206, 208.
[15] Work cited in footnote 5.

Luis Potosi; the Parral, Santa Barbara, Santa Eulalia, and the Plomosas units in the State of Chihuahua; the Aurora-Xichu unit in Guanajuato; and the Angangueo unit in the State of Michoacan.

The Topia unit of the American Metal Co. in Durango commenced production in 1952. The company's annual report for 1952 stated that the Avalos unit in Zacatecas, the largest lead-zinc mine operated by the American Metal Co. in Mexico, could not operate profitably at the metal prices in effect at the end of the year. Other American Metal Co. mines included the Guadalupe unit (Minas Viejas) in Nuevo Leon, the Calabaza unit in Jalisco, and the Ocampo unit in Coahuila.

Another American company operating in Mexico, the Eagle-Picher Co. (Minas de Iquala, S. A.), [16] works the Esmeralda mine near Parral, Chihuahua.

SOUTH AMERICA

Argentina.—The principal lead-producing district in the Argentine is Aguilar, where the Compania Minera Aguilar, S. A., a subsidiary of the St. Joseph Lead Co., treated 200,700 metric tons of ore, which yielded 23,100 metric tons of lead concentrates and 30,400 metric tons of zinc concentrates. Comparable figures for 1951 were 199,900, 26,200, and 30,700 metric tons, respectively. The lead concentrates were smelted at the National Lead Co., S. A., smelter at Barranqueras, Chaco Territory, Argentina.

Bolivia.—The Bolivian revolution in April 1952 resulted in a new Government, which nationalized the 24 producing tin, tungsten, copper, and lead and zinc mines and set up the Corporacion Minera de Bolivia to operate them. Statistical data from Bolivia as to details of mine and smelter production are lacking, but it is known that 28,300 tons of recoverable lead was exported. Four small smelters, one each at La Paz, Cochabamba, Tupiza, and Oruru have an estimated production rate of 700 tons of lead bullion per month, but their actual production is unknown.

Peru.—Mine output of lead increased to 98,000 tons in 1952, almost 20 percent above the 82,000 tons of 1951. Smelter production increased 10 percent to 48,600 tons, as the Cerro de Pasco Corp. operated its Oroya smelter and refinery at the highest level in the corporation's history. During the year the Volcan Mines Co. completed its 350-ton-per-day lead-zinc concentrator. The San Antonio de Esquilache mines [17] were purchased by Compania de Minas del Peru. Daily production was increased to 400 tons of low-grade ore from which lead and zinc concentrates are being produced.

The Northern Peru Mining & Smelting Co., a subsidiary of the American Smelting & Refining Co., began operating its new 250-ton selective flotation mill at Chilete,[18] Department of Cajamarca, in May 1952. The camp, a 770-kw. powerplant, and the mill were built in about 10 months at a cost of about $2,000,000.

---

[16] Burns, Robert L., Minas de Iquala's 1,000-Ton-per-Day Mill at Parral Treats Esmeralda Lead-Zinc Ore: Min. World, vol. 15, No. 10, September 1953, pp. 52–55.

[17] Engineering and Mining Journal, vol. 153, No. 11, November 1952, p. 170.

[18] Engineering and Mining Journal, Chilete Mine, Mill Go Into High Gear: Vol. 154, No. 1, January 1953, pp. 129–130; Mining World, vol. 15, No. 1, January 1953, p. 71.

AFRICA

Mine output of lead in Africa increased 22 percent to 184,000 metric tons in 1952, the chief gains being in French Morocco, Algeria, Tunisia, and South-West Africa.

North Africa.—Algerian lead production increased somewhat, but the most important gains in mine output were in French Morocco, where production of lead concentrate increased 24 percent to 115,300 metric tons containing approximately 84,000 metric tons of metal. The Zellidja mine was the chief source of concentrate, but the Touissit mine of the Compagnie Royale Asturienne des Mines was an important contributor. The Zellidja Co. in combination with the Fonderies Peñarroya has constructed a Scotch-hearth smelting plant with 10 Neuman hearths at Oued-El-Heimer, Morocco, and a blast furnace was under construction in 1952. The Zellidja-Peñarroya smelter processed 42,200 metric tons of lead concentrate to yield 28,800 metric tons of lead metal. In Tunisia mine output of lead totaled 23,300 metric tons, while smelter output was 25,500 metric tons. The most important mines with their output were El Grefa (6,300 tons), Djebel Semene (5,900 tons), Sidi Bou Aouane (4,100 tons), and Djebel Hallouf (3,650 tons). The Tunisian concentrate is processed in 3 smelters at Mégrine, Souk-el Khemis, and Bizerte in Tunisia.

Northern Rhodesia.—Rhodesian Broken Hill, Ltd., the only producer of lead and zinc, produced 12,800 metric tons of lead at its smelter. A new smelter to have 20 percent greater capacity was in process of construction.

South-West Africa.—Mine output of lead in South-West Africa totaled 52,800 metric tons, a notable increase over the 39,200 metric tons produced in 1951. The Tsumeb mine was almost the sole source of lead.

Tanganyika.—The Uruwira Minerals, Ltd., produced 4,800 tons of lead concentrate in 1952 as compared to 3,000 tons in 1951. A new plant designed to treat 1,000 tons per day was under construction. Reserves on which the mill will operate contain 3,000,000 tons of ore averaging 3.8 percent lead, 0.8 percent copper, with some gold and silver.

AUSTRALIA

The production of both lead and zinc increased slightly above the 1951 level, as Australian mine output of lead rose to 231,800 metric tons while smelter output was 197,400 metric tons. Producing States were New South Wales and Queensland.

In New South Wales the New Broken Hill Consolidated, Ltd.,[19] mined 240,000 tons of ore and milled 235,000 tons to produce 25,280 tons of lead concentrate containing 75.9 percent lead. In September 1952 the company began hoisting ore through its new haulage shaft and operating its new 30,000-ton-per-month mill. Total ore reserves at the end of 1952 were 2,400,000 tons assaying 10.6 percent lead, 10.9 percent zinc, and 2.6 ounces of silver per ton. Other operators in the Broken Hill district were North Broken Hill, Ltd., Broken Hill South, Ltd., and the Zinc Corp., Ltd. These companies together mine about 90,000 tons of crude ore monthly.

[19] Metal Bulletin (London), June 5, 1953, p. 17.

The Lake George Mines, Ltd., Captain's Flat, New South Wales,[20] concentrated about 550 long tons of ore per day; from the beginning of operations through June 1952 it had milled 2,000,000 tons of ore and recovered 319,000 tons of zinc concentrate, 219,000 tons of lead concentrate, 30,000 tons of copper concentrate, 275,000 tons of pyrite concentrate, and 1,800 tons of gold concentrate.

At Mount Isa, Queensland, Mount Isa Mines, Ltd., began to operate its No. 2 ore shaft and the new crushing plant for the lead-zinc concentrator. Drilling the main lead-zinc-copper ore bodies disclosed additional high-grade reserves, and north of the main ore bodies 270,000 tons of 10-percent oxidized lead ore was proved.

EUROPE

France.—During 1952 France imported 59,100 metric tons of lead concentrates chiefly from French Morocco, French Equatorial Africa, and Algeria and about 50,300 metric tons of pig lead principally from Morocco, Tunisia, Algeria, Mexico, Belgium, and Luxembourg. Domestic production of lead concentrates totaled 19,400 metric tons; these, with the imported concentrates, were smelted in French smelters to yield 51,500 metric tons of lead. Consumption totaled approximately 92,700 tons.

West Germany.—Lead mine output was 51,600 metric tons, essentially the same as in 1951, but smelter output increased 22 percent to 92,700 metric tons. The 1951 edition of the Jahrbuch des Deutsches Bergbau (Yearbook of German Mining) states that lead and zinc ores are produced in the Harz Mountains, the Rhineland, and to a lesser extent in Southern Germany. Uterharze-Berg-und Huettenwerke, G. m. b. H., in the Harz Mountains produces zinc and lead sulfides from a deposit at Rammelsberg, which is said to average 50 meters in thickness and contain 19 percent zinc, 9 percent lead, and 1 percent copper. In the same area, near Bad Grund, Harzer Berg und Huettenwerke operates the Erzbergwerke Grund mine, producing lead and zinc sulfide concentrates. The crude ore contains 6 percent lead and 2 percent zinc. Concentrates are produced by selective flotation, the lead concentrate being smelted and refined at the company's plant at Clausthal-Lautenthal.

Lead and zinc ores are also found on the right bank of the Rhine River at Ems, Holzappel, the Bergische Land, Ramsbeck, the Siegerland, the Schwelm-Iserlahn district, and others.

The Stolberger Zink, A. G., operates a mine at Holzappel 1,076 meters deep and a mine at Ramsbeck in the Sauerland. This last mine has an annual output of 23,000 tons of zinc concentrate and 3,200 tons of lead concentrate. Gewerkschaft Mechernicher Werke, a subsidiary of Preussische Bergwerks and Huetten, A. G., owns an extensive ore deposit at Mechernich in the Eifel Mountains. The ore body is estimated to contain 95,000,000 tons of low-grade lead ore. Daily mine output in 1952 averaged 3,200 tons per day. During the summer work was undertaken to increase capacity to 6,000 tons of crude ore daily, or about a fifth of the daily rate of operation in 1943, when approximately 33,000 tons of ore was milled daily.

[20] Hungerford, T. A. G., Min. Jour. (London), vol. 240, No. 6128, Jan. 30, 1953, pp. 128–129.

Yugoslavia.—Mine production of lead was essentially the same as in 1951, but smelter output of refined lead increased 12 percent to 67,200 metric tons. A new lead-zinc mine near Ljubovija, Yugoslavia, was opened in the latter half of 1952. The mine is said to produce 70 tons of 80-percent lead concentrate daily. At the Novo Brdo lead-zinc mine a new flotation mill was erected early in April, so that at least part of the Trepca ores can be concentrated at the mine instead of being shipped 50 miles to the mill at Svecan prior to smelting. The Yugoslav Government reported the discovery of lead-zinc deposits in the Kossovo-Metochia area near the Yugoslav-Albanian border.

342070—55——40

Lead and Zinc Pigments and Zinc Salts

By Robert L. Mentch [1]

THE OUTSTANDING feature of the lead and zinc pigments industry in 1952 was the continuing decline in volume of business. Shipments of the products covered by this report were well below the 1951 rate. Decreases in shipments of zinc pigments ranged from 4 percent for lead-free zinc oxide to 40 percent for lithopone. Shipments of lead pigments declined from 9 percent for litharge to 25 percent for white lead (dry and in oil). Zinc salts (zinc chloride and zinc sulfate) decreased 14 and 17 percent, respectively.

Decreases in shipments of pigments and salts were attributable partly to decreases in the volume of business in industries that are important consumers of these products and partly to increased use of substitutes. In 1952 the production of passenger automobiles was 19 percent lower than that in 1951, and output of trucks and buses declined 15 percent from the 1951 total. Consumption of natural and synthetic rubber increased 4 percent compared with 1951. The value of public and private construction was 5 percent greater than in 1951, and the value of sales of paint, varnish, and lacquer materials in 1952 was approximately the same as the 1951 total. Construction gains reflected, in part, higher material and labor costs.

Lead and zinc, the chief raw materials of the pigments industry, were in plentiful supply during the latter half of the year in contrast with the situation in 1951 and the first several months of 1952, when demand exceeded available supplies. Increased production of both lead and zinc on a worldwide basis permitted greatly expanded imports, which, combined with lower consumption in the United States, resulted in an oversupply situation in both metals and brought about marked reductions in prices as the year progressed. The price for common lead, New York, dropped from the 19-cent-a-pound ceiling established in October 1951 to 18 cents per pound on April 29 and was selling for 14.75 cents at the end of the year. The quotation for Prime Western grade slab zinc, East St. Louis, fell from 19.5 cents, first effective in October 1951, to 17.5 cents on June 2 and thereafter declined to 12.5 cents per pound on October 23, at which level it remained for the balance of the year.

Lead- and zinc-pigment price quotations maintained their historically close relationship to pig-lead and slab-zinc prices throughout the year. Prices for the pigments and zinc salts dropped considerably following the declines in metal prices; decreases averaged about 20 percent compared with reductions of 22 percent and 36 percent in the selling prices of lead and zinc.

[1] Commodity-industry analyst.

All National Production Authority restrictions on lead and zinc were revoked completely on May 15 and June 27, respectively, owing to the increased abundance of these metals.

Shipments of white lead (dry) and of the "in-oil" variety dropped 32 and 10 percent, respectively, from 1951 totals. The trend in utilization of white lead is markedly downward; shipments of both varieties in 1952 were the smallest by far since long before the beginning of the present century. Litharge shipments decreased 9 percent in 1952 but were considerably above average yearly shipments during World War II. Shipments of red lead declined 13 percent and were well below the yearly average for World War II years. Figure 1 shows trends in shipments of lead pigments for the period 1910–52.

Zinc oxide (lead-free) shipments declined 4 percent in 1952, the lowest percentage decrease among the products covered by this report, and were comparable in quantity to average annual shipments during the World War II period. Leaded zinc oxide shipments were 15 percent lower than in 1951 and, except for 1949, were the smallest since 1935. Shipments of lithopone dropped sharply; the 1952 total was 40 percent below 1951 and the lowest since 1921. Trends in shipments of zinc pigments are shown in figure 2.

Shipments of zinc salts declined considerably in 1952; zinc chloride decreased 14 percent and zinc sulfate fell 17 percent.

TABLE 1.—Salient statistics of the lead and zinc pigments industry of the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Production (shipments) [1] of principal pigments:						
White lead (dry and in oil)..short tons..	[2] 69,670	46,070	27,355	45,176	35,415	26,663
Red lead......do....	44,664	30,787	24,866	35,072	35,352	30,926
Litharge.......do....	138,188	154,775	121,052	177,658	154,753	140,798
Zinc oxide.....do....	146,131	150,958	110,132	160,829	147,716	142,210
Leaded zinc oxide short tons..	64,050	67,441	36,722	63,973	44,341	37,892
Lithopone.....do....	145,363	140,033	78,335	105,650	102,837	61,832
Value of products:						
All lead pigments....	[3] $52,267,400	[3] $90,915,000	[3] $58,564,000	[3] $79,858,000	[3] $89,273,000	[3] $72,230,000
All zinc pigments....	44,055,600	65,547,000	43,152,000	71,322,000	74,599,000	63,950,000
Total..............	96,323,000	[3] 156,462,000	[3] 101,716,000	[3] 151,180,000	[3] 163,872,000	[3] 136,180,000
Value per ton received by producers:						
White lead (dry)....	$194	$363	$351	$335	$426	$403
Red lead............	206	396	333	314	397	376
Litharge............	187	387	324	292	383	348
Zinc oxide..........	149	218	230	258	311	307
Leaded zinc oxide....	149	245	242	262	320	313
Lithopone...........	84	115	115	124	141	137
Foreign trade:						
Lead pigments:						
Value of exports..	$1,229,000	$970,000	$1,157,000	$950,000	$984,000	$933,000
Value of imports.	36,000	633,000	143,000	344,000	1,797,000	451,000
Zinc pigments:						
Value of exports..	3,299,600	5,229,000	3,426,000	2,124,000	6,855,000	4,352,000
Value of imports.	9,300	7,000	52,000	1,275,000	930,000	90,000
Export balance	4,483,300	5,559,000	4,388,000	1,455,000	5,112,000	4,744,000

[1] Reported as sales before 1945.
[2] Data for basic lead sulfate in 1946 included under white lead; Bureau of Mines not at liberty to show separately.
[3] Excludes value of basic lead sulfate; Bureau of Mines not at liberty to publish.

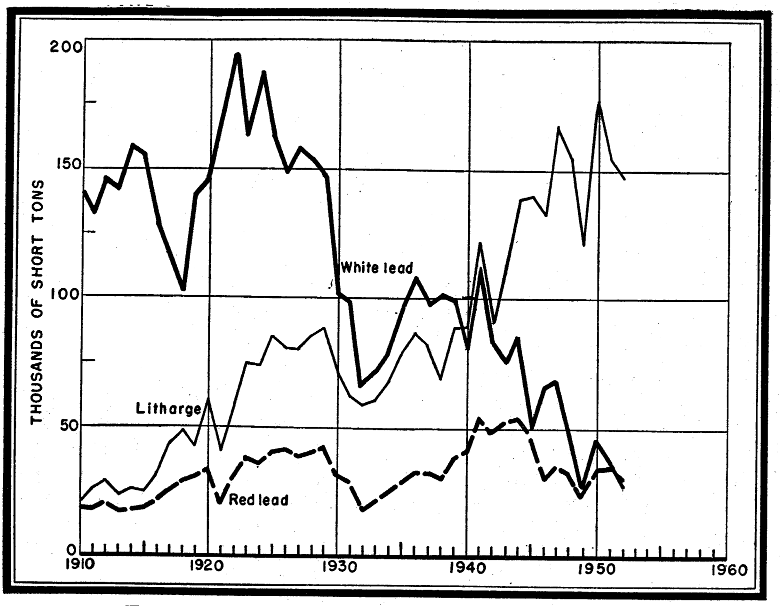

FIGURE 1.—Shipments of lead pigments, 1910–52.

The distribution of shipments of pigments to consumers in 1952 remained essentially the same as in previous years. The paint industry continued the largest user by far of white lead, leaded zinc oxide, and lithopone, receiving approximately 90, 99, and 73 percent, respectively, of shipments. In addition, 43 percent of red-lead shipments, 22 percent of zinc oxide (lead-free) shipments, and 4 percent of litharge shipments went into paint manufacture. Storage-battery makers were the chief users of litharge and red lead, taking 69 and 45 percent, respectively, of producers' deliveries. The rubber industry continued as the largest consumer of zinc oxide, taking 51 percent of total shipments. Relatively small quantities of litharge, lithopone, and leaded zinc oxide were also used in the manufacture of rubber products. The ceramics industry ranks fourth in consumption of lead and zinc pigments and was surpassed only by the paint, storage-battery, and rubber industries. In 1952, 11 percent of litharge shipments, 5 percent of zinc oxide (lead-free) shipments, 4 percent of white lead shipments, and 1 percent of red lead shipments were used in making ceramics.

Titanium pigments continued to furnish the chief competition to lead and zinc pigments in paint making. Production and shipments of titanium pigments dropped 4 and 11 percent, respectively, from the records established in 1951. Insufficient plant capacity and shortages of raw materials had been limiting factors in titanium pigment production in previous years; in 1952, however, the decrease was attributed principally to the general reduction in consumption of all types of pigments. At present, the Bureau of Mines is not at liberty to publish statistics for titanium pigments.

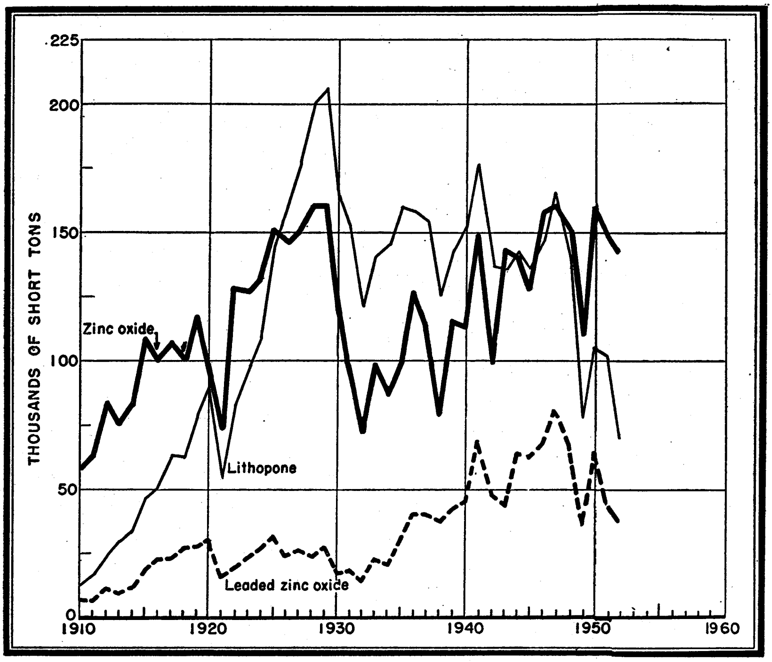

FIGURE 2.—Shipments of zinc pigments, 1910–52.

PRODUCTION

The value of shipments of lead and zinc pigments in 1952 (exclusive of that for basic lead sulfate, which cannot be shown) was $136,180,000, a 17-percent decrease from the 1951 value. Lead pigments comprised 53 percent of the total value and zinc pigments 47 percent in 1952, compared with 54 and 46 percent, respectively, in 1951.

For many years figures on "sales" were used in this series of reports as a better guide to activity in the pigments industry than production. Beginning with 1945 the base was changed to "shipments" to conform with data compiled on Bureau of Mines lead and zinc schedules. Available information for 1945 (the year of change) indicates little difference between sales and shipments in that year. In reporting tonnages of pigments, an attempt is made to avoid all duplication, one of the chief problems being that finished pigments frequently are blended to make another product. Basic lead sulfate and zinc oxide, for example, are blended to make leaded zinc oxide, and in this instance the pigment weights appear in the total for the last-named class only. Pigments consumed by producing companies to make products beyond those covered by this report—that is, paints, storage batteries, and other articles—are considered shipments.

LEAD PIGMENTS

Shipments of lead pigments decreased 12 percent in quantity and 19 percent in value in 1952. Substantial reductions in average prices received by producers accounted for the disproportionate decrease in value. Shipments of white lead, red lead, and litharge declined 25, 13, and 9 percent, respectively, from those in 1951.

Average values of lead pigments reported by producers were well below the record selling prices of 1951; the yearly average for white lead (dry) was $403 per ton, 5 percent under the 1951 average; red lead sold at an average of $376 per ton, also a decrease of 5 percent; and litharge brought $348 per ton, 9 percent less than the 1951 average.

White Lead.—The decline in shipments of white lead, first evident in the late 1920's, continued as competitive pigments supplanted both classes in many paint formulations. Total shipments fell 25 percent and were the lowest by far since long before the beginning of the 20th century. Paint manufacturers that had been using white lead almost exclusively are now using increasing quantities of other pigments.

Basic Lead Sulfate.—The Bureau of Mines is not at liberty to publish figures on basic lead sulfate for 1946–52.

TABLE 2.—Production and shipments of lead pigments [1] in the United States, 1951–52

Pigment	1951				1952			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Short tons	Value [2]			Short tons	Value [2]	
			Total	Average			Total	Average
White lead:								
Dry	22,982	23,359	$9,952,883	$426	16,405	15,779	$6,353,285	$403
In oil [3]	11,177	12,056	6,007,291	498	11,454	10,884	5,177,314	476
Red lead	34,065	35,352	14,025,182	397	32,620	30,926	11,634,969	376
Litharge	152,155	154,753	59,287,262	383	144,564	140,798	49,064,874	348

[1] Except for basic lead sulfate, figure for which is withheld to avoid disclosure of individual company operations.
[2] At plant, exclusive of container.
[3] Weight of white lead only, but value of paste.

TABLE 3.—Lead pigments shipped by manufacturers in the United States, 1943–47 (average) and 1948–52, in short tons

Year	White lead			Basic lead sulfate or sublimed lead		Red lead	Orange mineral	Litharge
	Dry	In oil	Total	White	Blue			
1943–47 (average)[1]	[1] 38,868	30,802	[1] 69,670	[2] 5,642	[2] 1,279	44,664	143	138,188
1948	26,551	19,519	46,070	(3)	(3)	30,787		154,775
1949	15,719	11,636	27,355	(3)	(3)	24,866		121,052
1950	28,506	16,670	45,176	(3)	(3)	35,072		177,658
1951	23,359	12,056	35,415	(3)	(3)	35,352		154,753
1952	15,779	10,884	26,663	(3)	(3)	30,926		140,798

[1] Basic lead sulfate for 1946 included with white lead (dry) in order to avoid disclosure of individual company operations.
[2] 1941–45 average; *see* footnote 1.
[3] Figure withheld to avoid disclosure of individual company operations.

Red Lead.—Shipments of red lead declined 13 percent in 1952 and were 43 percent below shipments in 1944, the peak year.

Orange Mineral.—No shipments of orange mineral were reported in 1947–52.

Litharge.—Although declining 9 percent from the 1951 total, litharge shipments remained at a comparatively high level, being exceeded only in 1947, 1948, 1950, and 1951. For many years, litharge has been the largest quantity lead pigment of the group covered by this report.

Battery manufacturers produced 76,000 tons of black or gray suboxide of lead in 1952 for their own use in place of litharge. This quantity compares with 77,000 tons in 1951 and 80,000 tons in 1950. This suboxide production required 73,000 tons of pig lead in 1952, the same as in 1951, and 77,000 tons in 1950.

ZINC PIGMENTS AND SALTS

Total shipments of zinc pigments decreased 18 percent in quantity and 14 percent in value in 1952. Shipments of lead-free zinc oxide, the most important of the zinc pigments in tonnage and value, declined 4 percent; tonnage shipments of leaded zinc oxide dropped 15 percent; and lithopone shipments fell 40 percent, the largest decrease among the products covered by this report.

Although declining slightly from the peaks established in 1951, producers' average values were the second highest on record. Average values received by primary shippers were as follows: Zinc oxide (lead-free) $307 per ton, a loss of 1 percent; leaded zinc oxide $313 per ton, a drop of 2 percent; and lithopone $137 per ton, a decrease of 3 percent.

Shipments of the zinc salts, zinc chloride and zinc sulfate, declined 14 and 17 percent, respectively, from 1951 totals. Average values of the two compounds increased; zinc chloride advanced from $85 per ton in 1951 to $93 per ton and zinc sulfate rose from $160 to $163 per ton.

TABLE 4.—Production and shipments of zinc pigments and salts in the United States, 1951–52

Pigment or salt	1951				1952			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Short tons	Value[1]			Short tons	Value[1]	
			Total	Average			Total	Average
Zinc oxide[2]	158,714	147,716	$45,948,219	$311	137,957	142,210	$43,614,186	$307
Leaded zinc oxide[2]	50,972	44,341	14,179,993	320	37,869	37,892	11,860,158	313
Lithopone	107,519	102,837	14,470,742	141	60,220	61,832	8,475,200	137
Zinc chloride, 50° B	62,527	60,730	5,152,882	85	50,599	51,966	4,822,995	93
Zinc sulfate	23,663	23,524	3,769,825	160	19,349	19,587	3,189,611	163

[1] Value at plant, exclusive of container.
[2] Zinc oxide containing 5 percent or more lead is classed as leaded zinc oxide. In this table data for leaded zinc oxide include a small quantity containing less than 5 percent lead.

TABLE 5.—Zinc pigments and salts shipped[1] by manufacturers in the United States, 1943–47 (average) and 1948–52, in short tons

Year	Zinc oxide	Leaded zinc oxide	Lithopone	Zinc chloride (50° B.)	Zinc sulfate
1943–47 (average)	146,131	64,050	145,363	58,064	20,027
1948	150,958	67,441	140,033	68,701	21,513
1949	110,132	36,722	78,335	55,208	20,065
1950	160,829	63,973	105,650	64,564	23,912
1951	147,716	44,341	102,837	60,730	23,524
1952	142,210	37,892	61,832	51,966	19,587

[1] Reported as sales before 1945.

Zinc Oxide.—Lead-free zinc oxide shipments remained at a relatively high level in 1952, declining only 4 percent from 1951.

TABLE 6.—Production of zinc oxide (lead-free) by processes, 1943–47 (average) and 1948–52, as percent of total

Process	1943–47 (average)	1948	1949	1950	1951	1952
American process (ore and primary residues)	77	76	71	72	75	74
French process (metal and scrap)	16	15	17	18	18	20
Other	7	9	12	10	7	6
Total	100	100	100	100	100	100

Leaded Zinc Oxide.—Shipments of leaded zinc oxide in 1952 were 15 percent lower than in 1951.

Four grades of leaded zinc oxide, classified according to lead content, are produced in the United States. The bulk of the output, however, is the 5- to 35-percent grade; only relatively small quantities of the other grades—less than 5 percent lead, over 35 to 50 percent lead, and over 50 percent lead—are produced. For publication purposes, the 2 top and 2 lower grades are combined. Production in 1952 (comparison with 1951 in parentheses) was as follows: 32,401 (46,960) tons of 35 percent lead and under and 5,468 (4,012) tons of over 35 percent lead.

Lithopone.—Lithopone shipments fell 40 percent below 1951 deliveries and were much lower than all years from 1922–51, inclusive.

The lithopone statistics in this report are given on the basis of ordinary lithopone sold as such plus the ordinary lithopone content of the high-strength product.

Consumption of ordinary lithopone in the manufacture of titanated lithopone has diminished to very small proportions. The trend has been downward almost continuously since 1937, when 19,400 tons were used in making the titanated variety. The tonnage consumed for this purpose in 1952 was 42 percent below the quantity used in 1951 and was the smallest on record. The lithopone figures in table 7 are included in the totals for ordinary lithopone in other tables.

Zinc Sulfide.—In 1952 only one company produced zinc sulfide, hence the Bureau of Mines is not at liberty to publish figures for this pigment.

TABLE 7.—Titanated lithopone produced in the United States and ordinary lithopone used in its manufacture, 1943–47 (average) and 1948–52, in short tons

Year	Titanated lithopone produced	Ordinary lithopone used	Year	Titanated lithopone produced	Ordinary lithopone used
1943–47 (average)	7,780	6,610	1950	3,400	2,900
1948	2,100	1,700	1951	1,550	1,300
1949	2,000	1,700	1952	900	750

Zinc Chloride.—Shipments of 50° B. solution zinc chloride declined 14 percent in 1952 and were the lowest in more than 10 years.

Zinc Sulfate.—Zinc sulfate shipments decreased 17 percent from the 1951 total and were the smallest since 1944.

RAW MATERIALS USED

Figures covering the raw materials used in making pigments and salts in 1952 and 1951 are shown in the accompanying tables.

Lead pigments and zinc pigments and salts are manufactured from a variety of materials, including ore, refined metal, and such secondary materials as scrap, residues, ashes, drosses, and skimmings. In 1952 approximately 95 percent of the lead in pigments was derived from pig lead and the remainder from ore; in 1951 and 1950 the percentage of contained lead from metal was 94. Of the lead in ore used to make leaded zinc oxide, about 13 percent (12 in 1951) was from foreign sources. The proportion of zinc in zinc pigments was as follows: 76 percent (76 in 1951) from ore and concentrates, 11 (9) percent from slab zinc, and 13 (15) percent from secondary materials; about 26 (19) percent of the ore used was of foreign origin.

Tables 8 and 9 give the source of the metal used in manufacturing each pigment and salt. Pig lead is employed exclusively, either directly or indirectly, in manufacturing white lead, litharge, red lead, and orange mineral and is used also in manufacturing basic lead sulfate. The lead content of leaded zinc oxide made from basic lead sulfate, which in turn is made from pig lead, is credited to pig lead in the table. Zinc oxide is the only pigment in which considerable slab zinc is used. Ore is employed in manufacturing zinc oxide, leaded zinc oxide, lithopone, zinc sulfide, zinc sulfate, and basic lead sulfate. Nearly half of the zinc contained in lithopone (45 percent in 1952 and 53 in 1951) and virtually all of that in zinc chloride (100 percent in 1952 and 1951) produced in the United States are derived from secondary material. The proportion of zinc oxide production derived from metal and scrap increased to 26 percent in 1952 compared with 24 percent in 1951. For a number of years before the United States entered World War II there had been a large increase in the quantity of secondary zinc used in manufacturing zinc oxide. The scarcity of supplies of both metal and scrap caused the proportion of the total oxide made by the French process—which uses only metal and scrap—to drop sharply in 1942 and to continue comparatively low in 1943–46, despite the fact that the total percentage from metal and scrap rose in 1943 and continued upward almost without interruption in 1944–50. The production of zinc oxide from metal and scrap accounted for the following percentages in relation to total production: 41 percent in 1939, 16 percent in 1942, 19 percent in 1943, 22 percent in 1944, 25 percent in 1945, 26 percent in 1946, 28 percent in 1947, 26 percent in 1948, and 29 percent in 1949 and 1950.

TABLE 8.—Lead content of lead and zinc pigments[1] produced by domestic manufacturers, by sources, 1951–52, in short tons

Pigment	1951				1952			
	Lead in pigments produced from—			Total lead in pigments	Lead in pigments produced from—			Total lead in pigments
	Ore		Pig lead		Ore		Pig lead	
	Domestic	Foreign			Domestic	Foreign		
White lead			27,409	27,409			22,287	22,287
Red lead			30,880	30,880			29,570	29,570
Litharge			141,215	141,215			134,445	134,445
Leaded zinc oxide	11,237	1,581		12,818	8,358	1,275		9,633
Total	11,237	1,581	199,504	212,322	8,358	1,275	186,302	195,935

[1] Excludes lead in basic lead sulfate, data for which are withheld to avoid disclosure of individual company operations.

TABLE 9.—Zinc content of zinc pigments[1] and salts produced by domestic manufacturers, by sources, 1951–52, in short tons

Pigment or salt	1951					1952				
	Zinc in pigments and salts produced from—				Total zinc in pigments and salts	Zinc in pigments and salts produced from—				Total zinc in pigments and salts
	Ore		Slab zinc	Secondary material[2]		Ore		Slab zinc	Secondary material[2]	
	Domestic	Foreign				Domestic	Foreign			
Zinc oxide	77,805	18,275	15,655	14,909	126,644	57,839	23,811	16,240	12,872	110,762
Leaded zinc oxide	21,364	4,046			25,410	15,357	3,211			18,568
Lithopone	7,684	2,010	59	11,098	20,851	5,544	796	2	5,261	11,603
Total pigments	106,853	24,331	15,714	26,007	172,905	78,740	27,818	16,242	18,133	140,933
Zinc chloride				14,078	14,078				11,399	11,399
Zinc sulfate	2,203	458		5,008	7,669	2,422	297		3,622	6,341

[1] Excludes zinc sulfide, data for which are withheld to avoid disclosure of individual company operations.
[2] These figures are higher than those shown in the report on Secondary Metals—Nonferrous because they include zinc recovered from byproduct sludges, residues, etc., not classified as purchased scrap material.

CONSUMPTION AND USES

LEAD PIGMENTS

White Lead.—The bulk of the white lead used in the United States goes into the making of paint; the paint industry usually accounts for 90 percent or more of total consumption. In 1952, however, the customary percentage was not indicated by available statistics. This situation probably was due to the inability of shippers to give complete data on end-use classification. It is known that in the past some white lead sold to the Government was reported under "Other," and it is likely that a substantial part of the entire "Other" classification belongs properly under paint. Shipments to ceramic makers and manufacturers of plasticizers and stabilizers each accounted for 4 percent of total distribution in 1952.

TABLE 10.—Distribution of white lead (dry and in oil) shipments,[1] by industry, 1943–47 (average) and 1948–52, in short tons

Industry	1943–47 (average) [2]	1948	1949	1950	1951	1952
Paints	63,003	40,892	24,284	38,920	28,718	21,223
Ceramics	1,252	1,369	894	1,815	1,548	1,079
Other	5,415	3,809	2,177	[3] 4,441	[3] 5,149	[3] 4,361
Total	69,670	46,070	27,355	45,176	35,415	26,663

[1] Reported as sales before 1945.
[2] Shipments of basic lead sulfate included with white lead for 1946 to avoid disclosure of individual company operations.
[3] Includes the following tonnages for plasticizers and stabilizers: 1950—1,257; 1951—1,003; 1952—986.

Basic Lead Sulfate.—Statistics covering distribution of basic lead sulfate shipments by uses have not been available for publication since 1945, when 3,000 tons went to the paint industry, 200 tons to the rubber industry, and 700 tons to other industries. Substantial quantities of lead sulfate are used as an intermediate product in manufacturing leaded zinc oxide. Such quantities have always been shown in this chapter under leaded zinc oxide rather than basic lead sulfate.

Red Lead.—Shipments to storage-battery manufacturers again represented the largest proportion of distribution, but by a smaller margin than in previous years. In 1952 shipments for batteries comprised 45 percent of the total compared to 47 percent in 1951, and shipments to the paint industry, the second largest consumer, accounted for 43 percent of the total compared to 42 percent in 1951. Relatively small quantities were used in making ceramics.

TABLE 11.—Distribution of red-lead shipments,[1] by industry, 1943–47 (average) and 1948–52, in short tons

Industry	1943–47 (average)	1948	1949	1950	1951	1952
Storage batteries	24,710	14,854	12,163	17,478	16,722	13,796
Paints	15,493	10,863	9,634	14,103	14,740	13,149
Ceramics	866	1,275	603	981	834	388
Other	3,595	3,795	2,466	2,510	3,056	3,593
Total	44,664	30,787	24,866	35,072	35,352	30,926

[1] Reported as sales before 1945.

Orange Mineral.—No shipments of orange mineral have been reported since 1946 when 123 tons went to various industries.

Litharge.—The use of litharge for storage batteries regularly accounts for roughly two-thirds of total shipments; in 1952 the proportion was 69 percent compared with 61 percent in 1951. The ceramics industry is the second largest consumer of litharge; shipments for this purpose declined 30 percent from 1951 and comprised 11 percent of the total in 1952. Shipments to insecticide makers fell 52 percent, and deliveries to oil refineries and rubber manufacturers decreased 33 and 20 percent, respectively. The tonnage of litharge used for varnish was about the same as in 1951, whereas shipments for chrome pigments declined 25 percent. Shipments to makers of floor coverings dropped 55 percent but were well above average yearly quantities in previous years.

TABLE 12.—Distribution of litharge shipments,[1] by industry, 1943–47 (average) and 1948–52, in short tons

Industry	1943–47 (average)	1948	1949	1950	1951	1952
Storage batteries	78,996	100,645	77,163	105,558	94,064	97,656
Ceramics	13,057	19,979	13,299	27,771	22,815	15,906
Chrome pigments	9,817	7,455	8,557	10,017	11,117	8,376
Varnish	3,351	4,424	4,286	4,347	5,584	5,572
Oil refining	6,325	7,248	5,720	6,488	6,068	4,080
Insecticides	17,160	6,033	5,353	10,651	5,691	2,724
Rubber	2,705	2,835	1,398	3,047	2,641	2,109
Floor coverings	115	152	62	220	1,772	791
Other	6,662	6,004	5,214	9,559	5,001	3,584
Total	138,188	154,775	121,052	177,658	154,753	140,798

[1] Reported as sales before 1945.

ZINC PIGMENTS AND SALTS

Zinc Oxide.—Shipments of lead-free zinc oxide to consuming industries followed the same distribution pattern in 1952 as in previous years. The rubber industry and paint manufacturers remained by far the leading consumers, accounting for 51 percent (48 in 1951) and 22 percent (22), respectively, of total shipments. Shipments for ceramics and coated fabrics and textiles comprised 5 and 4 percent of the total (7 and 5 in 1951), respectively. Except for the rubber industry, which increased its receipts of zinc oxide slightly, shipments to all consuming industries declined in 1952.

TABLE 13.—Distribution of zinc oxide shipments,[1] by industry, 1943–47 (average) and 1948–52, in short tons

Industry	1943–47 (average)	1948	1949	1950	1951	1952
Rubber	71,377	82,895	58,496	82,944	71,507	72,774
Paints	30,103	26,779	26,205	39,699	32,934	31,424
Ceramics	6,470	12,327	6,982	12,679	10,324	7,760
Coated fabrics and textiles [2]	11,016	9,474	5,200	6,303	7,265	6,262
Floor coverings		4,938	2,665	3,670	3,114	2,413
Chemical warfare	10,308					
Other	16,857	14,545	10,584	15,534	22,572	21,577
Total	146,131	150,958	110,132	160,829	147,716	142,210

[1] Reported as sales before 1945.
[2] Includes the following tonnages for rayon: 1948—8,209; 1949—4,470; 1950—4,850; 1951—5,275; 1952—5,852.

Leaded Zinc Oxide.—Leaded zinc oxide (all grades) is used almost exclusively as a pigment in paint manufacturing; in 1952 over 99 percent of total shipments was for this purpose. Small quantities (less than 1 percent of shipments) are used by the rubber industry. The fact that leaded zinc oxide is produced from ores rather than metal or secondary materials improves its competitive position for paint manufacture when metal and scrap are in short supply.

TABLE 14.—Distribution of leaded zinc oxide shipments,[1] by industry, 1943–47 (average) and 1948–52, in short tons

Industry	1943–47 (average)	1948	1949	1950	1951	1952
Paints	61,237	64,912	35,938	63,002	43,678	37,607
Rubber	132	218	124	240	82	9
Other	2,681	2,311	660	731	581	276
Total	64,050	67,441	36,722	63,973	44,341	37,892

[1] Reported as sales before 1945.

Lithopone.—The chief use of lithopone is in the manufacture of paints, varnish, and lacquers; approximately three-fourths of total shipments are to these industries. In 1952 this category took 73 percent (75 in 1951) of the total. Shipments for use in coated fabrics and textiles increased 18 percent, the only increase among the lithopone end-use items covered by this report. Shipments for all other purposes—rubber, paper, floor coverings, and printing ink—declined—54, 52, 35, and 24 percent, respectively.

TABLE 15.—Distribution of lithopone shipments,[1] by industry, 1943–47 (average) and 1948–52, in short tons

Industry	1943–47 (average)	1948	1949	1950	1951	1952
Paint, varnish, and lacquers [2]	116,033	104,441	56,146	78,177	76,614	45,267
Coated fabrics and textiles	6,092	8,436	6,602	7,945	4,814	5,698
Paper	4,139	4,814	2,375	3,821	6,462	3,089
Floor coverings	9,747	12,423	6,380	5,297	4,620	3,009
Rubber	1,494	4,192	3,245	4,092	3,295	1,523
Printing ink	(3)	(3)	(3)	838	868	657
Other	7,858	5,727	3,587	5,480	6,164	2,589
Total	145,363	140,033	78,335	105,650	102,837	61,832

[1] Reported as sales before 1945.
[2] Includes a small quantity, not separable, used for printing ink, except in 1950, 1951 and 1952.
[3] Included in "Other" before 1950, except for those quantities reported under "Paint, varnish, and lacquers."

Zinc Chloride.—Statistics on the end-use distribution of zinc chloride shipments are not available. The principal uses of the salt are in wood preserving, battery manufacturing, vulcanized fibre, oil refining, and as a soldering flux.

Zinc Sulfate.—The textile (rayon) industry has ranked first in consumption of zinc sulfate since 1946 when the agricultural use (fertilizers and fungicides) led; in 1952 shipments for rayon decreased 19 percent from 1951 and were the smallest since 1946. Agriculture continued as the second largest use; shipments for this purpose declined 9 percent. Among the smaller uses, shipments for chemicals, textile dyeing and printing, and glue decreased, whereas shipments for flotation reagents, electrogalvanizing, and paint and varnish processing increased.

TABLE 16.—Distribution of zinc sulfate shipments,[1] by industry, 1943–47 (average) and 1948–52, in short tons

Industry	1943–47 (average)	1948		1949		1950		1951		1952	
	Gross weight	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis
Rayon	6,613	9,900	7,333	10,591	7,957	11,217	8,322	10,073	7,925	8,181	6,812
Agriculture	6,718	5,210	4,248	4,429	3,595	5,841	4,880	5,588	4,847	5,111	4,446
Chemicals	2,018	1,734	1,193	1,197	851	1,879	1,377	2,871	2,243	1,675	1,489
Flotation reagents	1,168	1,632	1,366	921	757	952	727	858	736	1,070	950
Glue	465	561	462	453	370	579	464	396	337	391	329
Textile dyeing and printing	272	102	66	30	21	145	129	1,400	1,163	350	301
Electrogalvanizing	288	319	205	217	154	324	203	190	129	342	243
Paint and varnish processing	919	121	104	663	585	189	119	32	20	172	130
Other	1,566	1,934	1,191	1,564	979	2,786	1,820	2,116	1,274	2,295	1,422
Total	20,027	21,513	16,168	20,065	15,269	23,912	18,041	23,524	18,674	19,587	16,122

[1] Reported as sales before 1945.

PRICES

Total and average values received by producers for lead and zinc pigments and zinc salts are given in the tables in the first part of this report. Average values for red lead, white lead, and litharge declined $21, $23, and $35 per ton in 1952 but remained at high levels compared with other years. The average value for white lead was the second highest on record, being smaller only than in 1951; red lead and litharge were higher than in any year except 1948 and 1951. Quotations for lead pigments reached a low for the year during the last week of October when lead was selling at its lowest level (13.5 cents per pound). Pigment prices at that time were about 4 cents a pound or 20 percent under quoted prices at the beginning of the year. When the

TABLE 17.—Range of quotations on lead pigments, and zinc pigments and salts at New York (or delivered in the East), 1949–52, in cents per pound

[Oil, Paint and Drug Reporter]

Product	1949	1950	1951	1952
White lead (basic lead carbonate), dry, carlots, barrels	14.75–22.10	14.00–18.50	18.50–20.10	16.25–20.10
Basic lead sulfate (sublimed lead), less than carlots, barrels	14.25–21.25	13.25–18.75	18.75–20.19	15.75–20.19
Red lead, dry, 95 percent or less, less than carlots, barrels	15.75–25.25	14.25–20.75	20.75–22.57	17.25–22.57
Orange mineral, American, small lots, barrels	18.10–27.60	16.60–23.10	23.10–24.92	19.60–24.92
Litharge, commercial, powdered, barrels	13.75–24.25	13.25–19.75	19.75–21.65	16.25–21.65
Zinc oxide:				
American process, lead free, bags, carlots	10.00–15.50	11.00–16.00	16.00–17.60	14.25–17.60
American process, 5 to 35 percent lead, barrels, carlots	10.25–17.38	11.25–16.88	16.88–18.35	14.40–18.35
French process, red seal, bags, carlots	11.50–16.75	12.25–17.25	17.25–18.85	15.25–18.85
French process, green seal, bags, carlots	11.75–17.25	12.75–17.75	17.75–19.35	16.00–19.35
French process, white seal, barrels, carlots	12.50–18.00	13.50–18.50	18.25–19.85	16.50–19.85
Lithopone, ordinary, small lots, bags	6.50–6.75	6.50–8.50	8.50–8.90	8.25–8.90
Zinc sulfide, less than carlots, bags, barrels	12.50–14.00	13.50–25.00	25.00–26.30	26.30
Zinc chloride, works:				
Solution, tanks	3.25	3.25–4.10	4.10–5.35	4.10–5.35
Fused, drums	6.75–8.15	7.00–9.85	9.85	9.60–9.85
Zinc sulfate, crystals,[1] barrels	4.95–6.85	4.95–10.15	10.15–11.20	10.00–11.20

[1] Includes granulated.

price of lead rose to 14.75 cents in December, pigment quotations registered proportionate increases.

Although declining slightly in 1952, average values for zinc pigments were the second highest on record, being surpassed only by values in 1951, the peak year. Quotations for zinc oxide (lead-free and leaded) dropped about 3.5 cents per pound during the year as the price of zinc fell from 19.5 cents to 12.5 cents. Lithopone quotations declined about 0.5 cent per pound.

New highs were again recorded for zinc chloride and zinc sulfate; average values were 9 and 2 percent, respectively, above the peaks established in 1951.

FOREIGN TRADE [2]

Foreign trade in lead and zinc pigments and salts is of relatively minor importance in relation to domestic shipments of these commodities. A "favorable balance of trade"—that is, value of exports exceeding value of imports—is generally maintained with respect to these products. In 1952 the value of major classes of exports totaled $5,285,000 compared with imports valued at $541,000. These figures represented decreases from 1951 figures of 33 percent for exports and 80 percent for imports.

Tonnage imports and exports of lead and zinc pigments and zinc salts in 1952 were also at much reduced rates from those for 1951.

White lead and litharge, usually the chief lead entries, declined 85 and 67 percent, respectively, from 1951 and zinc oxide, lithopone, and zinc chloride, the principal zinc items imported, fell 90, 99, and 61 percent, respectively. Small quantities of zinc sulfate, red lead,

TABLE 18.—Value of foreign trade of the United States in lead and zinc pigments and salts, 1950–52

[U. S. Department of Commerce]

	Imports for consumption			Exports		
	1950	1951	1952	1950	1951	1952
Lead pigments:						
White lead	$271,035	$886,973	$139,829	$243,344	$272,695	$222,092
Red lead	27,114	89,351	623	194,939	266,098	183,649
Litharge	4,570	788,064	273,719	511,942	445,201	527,450
Other lead pigments	40,781	32,373	36,386	(1)	(1)	(1)
Total	343,500	1,796,761	450,557	(1)	(1)	(1)
Zinc pigments:						
Zinc oxide	1,081,816	779,299	88,056	875,829	3,238,685	2,720,203
Zinc sulfide	14,479			(1)	(1)	(1)
Lithopone	179,197	151,165	2,308	1,248,538	3,615,915	1,632,106
Total	1,275,492	930,464	90,364	2,124,367	6,854,600	4,352,309
Lead and zinc salts:						
Lead arsenate		2,664	36,879	216,034	165,215	62,498
Other lead compounds	1,055	68,609	12,550	(1)	(1)	(1)
Zinc arsenate			22	(1)	(1)	(1)
Zinc chloride	30,447	194,595	79,645	(1)	(1)	(1)
Zinc sulfate	11,202	15,565	10,767	(1)	(1)	(1)
Total	42,704	281,433	139,863	(1)	(1)	(1)
Grand total	1,661,696	3,008,658	680,784	(1)	(1)	(1)

[1] Data not available.

[2] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

lead suboxide, lead arsenate, and other lead compounds were also imported for consumption in 1952.

Litharge, white lead, red lead, and lead arsenate are also exported by the United States, but totals constitute only a small portion of shipments by domestic producers.

Zinc oxide and lithopone are the pigments exported in greatest tonnages from the United States. Exports of these pigments decreased 14 and 51 percent, respectively, from the quantities exported in 1951. Tonnages given comprise 5 and 16 percent, respectively, of total domestic shipments.

TABLE 19.—Lead pigments and salts imported for consumption in the United States, 1948–52

[U. S. Department of Commerce]

Year	Short tons							Total value
	White lead (basic carbonate)	Red lead	Litharge	Lead suboxide	Lead pigments n. s. p. f.	Lead arsenate	Other lead compounds	
1948	203	247	1,064	34	30	----------	1	$633,776
1949	161	23	96	23	6	----------	(1)	142,607
1950	944	70	12	57	27	----------	2	344,555
1951	2,575	215	1,855	53	----------	7	180	1,868,034
1952	390	2	621	53	(1)	81	32	499,986

1 Less than 0.5 ton.

TABLE 20.—Zinc pigments and salts imported for consumption in the United States, 1948–52

[U. S. Department of Commerce]

Year	Short tons							Total value
	Zinc oxide		Lithopone	Zinc sulfide	Zinc chloride	Zinc arsenate	Zinc sulfate	
	Dry	In oil						
1948	27	(1)	----------	----------	----------	----------	180	$17,758
1949	239	(1)	12	----------	17	----------	120	60,984
1950	5,093	2	1,201	33	210	----------	159	1,317,141
1951	1,772	10	794	----------	714	----------	201	1,140,624
1952	173	(1)	11	----------	275	(1)	66	180,798

1 Less than 0.5 ton.

TABLE 21.—Lead pigments and salts exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Short tons				Total value
	White lead	Red lead	Litharge	Lead arsenate	
1948	663	953	644	1,019	$1,404,001
1949	699	1,042	1,357	430	1,343,513
1950	815	549	1,612	520	1,166,259
1951	767	585	1,038	313	1,149,209
1952	675	435	1,233	128	995,689

TABLE 22.—Zinc pigments and salts exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Short tons		Total value	Year	Short tons		Total value
	Zinc oxide	Lithopone			Zinc oxide	Lithopone	
1948	8,642	21,015	$5,228,962	1951	8,895	20,473	$6,854,600
1949	5,040	14,460	3,426,118	1952	7,615	9,985	4,352,309
1950	3,094	9,357	2,124,367				

WORLD REVIEW

France.—The Belgian and French works of the Mines et fonderies de zinc de la Vielle-Montagne produced 12,800 short tons of zinc white in 1952. The New Jersey distillation tower for the production of "snow" zinc oxide (oxyde de zinc "neige") was put into service at the end of 1951 and is working regularly at the Creil (Oise) works.[3]

Germany, West.—Two methods are used in Germany to manufacture zinc oxide of pigment quality: The "indirect" process (that is, producing zinc oxide from virgin metal, remelted zinc, or hard zinc) and the "direct" process (that is, producing zinc oxide from zinciferous products such as zincy slags, residues, or other waste products or byproducts containing zinc mainly in the form of zinc oxide). The indirect process produces a first-quality zinc oxide well suited for pigments. By the direct process a zinc oxide is obtained generally of second quality and largely unsuited for pigments.

The zinc oxide produced in the indirect process is called zinc white in Germany, whereas the zinc oxide obtained in the direct process is called, simply, zinc oxide. If suitable for pigment, the latter is called pigment zinc oxide; if not suitable for pigment it is called technical zinc oxide or off-grade zinc oxide.

Nearly all German producers of zinc white use the Grillo process, which was developed 80 years ago at the Grillo zinc smelter at Hamborn. This method has been periodically modernized, but its principle has remained the same. Only to a small extent is the crucible process in operation.

Five firms in Western Germany use the Grillo process to manufacture zinc white. These are: Grillo, Hamborn; Bergmann u. Simons, Cologne; Lindgens u. Sohne, Cologne; Gebrüder Rhodius, Burgbrohl; and Zinkhütte Hamburg, Hamburg. These 5 firms have a combined capacity of about 30,000 tons of zinc white a year.

In its essentials the Grillo process consists of heating zinc metal in clay retorts with producer gas. The zinc vaporizes and mixes with the producer gas; this mixture leaves the retort on the side opposite that which it enters through a combustion chamber arranged outside

[3] Metal Bulletin (London), No. 3796, May 29, 1953, p. 19.

the furnace. There the mixture of gas and vapor comes into contact with air and burns immediately to zinc oxide.

Zinkhütte Hamburg employes the crucible process to produce a special kind of zinc white for the rubber industry. Metall u. Farbwerke, Oker, uses crucibles to produce normal zinc white.

The so-called smelting process, operating in a rotary kiln, is not in use in Germany, although this process produces a zinc white of excellent quality under close supervision.

Various plants are engaged in producing zinc oxide by the direct process, using zinc-containing materials. The most important of these are at Oker, Langelsheim, Gelsenkirchen, and Siegen. None of these plants produces a zinc oxide equal in its quality and lead content to zinc white. At best the pigment zinc oxide produced by this method is of second quality.[4]

Netherlands.—A mixed Anglo-Netherlands enterprise has put into operation at Bois-le-Duc, a works producing red lead, reports L'Usine nouvelle. Output was put at 3,000 tons a year, most of which at first was to be absorbed domestically.[5]

[4] Jensen, C. W., Zinc Oxide Manufacture in Germany: Min. Mag. (London), vol. 86, No. 1, January 1952, pp. 15-21.
[5] Metal Bulletin (London), No. 3570, Feb. 23, 1951, p. 15.

Lime[1]

By Oliver Bowles,[2] Flora B. Mentch,[3] and Annie L. Marks[4]

BECAUSE the major uses of lime are in the chemical and processing industries, the continuing high level of industrial activity throughout 1952 was reflected in an output of lime exceeded only by the record production of 1951. The small decline from 1951 was occasioned by lack of demand for metallurgical and refractory lime during the steel-plant strike. Lime sold or used in 1952 totaled 8,073,000 short tons, a decrease of 2 percent from 1951. Of total sales, 77 percent was in the form of quicklime or dead-burned dolomite and 23 percent hydrated lime. The average sales value of quicklime increased from \$11.42 to \$11.43 per ton in 1952. Hydrated-lime value increased from \$12.81 to \$12.99. The number of plants increased from 155 to 160.

TABLE 1.—Salient statistics of open-market lime in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Active plants	201	181	180	168	155	160
Sold by producers:						
By types:						
Quicklime short tons	4,872,962	5,441,313	4,624,356	5,593,315	6,335,729	6,190,254
Hydrated do	1,479,525	1,822,663	1,693,946	1,885,101	1,919,783	1,882,824
Total lime:						
Short tons	6,352,487	7,263,976	6,318,302	7,478,416	8,255,512	8,073,078
Value [1]	\$51,707,972	\$75,162,879	\$69,319,374	\$83,247,990	\$96,934,611	\$95,231,221
Per ton	\$8.14	\$10.35	\$10.97	\$11.13	\$11.74	\$11.80
By uses:						
Agricultural short tons	403,791	323,300	328,528	332,687	343,619	392,383
Building do	696,264	1,140,518	1,052,097	1,248,989	1,234,136	1,191,263
Chemical and other industrial do	4,006,825	4,255,403	3,618,969	4,137,297	4,711,297	4,561,407
Refractory (dead-burned dolomite) short tons	1,245,607	1,544,755	1,318,708	1,759,443	1,966,460	1,928,025
Imports for consumption do	21,336	35,624	34,332	34,284	34,025	24,008
Exports do	30,915	63,088	59,927	50,491	63,295	64,952

[1] Selling value, f. o. b. plant, excluding cost of containers.

As lime is used extensively in industrial plants, such uses tend to follow the trend of industrial activity. This relationship is shown in figure 1. Similarly the production of building lime follows the course of total new building construction. Since 1948, however, building-lime sales, as indicated in figure 1, have not paced building construction.

Figure 2 shows the trends in sales of lime by principal uses over a period of years.

[1] Figures in this chapter pertain chiefly to open-market lime, excluding coverage of most captive lime operations.
[2] Commodity specialist.
[3] Statistical assistant.
[4] Statistical clerk.

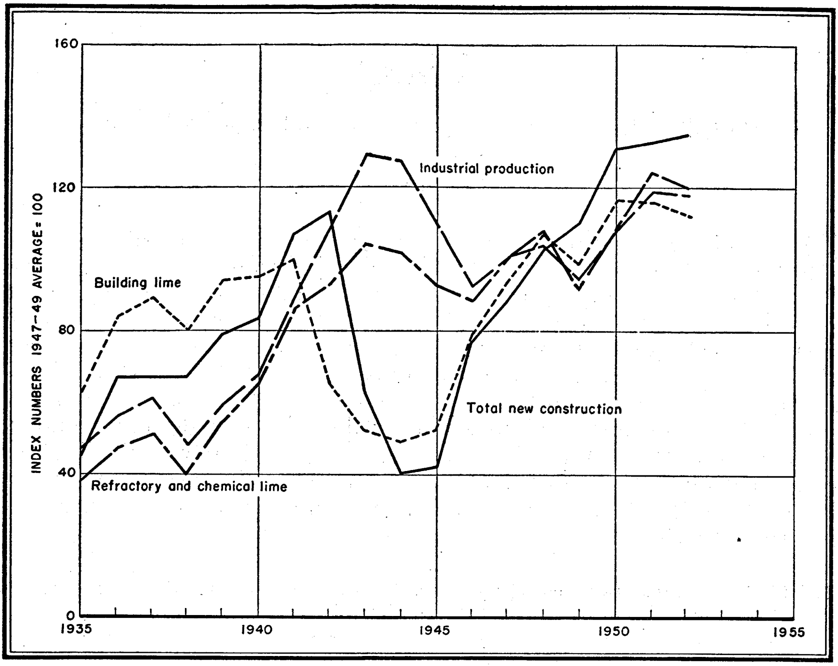

FIGURE 1.—Sales of building lime compared with physical volume of total new construction and sales of refractory and chemical lime compared with industrial production, 1935–52. Units are reduced to percentages of the 1947–49 average. Statistics on new construction from Construction and Building Materials, U. S. Department of Commerce, and on industrial production from Federal Reserve Board.

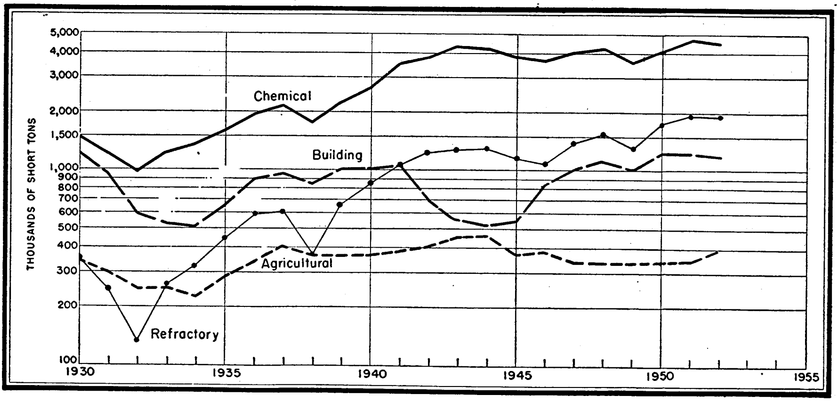

FIGURE 2.—Trends in major uses of lime, 1930–52.

DOMESTIC PRODUCTION

Total production (as indicated by sales) of open-market lime decreased 2 percent in quantity and value from 1951 to 1952. A major gain in volume of output was in agricultural lime, sales of which increased 14 percent. Chemical and industrial lime and lime sold to the building trades each declined 3 percent. Sales of dead-burned dolomite declined 2 percent. Chemical, industrial, and refractory lime combined comprised 80 percent of total sales compared with 81 percent in 1951. Building lime was 15 percent of the total, and agricultural 5 percent.

In 1952, open-market lime was produced in 33 States and 2 Territories, compared with 32 States and 2 Territories in 1951. The new State was Iowa, which had not appeared among producers since 1931. As in previous years, Ohio, Pennsylvania, and Missouri were the leading producers. Their combined output was 56 percent of the United States total in 1952. Illinois, Virginia, and Alabama were next in order of importance; together they supplied 16 percent of the total. It appears, therefore, that nearly three-fourths of the United States production of open-market lime originated in these six States.

TABLE 2.—Lime (quick and hydrated) sold by producers in the United States, 1951–52, by States

State or Territory	1951			1952		
	Active plants	Short tons	Value	Active plants	Short tons	Value
Alabama	7	455,953	$4,395,922	7	424,028	$4,458,604
Arizona	4	54,023	772,899	4	53,019	757,390
Arkansas	1	(1)	(1)	1	(1)	(1)
California	6	203,344	3,366,959	6	238,957	3,752,738
Connecticut	1	(1)	(1)	1	(1)	(1)
Florida	2	(1)	(1)	2	(1)	(1)
Georgia	1	10,616	104,626	1	7,854	87,587
Hawaii	1	8,740	236,052	1	8,894	240,786
Illinois	6	462,690	5,878,289	6	460,775	5,917,038
Indiana	1	(1)	(1)	1	(1)	(1)
Iowa				1	(1)	(1)
Maine	1	(1)	(1)	1	(1)	(1)
Maryland	7	67,684	722,011	7	72,885	746,893
Massachusetts	3	143,316	1,930,225	3	132,135	1,999,545
Michigan	3	(1)	(1)	3	(1)	(1)
Minnesota	1	(1)	(1)	1	(1)	(1)
Missouri	6	1,122,299	11,285,877	7	1,130,970	11,326,941
Montana	1	(1)	(1)	2	(1)	(1)
Nevada	3	(1)	(1)	3	(1)	(1)
New Jersey	1	(1)	(1)	2	(1)	(1)
New York	2	(1)	(1)	3	(1)	(1)
Ohio	18	2,289,473	29,046,196	18	2,205,432	28,393,260
Oklahoma	1	(1)	(1)	1	(1)	(1)
Oregon	2	(1)	(1)	2	(1)	(1)
Pennsylvania	28	1,181,100	14,260,054	28	1,202,981	13,842,213
Puerto Rico	3	10,350	191,415	3	8,575	195,000
South Dakota	1	(1)	(1)	1	(1)	(1)
Tennessee	3	108,970	1,097,874	3	100,189	1,005,235
Texas	9	279,957	2,532,387	9	281,604	2,622,975
Utah	3	(1)	(1)	3	(1)	(1)
Vermont	3	32,179	432,483	3	(1)	(1)
Virginia	11	452,680	4,551,656	12	442,845	4,448,924
Washington	2	(1)	(1)	2	(1)	(1)
West Virginia	5	(1)	(1)	5	(1)	(1)
Wisconsin	8	124,852	1,562,200	7	107,813	1,368,556
Undistributed [1]		1,247,286	14,567,486		1,194,122	14,067,536
Total	155	8,255,512	96,934,611	160	8,073,078	95,231,221

[1] Figures that may not be shown separately are combined as "Undistributed" to avoid disclosure of individual company operations.

Captive Tonnage.—The statistics included in this chapter pertain primarily to lime sold in the open market, but in some instances relatively small quantities of captive tonnage are included where it is particularly desirable to show complete figures for consumption by use. Specifically, the figures for lime sold or used in the United States in 1952 (1951 in parentheses) include a total of 485,600 short tons of captive tonnage, used by producers, distributed as follows: For building, 70,200 tons (53,000); for metallurgical uses, 259,800 (339,500 revised); for miscellaneous chemical uses, 114,300 (98,700); and for refractory lime (dead-burned dolomite), 41,300 (44,000 revised). A more complete figure for total lime production can be obtained by adding to the total given herein the quantity calculated from the limestone tonnages (shown in the chapter on Stone in this volume) consumed in the uses in which limestone is usually calcined.

TABLE 3.—Lime sold by producers in the United States,[1] 1951–52, by type and by major use

	1951				1952					
	Quantity		Value [2]		Quantity		Value [2]		Percent change from 1951 in—	
	Short tons	Percent of total	Total	Average	Short tons	Percent of total	Total	Average	Tonnage	Average value
By type:										
Quicklime	6,335,729	77	$72,347,501	$11.42	6,190,254	77	$70,772,085	$11.43	−2	(3)
Hydrated lime	1,919,783	23	24,587,110	12.81	1,882,824	23	24,459,136	12.99	−2	+1
Total lime [4]	8,255,512	100	96,934,611	11.74	8,073,078	100	95,231,221	11.80	−2	+1
By use:										
Agricultural:										
Quicklime	118,673	1	1,144,083	9.64	163,138	2	1,333,784	8.18	+37	−15
Hydrated lime	224,946	3	2,568,525	11.42	229,245	3	2,482,819	10.83	+2	−5
Total	343,619	4	3,712,608	10.80	392,383	5	3,816,603	9.73	+14	−10
Building:										
Quicklime	252,098	3	3,227,501	12.80	216,351	3	2,733,996	12.64	−14	−1
Hydrated lime	982,038	12	13,203,027	13.44	974,912	12	13,498,165	13.85	−1	+3
Total	1,234,136	15	16,430,528	13.31	1,191,263	15	16,232,161	13.63	−3	+2
Chemical and other industrial:										
Quicklime	3,998,498	48	41,600,604	10.40	3,882,740	48	40,605,850	10.46	−3	+1
Hydrated lime	712,799	9	8,815,558	12.37	678,667	8	8,478,152	12.49	−5	+1
Total	4,711,297	57	50,416,162	10.70	4,561,407	56	49,084,002	10.76	−3	+1
Refractory (dead-burned dolomite)	1,966,460	24	26,375,313	13.41	1,928,025	24	26,098,455	13.54	−2	+1

[1] Includes Hawaii and Puerto Rico.
[2] Selling value, f. o. b. plant, excluding cost of container.
[3] Less than ±0.5 percent.
[4] Includes lime used by producers (captive tonnage) as follows—1951: 535,179 tons, $4,933,013; 1952: 485,635 tons, $4,952,140.

Size of Plants.—The downward trend in the number of lime plants that has been rapid for many years has leveled since 1949. The more stabilized condition is due primarily to the disappearance of most of the small plants. Plants producing less than 1,000 tons of lime a year numbered 375 in 1930 and 12 in 1952. The average output per plant, which has been increasing steadily for some years, shows little change in 1952, compared with 1951. Plants producing 25,000 tons or more per year totaled 78 and produced 92 percent of total output in 1951. In 1952 the plants in these categories totaled 79 and likewise produced 92 percent of the total. Other relationships of interest are indicated in table 4.

TABLE 4.—Distribution of open-market lime (including refractory) plants, 1950–52, according to size of production

Size group (short tons)	1950			1951			1952		
	Plants	Production		Plants	Production		Plants	Production	
		Short tons	Percent of total		Short tons	Percent of total		Short tons	Percent of total
Less than 1,000	17	6,199	(1)	11	4,483	(1)	12	4,982	(1)
1,000 to less than 5,000	29	77,098	1	23	62,869	1	26	76,517	1
5,000 to less than 10,000	19	136,637	2	13	96,617	1	17	116,896	1
10,000 to less than 25,000	30	480,555	6	30	497,545	6	26	443,834	6
25,000 to less than 50,000	30	1,143,169	15	28	1,054,314	13	35	1,302,652	16
50,000 to less than 100,000	22	1,473,928	20	24	1,563,026	19	19	1,248,714	16
100,000 and over	21	4,160,830	56	26	4,976,658	60	25	4,879,483	60
Total	168	7,478,416	100	155	8,255,512	100	160	8,073,078	100

[1] Less than 0.5 percent.

Hydrated Lime.—Quicklime (CaO or CaO–MgO) has a strong affinity for water, with which it combines to form hydrated lime ($Ca(OH)_2$ or $Ca,Mg(OH)_2$). Hydrated lime has some advantages over quicklime in handling and transportation; and, for certain applications, the hydrated form is preferred. Accordingly, part of the output—22 percent in 1952—was hydrated before it was shipped. Production by States is indicated in table 5.

TABLE 5.—Hydrated lime sold by producers in the United States, 1951–52, by States

State or Territory	1951			1952		
	Active plants	Short tons	Value	Active plants	Short tons	Value
Alabama	5	46,254	$520,225	5	62,480	$784,581
California	5	34,554	536,425	5	33,289	498,097
Georgia	1	9,554	99,431	1	6,718	82,112
Hawaii	1	8,736	235,872	1	8,858	239,166
Illinois	4	46,781	585,574	4	54,226	687,487
Maryland	4	23,058	249,865	4	18,818	189,634
Massachusetts	3	56,215	754,019	3	53,375	705,358
Missouri	5	192,167	2,165,807	5	181,398	2,145,140
Ohio	14	716,289	9,330,363	14	670,702	9,104,352
Pennsylvania	15	341,625	4,311,696	14	332,009	4,127,369
Tennessee	3	22,194	280,455	3	19,726	214,037
Texas	6	67,173	769,702	6	71,700	820,076
Vermont	1	9,264	143,593	(1)	(1)	(1)
Virginia	9	68,875	807,538	10	73,119	841,842
Other States [2]	29	277,044	3,796,545	32	296,406	4,019,885
Total	105	1,919,783	24,587,110	107	1,882,824	24,459,136

[1] Included with "Other States" to avoid disclosure of individual company operations.
[2] Includes the following States and number of plants in 1952 (1951 same as 1952 unless shown differently in parentheses): Arizona 3, Arkansas 1, Connecticut 1, Florida 1, Indiana 1, Iowa 1 (0), Maine 1, Michigan 1, Minnesota 1, Montana 1 (0), Nevada 2, New Jersey 2 (1), New York 2, Oklahoma 1, Puerto Rico 1 (2), Utah 2, Vermont 1, Washington 1, West Virginia 3, and Wisconsin 5.

CONSUMPTION AND USES

Geographic data on sales of lime by uses are presented in table 6 on a district rather than on a State basis, in order that more informa-

TABLE 6.—Lime (quick and hydrated) sold by producers in the United States in 1952, by districts [1] and by types

State or Territory	Agricultural		Building		Chemical and other industrial		Refractory		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
District 1: Connecticut, Maine, Massachusetts, and Vermont	13,896	$165,881	59,430	$853,529	142,542	$2,144,084	—	—	215,868	$3,163,494
Districts 2 and 3: Maryland, New Jersey, New York, Pennsylvania, and West Virginia	230,335	2,426,697	148,064	1,966,801	988,129	10,668,788	332,266	$4,434,788	1,698,794	19,497,074
District 4: Virginia	20,151	241,139	11,566	126,428	411,128	4,081,357	—	—	442,845	4,448,924
District 5: Ohio	53,467	637,589	578,088	8,009,903	407,007	4,139,066	1,166,870	15,606,702	2,205,432	28,393,260
District 7: Illinois, Indiana, and that portion of Missouri east of 93d meridian	—	—	(2)	(2)	1,117,427	11,308,257	(2)	(2)	1,506,905	16,545,454
Districts 6, 8, and 9: Iowa, Michigan, Minnesota, South Dakota, and Wisconsin	(2)	(2)	(2)	(2)	301,488	3,486,437	—	—	353,478	3,917,461
Districts 10–11: Alabama, Florida, Georgia, and Tennessee	3,529	39,485	(2)	(2)	443,736	4,646,583	(2)	(2)	566,229	5,992,957
District 12: Arkansas, Oklahoma, and that portion of Missouri west of 93d meridian	(2)	(2)	(2)	(2)	171,063	1,782,578	—	—	264,696	2,596,944
District 13: Texas	350	3,162	45,545	484,587	235,709	2,135,226	—	—	281,604	2,622,975
Districts 14 and 15: Arizona, California, Montana, Nevada, Oregon, Utah, and Washington	(2)	(2)	102,626	1,870,015	334,552	4,476,160	(2)	(2)	519,758	7,616,892
Noncontiguous Territories:										
Hawaii	—	—	(2)	(2)	(2)	(2)	—	—	8,894	240,786
Puerto Rico	(2)	(2)	(2)	(2)	(2)	(2)	—	—	8,575	195,000
Undistributed [2]	70,655	302,650	245,944	2,920,898	8,626	215,466	428,889	6,056,965	—	—
Total	392,383	3,816,603	1,191,263	16,232,161	4,561,407	49,084,002	1,928,025	26,098,455	8,073,078	95,231,221

[1] The districting is the same as that used by the National Lime Association. Non-lime-producing States are omitted.
[2] Figures that may not be shown separately are combined as "Undistributed" to avoid disclosure of individual company operations.

tion may be made available than was possible heretofore. When presented on a State basis, as in previous years, numerous concealments were necessary to avoid disclosure of individual operations.

Table 7 shows the quantity and value of lime sold to many chemical and processing industries. These applications have attained great importance during recent years. Fifty-seven percent of all lime sold was applied to such uses in 1952, the same percentage as in 1951.

The total quantity of lime applied to chemical and industrial uses in 1952 was 3 percent lower than in 1951. The principal declines were in steel flux, 10 percent; sewage and trade waste, 11 percent; paper mills, 7 percent, insecticides and related products, 11 percent; tanneries, 5 percent; and calcium carbide, 3 percent. Sales of refractory lime (dead-burned dolomite) declined 2 percent. Gains were recorded for ore-concentration uses, 11 percent; water purification, 4 percent; and sugar refining, 2 percent.

The quantity of lime used in agriculture increased 14 percent, while building-trade uses declined 3 percent.

The sales distribution of hydrated lime by uses is indicated in table 8.

TABLE 7.—Lime (quick and hydrated) sold by producers in the United States, 1951–52, by uses

Use	1951			1952		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Agricultural	343, 619	$3, 712, 608	$10. 80	392, 383	$3, 816, 603	$9. 73
Building:						
Finishing lime	599, 301	8, 524, 569	14. 22	597, 065	8, 643, 902	14. 48
Mason's lime	469, 101	6, 140, 350	13. 09	469, 507	6, 236, 377	13. 28
Prepared masonry mortars	92, 586	954, 352	10. 31	99, 516	1, 057, 255	10. 62
Unspecified	73, 148	811, 257	11. 09	25, 175	294, 627	11. 70
Total	1, 234, 136	16, 430, 528	13. 31	1, 191, 263	16, 232, 161	13. 63
Chemical and other industrial:						
Alkalies (ammonium, potassium, and sodium compounds)	(1)	(1)	(1)	(1)	(1)	(1)
Asphalts and other bitumens	(1)	(1)	(1)	(1)	(1)	(1)
Bleach, liquid and powder [2]	2, 504	29, 155	11. 64	4, 440	47, 246	10. 64
Brick, sand-lime and slag	23, 517	286, 980	12. 20	20, 575	240, 922	11. 71
Brick, silica (refractory)	17, 187	226, 444	13. 18	17, 616	225, 882	12. 82
Calcium carbide and cyanamide	576, 659	5, 592, 490	9. 70	558, 370	5, 333, 540	9. 55
Calcium carbonate (precipitated)	26, 988	305, 237	11. 31	20, 222	579, 971	28. 68
Coke and gas (gas purification and plant byproducts)	28, 681	317, 035	11. 05	29, 060	314, 896	10. 84
Explosives	4, 407	56, 313	12. 78	9, 569	107, 561	11. 24
Food products:						
Creameries and dairies	741	12, 137	16. 38	990	15, 012	15. 16
Gelatin	6, 444	78, 340	12. 16	6, 105	73, 863	12. 10
Stock feed	21, 109	235, 365	11. 15	21, 258	248, 993	11. 71
Other [3]	2, 432	32, 466	13. 35	1, 381	16, 330	11. 82
Glassworks	237, 479	2, 403, 987	10. 12	237, 172	2, 350, 536	9. 91
Glue	9, 598	109, 746	11. 43	7, 844	88, 618	11. 30
Grease, lubricating	7, 724	89, 691	11. 61	5, 187	58, 302	11. 24
Insecticides, fungicides, and disinfectants	79, 136	988, 996	12. 50	70, 347	879, 160	12. 50
Medicines and drugs	(1)	(1)	(1)	(1)	(1)	(1)
Metallurgy:						
Nonferrous smelter flux	4, 063	64, 763	15. 94	1, 378	22, 859	16. 59
Steel (open-hearth and electric furnace flux)	1, 354, 883	14, 190, 178	10. 47	1, 222, 543	12, 994, 294	10. 63
Ore concentration [4]	275, 022	2, 869, 987	10. 44	305, 309	3, 376, 010	11. 06
Wire drawing	21, 495	282, 688	13. 15	24, 598	291, 550	11. 85
Other [5]	13, 601	145, 638	10. 71	10, 399	108, 714	10. 45

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Bleach used in paper mills excluded from "Bleach" and included with "Paper mills."
[3] Includes citrates, tartrates, and miscellaneous food products.
[4] Includes floatation, cyanidation, bauxite purification, and magnesium manufacture.
[5] Includes barium and vanadium processing, cupola, gold recovery, and unspecified metallurgical uses.

TABLE 7.—Lime (quick and hydrated) sold by producers in the United States, 1951–52, by uses—Continued

Use	1951			1952		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Chemical and other industrial—Con.						
Paints	28, 536	$352, 258	$12. 34	25, 926	$319, 508	$12. 32
Paper mills	735, 393	8, 103, 544	11. 02	683, 628	7, 422, 034	10. 86
Petroleum refining	52, 509	621, 556	11. 84	40, 621	466, 869	11. 49
Rubber manufacture	1, 126	13, 579	12. 06	2, 028	23, 749	11. 71
Salt refining	9, 852	95, 809	9. 72	9, 677	91, 545	9. 46
Sewage and trade-wastes treatment	100, 553	1, 181, 644	11. 75	89, 338	1, 084, 262	12. 14
Soap and fat	753	9, 310	12. 36	815	9, 953	12. 21
Sugar refining	34, 941	529, 822	15. 16	35, 492	529, 293	14. 91
Tanneries	68, 239	784, 041	11. 49	64, 991	725, 065	11. 16
Varnish	(1)	(1)	(1)	(1)	(1)	(1)
Water purification	577, 953	6, 181, 745	10. 70	601, 592	6, 447, 682	10. 72
Wood distillation	5, 467	61, 563	11. 26	14, 206	126, 073	8. 87
Undistributed [6]	122, 459	1, 307, 902	10. 68	143, 999	1, 484, 346	10. 31
Unspecified	259, 846	2, 855, 753	10. 99	274, 731	2, 979, 364	10. 84
Total	4, 711, 297	50, 416, 162	10. 70	4, 561, 407	49, 084, 002	10. 76
Refractory lime (dead-burned dolomite)	1, 966, 460	26, 375, 313	13. 41	1, 928, 025	26, 098, 455	13. 54
Grand total lime [7]	8, 255, 512	96, 934, 611	11. 74	8, 073, 078	95, 231, 221	11. 80
Hydrated lime included in above distribution	1, 919, 783	24, 587, 110	12. 81	1, 882, 824	24, 459, 136	12. 99

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[6] Includes alcohol, alkalies, asphalt, medicines and drugs, oil drilling, petrochemicals (glycol), magnesium products, plastics, polishing compounds, retarder, sulfur, tobacco, varnish, and miscellaneous industrial uses.
[7] Includes lime used by producers (captive tonnage) as follows—1951: 535,179 tons, valued at $4,933,013; 1952: 485,635 tons, $4,952,140.

TABLE 8.—Hydrated lime sold by producers in the United States, 1951–52, by uses

Use	1951			1952		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Agricultural	224, 946	$2, 568, 525	$11. 42	229, 245	$2, 482, 819	$10. 83
Building	982, 038	13, 203, 027	13. 44	974, 912	13, 498, 165	13. 85
Chemical and other industrial:						
Bleach, liquid and powder	807	10, 123	12. 54	2, 428	30, 499	12, 56
Brick, sand-lime and slag	8, 255	107, 328	13. 00	7, 628	88, 660	11. 62
Brick, silica	14, 911	200. 744	13. 46	14, 477	196, 565	13. 58
Coke and gas	462	5, 278	11. 42	691	7, 951	11. 51
Food products	16, 914	209, 292	12. 37	15, 721	206, 465	13. 13
Insecticides, fungicides, and disinfectants	66, 647	840, 004	12. 60	60, 017	763, 300	12. 72
Metallurgy	29, 741	402, 777	13. 54	25, 452	344, 170	13. 52
Paints	18, 222	235, 445	12. 92	16, 494	211, 932	12. 85
Paper mills	53, 598	678, 446	12. 66	38, 988	481, 331	12. 35
Petroleum	35, 231	446, 841	12. 68	26, 332	324, 531	12. 32
Sewage and trade-waste treatment	49, 434	591, 733	11. 97	49, 632	596, 669	12. 02
Sugar refining	25, 618	421, 176	16. 44	26, 132	427, 505	16. 36
Tanneries	37, 580	452, 839	12. 05	34, 192	405, 427	11. 86
Water purification	249, 102	2, 891, 629	11. 61	237, 438	2, 778, 567	11. 70
Undistributed [1]	36, 089	447, 832	12. 41	43, 830	649, 770	14. 82
Unspecified	70, 188	874, 071	12. 45	79, 215	964, 810	12. 18
Total	712, 799	8, 815, 558	12. 37	678, 667	8, 478, 152	12. 49
Grand total, hydrated lime	1, 919, 783	24, 587, 110	12. 81	1, 882, 824	24, 459, 136	12. 99

[1] Includes cement products, glass, glue, grease (lubricating), medicines and drugs, oil-well drilling, rubber, wood distillation, and miscellaneous industrial uses.

To furnish a more comprehensive picture of the various materials used in liming land, table 9 shows, in addition to agricultural lime, the quantities of oystershells, limestone, and calcareous marl that are applied to soil amendment.

TABLE 9.—Agricultural lime and other liming materials sold by producers in the United States, 1951–52, by kinds

Kind	1951				1952			
	Short tons		Value		Short tons		Value	
	Gross weight	Effective lime content [1]	Total	Average	Gross weight	Effective lime content [1]	Total	Average
Lime:								
Quicklime	118,673	100,870	$1,144,083	$9.64	163,138	138,660	$1,333,784	$8.18
Hydrated lime	224,946	157,460	2,568,525	11.42	229,245	160,470	2,482,819	10.83
Oystershells (crushed)[2]	75,528	35,500	411,616	5.45	72,917	34,270	419,306	5.75
Limestone	19,400,610	9,118,290	31,051,933	1.60	21,147,295	9,939,220	34,456,594	1.63
Calcareous marl	269,955	113,380	233,787	.87	260,213	109,280	187,148	.72
Total		9,525,500	35,409,944			10,381,900	38,879,651	

[1] Calculated upon basis of average percentages used by the National Lime Association, as follows: Quicklime (including lime from oystershells), 85 percent; hydrated lime, 70 percent; pulverized uncalcined limstone and oystershells, 47 percent; calcareous marl, 42 percent.
[2] Figures compiled by Fish and Wildlife Service.

As the trend for many years has been toward concentration of lime production in fewer and larger plants, it is evident that interstate shipments have been increasing. Some States produce a surplus, while others are deficient in supplies. Furthermore, limes vary considerably in physical and chemical properties, and the specialized needs of consuming industries often demand shipments from distant points. Accordingly, as table 10 indicates, large quantities now enter interstate trade. The principal States that exported lime beyond their borders in 1952 were Ohio, Missouri, Pennsylvania, Virginia, West Virginia, and Illinois.

Data on origin and destination of lime shipments, by States and groups of States, are given in table 11.

TABLE 10.—Apparent consumption of open-market lime in continental United States in 1952, by States, in short tons

State	Sales by producers	Shipments from States [1]	Shipments into States	Apparent consumption		
				Quicklime	Hydrated lime	Total
Alabama	424,028	158,417	15,766	265,431	15,946	281,377
Arizona	53,019	4,916	5,830	48,568	5,365	53,933
Arkansas	(2)	(2)	(2)	25,249	7,321	32,570
California	238,957	31,436	78,288	212,143	73,666	285,809
Colorado			24,741	17,961	6,780	24,741
Connecticut	(2)	(2)	(2)	23,774	28,732	52,506
Delaware			85,672	47,708	37,964	85,672
District of Columbia			10,756	330	10,426	10,756
Florida	(2)		(2)	56,954	60,226	117,180
Georgia	7,854	1,490	65,982	46,119	26,227	72,346
Idaho			5,235	2,830	2,405	5,235
Illinois	460,775	219,108	357,846	455,458	144,055	599,513
Indiana	(2)	(2)	(2)	290,796	41,798	332,594
Iowa	(2)		(2)	98,266	33,283	131,549
Kansas			72,877	59,506	13,371	72,877
Kentucky			285,725	259,260	26,465	285,725
Louisiana			121,659	80,084	41,575	121,659
Maine	(2)		(2)	53,677	4,239	57,916
Maryland	72,885	15,556	115,761	132,015	41,075	173,090

[1] Includes 99,465 tons exported or unclassified as to destination.
[2] Figures that may not be shown separately are combined as "Undistributed" to avoid disclosure of individual company operations.

TABLE 10.—Apparent consumption of open-market lime in continental United States in 1952, by States, in short tons—Continued

State	Sales by producers	Shipments from States [1]	Shipments into States	Apparent consumption		
				Quicklime	Hydrated lime	Total
Massachusetts	132, 135	83, 740	53, 918	44, 261	58, 052	102, 313
Michigan	(2)	(2)	(2)	290, 897	67, 459	358, 356
Minnesota	(2)	(2)	(2)	79, 554	18, 571	98, 125
Mississippi	------	------	38, 867	31, 415	7, 452	38, 867
Missouri	1, 130, 970	972, 936	23, 159	126, 752	54, 441	181, 193
Montana	(2)	------	(2)	29, 944	4, 269	34, 213
Nebraska	------	------	11, 996	2, 556	9, 440	11, 996
Nevada	(2)	(2)	(2)	24, 133	2, 114	26, 247
New Hampshire	------	------	9, 268	2, 723	6, 545	9, 268
New Jersey	(2)	(2)	(2)	58, 563	124, 908	183, 471
New Mexico	------	------	4, 733	574	4, 159	4, 733
New York	(2)	(2)	(2)	384, 676	156, 692	541, 368
North Carolina	------	------	68, 570	34, 600	33, 970	68, 570
North Dakota	------	------	6, 893	3, 475	3, 418	6, 893
Ohio	2, 205, 432	1, 555, 077	307, 671	803, 241	154, 785	958, 026
Oklahoma	(2)	(2)	(2)	37, 112	15, 220	52, 332
Oregon	(2)	------	(2)	43, 941	7, 745	51, 686
Pennsylvania	1, 202, 981	512, 482	674, 264	1, 140, 017	224, 746	1, 364, 763
Rhode Island	------	------	21, 606	7, 048	14, 558	21, 606
South Carolina	------	------	18, 709	8, 327	10, 382	18, 709
South Dakota	(2)	------	(2)	4, 527	1, 775	6, 302
Tennessee	100, 189	84, 556	26, 275	17, 204	24, 704	41, 908
Texas	281, 604	36, 625	31, 530	209, 604	66, 905	276, 509
Utah	(2)	(2)	(2)	66, 683	5, 934	72, 617
Vermont	(2)	(2)	(2)	334	2, 068	2, 402
Virginia	442, 845	375, 226	67, 344	82, 521	52, 442	134, 963
Washington	(2)	(2)	(2)	39, 311	12, 683	51, 994
West Virginia	(2)	(2)	(2)	283, 413	22, 584	305, 997
Wisconsin	107, 813	54, 728	78, 145	91, 676	39, 554	131, 230
Wyoming	------	------	2, 439	287	2, 152	2, 439
Undistributed [2]	1, 194, 122	614, 583	1, 929, 886	------	------	------
Total	8, 055, 609	4, 720, 876	4, 621, 411	6, 125, 498	1, 830, 646	7, 956, 144

[1] Includes 99,465 tons exported or unclassified as to destination.
[2] Figures that may not be shown separately are combined as "Undistributed" to avoid disclosure of individual company operations.

TABLE 11.—Apparent consumption of open-market lime in continental United States in 1952, by region of origin and destination, in short tons

Destination	Origin								
	Illinois, Indiana, Michigan, Ohio			Maryland, New Jersey, New York, Pennsylvania, West Virginia			Connecticut, Maine, Massachusetts, Vermont		
	Quicklime	Hydrated lime	Total	Quicklime	Hydrated lime	Total	Quicklime	Hydrated lime	Total
Illinois, Indiana, Michigan, Ohio	1, 347, 650	327, 038	1, 674, 688	92, 182	5, 627	97, 809	235	338	573
Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, West Virginia	570, 859	190, 730	761, 589	1, 111, 485	377, 360	1, 488, 845	62, 512	16, 962	79, 474
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	1, 845	35, 118	36, 963	60, 360	17, 854	78, 214	67, 626	61, 049	128, 675
Florida, Georgia, North Carolina, South Carolina, Virginia	11, 039	82, 665	93, 704	13, 719	7, 068	20, 787	5, 269	40	5, 309
Alabama, Kentucky, Louisiana, Mississippi, Tennessee	60, 727	39, 813	100, 540	161	152	313	------	------	------
Arkansas, Kansas, Nebraska, Oklahoma, Texas	15, 057	11, 822	26, 879	18	------	18	------	------	------
Iowa, Minnesota, Missouri, Wisconsin	51, 760	50, 346	102, 106	47	------	47	------	------	------
Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming	20, 010	5, 046	25, 056	------	1	1	------	------	------

TABLE 11.—Apparent consumption of open-market lime in continental United States in 1952, by region of origin and destination, in short tons—Continued

Destination	Origin—Continued								
	Florida, Georgia, Virginia			Alabama, Tennessee			Arkansas, Oklahoma, Texas		
	Quicklime	Hydrated lime	Total	Quicklime	Hydrated lime	Total	Quicklime	Hydrated lime	Total
Illinois, Indiana, Michigan, Ohio	56, 532	4, 996	61, 528	7, 831	2, 220	10, 051	1, 880	51	1, 931
Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, West Virginia	241, 082	21, 742	262, 824	5, 565	1, 045	6, 610	-	-	-
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	700	120	820	811	-	811	-	-	-
Florida, Georgia, North Carolina, South Carolina, Virginia	90, 655	57, 174	147, 829	103, 104	35, 465	138, 569	306	140	446
Alabama, Kentucky, Louisiana, Mississippi, Tennessee	4, 770	1, 415	6, 185	324, 700	30, 182	354, 882	47, 979	27, 938	75, 917
Arkansas, Kansas, Nebraska, Oklahoma, Texas	-	1, 871	1, 871	-	-	-	250, 331	74, 069	324, 400
Iowa, Minnesota, Missouri, Wisconsin	-	-	-	-	-	-	3, 875	178	4, 053
Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming	-	-	-	-	-	-	851	4, 727	5, 578

Destination	Origin—Continued								
	Iowa, Minnesota, Missouri, Wisconsin			Arizona, California, Colorado, Montana, Nevada, Oregon, South Dakota, Utah, Washington			Total		
	Quicklime	Hydrated lime	Total	Quicklime	Hydrated lime	Total	Quicklime	Hydrated lime	Total
Illinois, Indiana, Michigan, Ohio	334, 082	67, 827	401, 909	-	-	-	1, 840, 392	408, 097	2, 248, 489
Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, West Virginia	55, 219	10, 549	65, 768	-	7	7	2, 046, 722	618, 395	2, 665, 117
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	475	53	528	-	-	-	131, 817	114, 194	246, 011
Florida, Georgia, North Carolina, South Carolina, Virginia	4, 429	695	5, 124	-	-	-	228, 521	183, 247	411, 768
Alabama, Kentucky, Louisiana, Mississippi, Tennessee	215, 057	16, 642	231, 699	-	-	-	653, 394	116, 142	769, 536
Arkansas, Kansas, Nebraska, Oklahoma, Texas	68, 621	24, 495	93, 116	-	-	-	334, 027	112, 257	446, 284
Iowa, Minnesota, Missouri, Wisconsin	340, 566	95, 325	435, 891	-	-	-	396, 248	145, 849	542, 097
Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming	55, 811	20, 635	76, 446	417, 705	102, 056	519, 761	494, 377	132, 465	626, 842

For many years the figures for domestic shipments of lime to possessions and other areas administered by the United States have appeared in the Minerals Yearbook. Since July 1951 such figures have not been separately classified and therefore are no longer available. The latest published figures are those given in table 13 of the chapter on Lime from Minerals Yearbook, 1951.

PRICES

Prices of lime increased in 1952; the average selling price, f. o. b. plant, was $11.80 per short ton compared with $11.74 in 1951. The average selling price of quicklime in 1952 was $11.43 ($11.42 in 1951) and of hydrated lime $12.99 ($12.81 in 1951). The trend in prices over a period of years is shown in figure 3.

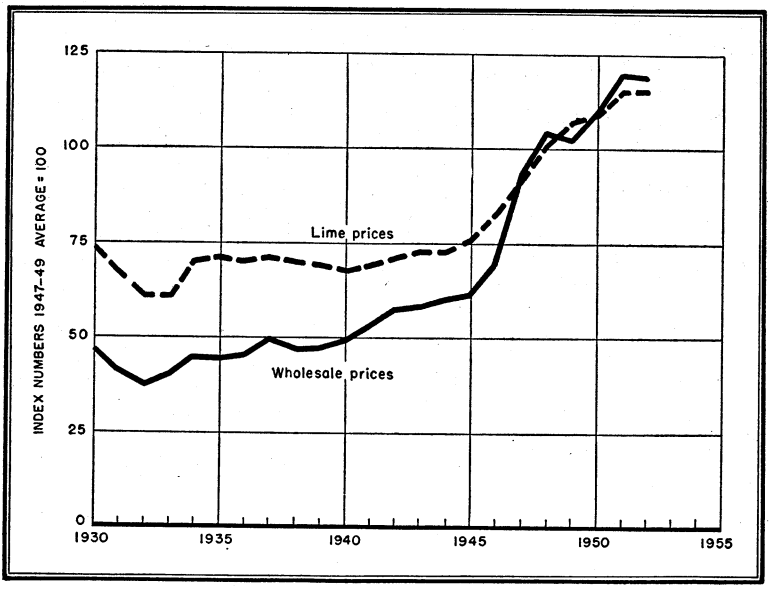

FIGURE 3.—Average price of lime per ton compared with wholesale prices of all commodities, 1930–52. Units are reduced to percentages of the 1947–49 average. Wholesale prices from U. S. Department of Labor.

FOREIGN TRADE[5]

Imports.—As indicated in tables 12 and 13, imports of lime into the United States are relatively small and in 1952 were much smaller than during other recent years. These imports originate chiefly in Canada to satisfy local needs in border areas, particularly in the Niagara district, and in the State of Washington.

[5] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 12.—Lime imported for consumption in the United States, 1948–52

[U. S. Department of Commerce]

Year	Hydrated lime		Other lime		Dead-burned dolomite [1]		Total	
	Short tons [2]	Value	Short tons [2]	Value	Short tons [2]	Value	Short tons [2]	Value
1948	2,861	$48,157	30,336	$401,473	2,427	$91,613	35,624	$541,243
1949	1,674	35,129	30,807	545,792	1,851	72,680	34,332	653,601
1950	1,253	23,910	30,904	524,132	2,127	86,425	34,284	634,467
1951	1,131	22,704	29,849	554,362	3,045	128,207	34,025	705,273
1952	109	2,940	21,557	377,926	2,342	123,596	24,008	504,462

[1] "Dead-burned basic refractory material consisting chiefly of magnesia and lime."
[2] Includes weight of immediate container.

TABLE 13.—Lime imported for consumption in the United States, 1950–52, by countries and customs districts [1]

[U. S. Department of Commerce]

Country of origin	Customs district of entry	1950		1951		1952	
		Short tons [2]	Value	Short tons [2]	Value	Short tons [2]	Value
Canada	Buffalo	7,847	$76,892	8,946	$89,530	5,857	$61,046
	Dakota					(3)	5
	Duluth and Superior	4	100				
	Maine and New Hampshire	85	688	1	32		
	Michigan	6	485	2	35		
	St. Lawrence					1	20
	Washington	24,214	469,852	22,031	487,469	15,762	318,481
Mexico	Arizona					44	600
United Kingdom	New Orleans					2	713
	New York					(3)	1
	Virginia	1	25				
Total		32,157	548,042	30,980	577,066	21,666	380,866

[1] Exclusive of dead-burned basic refractory material.
[2] Includes weight of immediate container.
[3] Less than 1 ton.

Exports.—Exports of lime are larger than imports; but, as indicated in tables 14 and 15, they are still relatively small. They are confined chiefly to points in Canada and to South and Central American countries.

TABLE 14.—Lime exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1948	63,088	$865,157	1951	63,295	$1,157,652
1949	59,927	937,444	1952	64,952	1,156,991
1950	50,491	825,927			

TABLE 15.—Lime exported from the United States, 1950–52, by country of destination

[U. S. Department of Commerce]

Country	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Bahamas	15	$360	10	$370	49	$1,505
Canada	18,725	260,195	16,757	248,072	23,771	322,562
Canal Zone	----------	----------	138	4,105	174	3,864
Chile	5	174	8	546	5	405
Colombia	3,643	81,082	4,022	85,902	5,430	107,876
Costa Rica	8,225	141,902	15,494	289,472	13,363	268,270
Cuba	20	641	72	2,241	8	170
Dominican Republic	624	11,654	649	12,539	124	2,389
El Salvador	75	2,999	100	4,456	106	4,051
Haiti	309	5,846	600	12,961	(1)	220
Honduras	8,367	136,554	14,317	251,822	9,738	176,338
Japan	50	2,705	25	1,307	57	3,720
Leeward and Windward Islands	----------	----------	----------	----------	50	2,083
Mexico	4,541	67,405	2,474	62,368	2,540	64,524
Netherlands Antilles	277	5,112	85	1,621	55	1,286
Nicaragua	231	4,489	281	5,715	350	7,374
Panama	3,859	67,697	6,545	125,776	6,792	138,715
Philippines	240	6,939	170	3,983	60	1,510
Saudi Arabia	90	2,612	119	1,782	1,352	25,767
Venezuela	1,104	22,437	1,310	35,619	843	18,581
Other countries	91	5,124	119	6,995	85	5,781
Total	50,491	825,927	63,295	1,157,652	64,952	1,156,991

[1] Less than 1 ton.

TECHNOLOGY

A new type of fuel for lime burning is now being used by the Rockwell Lime Co., Manitowoc, Wis. Wood, formerly used, involved excessive labor, and the supply became more and more uncertain. The costs involved in using coal, oil, or gas would be prohibitive in that area. Accordingly, the company decided upon propane, liquefied petroleum gas. It is delivered to two large tanks at the plant, and is vaporized before use. The change from wood to propane has reduced substantially both fuel and labor costs and has insured a constant and dependable fuel supply.[6]

The Fluosolids process of lime burning is used successfully by the New England Lime Co. at Adams, Mass. The equipment consists essentially of a Fluodry unit, which discharges sized and dried limestone to a second unit, the Fluosolids reactor, where calcination is accomplished. Fuel economy is one advantage claimed for this process. Approximately 5,000,000 B. t. u. is required to calcine 1 ton of recoverable lime, whereas the rotary kiln requires 7,000,000 to 8,000,000.[7]

It has been reported that selective calcination of dolomite may be accomplished by introducing steam into the calciner. The $MgCO_3$ was completely converted to MgO at a temperature range of 550° to 600° C., while the $CaCO_3$ was virtually unaffected. It is claimed that the steam serves as a catalyst. Not only does the introduction of steam permit selective calcination under controlled temperature, but the $CaCO_3$ may be calcined at a temperature well below the normal when steam is used to displace gas.[8]

[6] Atherton, C. R., Rockwell Lime Company Fires Masonry Kilns With Propane: Pit and Quarry, vol. 45, No. 6, December 1952, pp. 76–77.

[7] White, F. S., and Kinsella, E. L., Solids Fluidization Applied to Lime Burning: Min. Eng., vol. 4, No. 9, September 1952, pp. 903–906.

[8] Rock Products, Lime Men Talk Quality Control: Vol. 55, No. 11, November 1952, p. 82.

The Kaiser Aluminum & Chemical Corp. has introduced a heavy-medium separation process to purify the raw materials used in making lime at Natividad, Calif. The rock is put through a medium of controlled density, which floats the impure high-silica dolomite and allows the heavier, relatively pure dolomite to sink. The preferred medium is a mixture of finely ground magnetite and ferrosilicon which, because of its magnetic properties, is easily recovered for reuse. The loss of medium is said to be small. The process is so effective that sink material is being held to less than 1 percent silica, whereas the floats contain 22.7 to 40 percent. Stone that was formerly unusable is now used with a loss of only 8 to 10 percent of the feed. As a result, the life of the quarry has been extended. The cost involved is said to be less than 50 cents a ton.[9]

The use of lime in stabilizing road soils is attaining increasing importance. Tests at Purdue University indicated that addition of 2 percent of lime had little or no effect upon soil performance, but additions of 5 percent or more significantly increased both strength and durability of the soils. A new departure in testing methods was employment of the soniscope to measure progressive deterioration of the soils. Resonant-frequency tests are commonly conducted with this equipment to measure the deterioration of concrete specimens undergoing freezing and thawing, but it has not been used heretofore in testing road soils.[10]

Flash drying of calcium carbonate sludge before calcining in a rotary kiln has decided advantages, according to recent tests. The Chesapeake Corp. of Virginia at West Point, Va., uses this process in a kraft pulp mill where lime carbonate accumulations are calcined into lime for reuse. Flash drying is the almost instantaneous removal of moisture by intimate contact of the wet material with a turbulent stream of hot air. Maximum agitation is accomplished with a cage mill equipped with a special rotor enclosed in a housing. Before flash drying was used, the vacuum filter cake sent to the kilns contained 40 to 45 percent moisture; in the flash-dried product the water content has been reduced to about 1 percent. Ordinarily the rotary kiln is a combined drier and calciner, but with the use of flash-drying equipment the entire kiln is devoted to calcining; thus its capacity is greatly increased.[11]

In November 1952 the Bureau of Mines issued a report covering the major technical and economic aspects of the lime industry.[12]

Thermodynamics of lime manufacture has been discussed in some detail by Ralph Gibbs in a series of articles that began in 1950. Two numbers of the series appeared during 1952.[13]

Part V of the series applies the principles developed in the earlier parts to the problem of determining the most economical length of a rotary kiln of a given diameter. Part VI outlines the calculations that should be made to determine the proper diameter and length of a rotary kiln to produce a given output of lime.

[9] Rock Products, Lime Men Talk Quality Control: Vol. 55, No. 11, November 1952, pp. 82–84.

[10] Whitehurst, E. A., and Yoder, E. J., Durability Tests on Lime-Stabilized Soils: Preprint from Proc., 31st Ann. Meeting, Highway Research Board, January 1952.

[11] Chemical Engineering, Flash Drying Aids a Rotary Kiln: Vol. 59, No. 5, May 1952, pp. 266–268.

[12] Bowles, Oliver, The Lime Industry: Bureau of Mines Inf. Circ. 7651, 1952, 43 pp.

[13] Gibbs, Ralph, Thermodynamics of Lime Manufacture; Part V, Factors to be Considered in Design of Lime Kilns for Best Overall Economy: Rock Products, vol. 55, No. 5, May 1952, pp. 92–94; Part VI, Balancing Economic Factors in the Determination of Optimum Size of Rotary Kilns; No. 6, June 1953, pp. 119–123.

Lithium

By Joseph C. Arundale[1] and Flora B. Mentch[2]

THE WIDE use and rapidly growing demand for lithium in its many forms is an outstanding example of successful research and market development. In the lithium industry the year 1952 was characterized by a shortage of lithium minerals and compounds and an expansion of facilities for mining and processing lithium minerals and manufacturing lithium compounds in anticipation of a further increase in requirements. The many important industrial applications for lithium in its various forms have focused considerable attention and interest on this element.

DOMESTIC PRODUCTION

Shipments of 15,611 short tons of lithium minerals with an estimated lithia content of 1,088 short tons was the largest quantity ever shipped from mines in the United States in a single year.

TABLE 1.—Shipments of lithium ores and compounds from mines in the United States, 1943–47 (average) and 1948–52

Year	Ore (short tons)	Value	Li_2O (short tons)	Year	Ore (short tons)	Value	Li_2O (short tons)
1943–47 (average)	5,885	$321,632	421	1950	9,306	$579,922	747
1948	3,881	210,792	291	1951	12,897	[1] 896,000	956
1949	4,838	345,970	475	1952	15,611	[1] 1,052,000	1,088

[1] Partly estimated.

During the early part of 1952 the Defense Production Administration conducted a survey of anticipated requirements for lithium compounds and on June 5 announced a goal of the equivalent of 10,000,000 pounds of lithium carbonate production capacity by January 1, 1955. This goal is an expansion of 6,185,000 pounds over estimated capacity January 1, 1951. Approximately 1,175,000 pounds of the 1951 capacity was based on the utilization of raw material no longer available to some of the processors. Therefore, it was considered necessary to construct an estimated 7,360,000 pounds of new capacity.[3] Some new capacity was added during 1952, and certificates of necessity were issued for additional facilities. The current expansion rate indicates that this objective probably will be reached. Such a tonnage of lithium compounds would require as raw material the equivalent of nearly 50,000 short tons of spodumene averaging 5 percent contained lithia.

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.
[3] Defense Production Administration, press release, DPA-357, June 5, 1952.

Foote Mineral Co. began construction of a lithium chemical plant at Sunbright, Va., which was expected to be completed in 1953. This firm had its first full year of production at its open-pit operation near Kings Mountain, N. C. Spodumene from this mine will be processed into a line of lithium compounds in the new chemical plant.

Early in the year Lithium Corp. of America completed a new flotation mill near Hill City, S. Dak., and began beneficiating spodumene ore from the Mateen deposit. Future plans reportedly call for treatment of ore from the Beecher and possibly other deposits in the area. The Edison mine and the nearby sink-float mill formerly operated by this firm were abandoned. Metalloy Corp., a wholly owned subsidiary of Lithium Corp. of America, expanded its facilities for lithium chemical manufacture at St. Louis Park near Minneapolis, Minn.

Maywood Chemical Works continued to operate the Etta mine in the Black Hills and was attempting to augment the supply of spodumene for its chemical plant at Maywood, N. J.

Black Hills Tin Mining Co. rehabilitated its flotation mill in the Black Hills and began producing spodumene concentrates for shipment to Maywood Chemical Works. The Holy Terror Gold Mining Co. in the Black Hills was rehabilitating its mill for the production of spodumene concentrates.

American Potash & Chemical Corp. endeavored to increase the recovery of dilithium sodium phosphate from Searles Lake, Calif. Early in 1952 this firm was ready to convert this raw material into lithium carbonate but at the request of the National Production Authority continued for several months to ship dilithium sodium phosphate to processors whose capacity otherwise would have been idle. Later in 1952 this firm began converting the bulk of its raw material to lithium carbonate.

Others reporting production of lithium minerals in 1952 were Black Hills Keystone Corp. in the Black Hills and Vulture & Berry near Aguilla, Ariz.

There were numerous reports of other firms and individuals investigating the lithium field and some indication that new producers might engage in this business.

CONSUMPTION AND USES

Producers of lithium minerals and compounds could not meet all demands for these products, but an attempt was made to insure that the available supply was used to satisfy the most urgent requirements.

The two largest uses for lithium compounds—ceramics and greases—are increasing rapidly. It has been estimated that approximately 15 percent of the grease manufactured contains lithium. This application presents a large and growing market. Another large field for expansion in consumption of both lithium minerals and compounds is in the manufacture of ceramics such as glass, sanitary ware, whiteware, glazes, and porcelain enamels.

Another important use for lithium compounds is in Edison nickel-iron alkaline storage cells. These cells are used in batteries for electric industrial trucks, mine locomotives, and portable lighting equipment and in standby or emergency power-supply systems.

In the cells that make up these batteries the electrolyte is an aqueous solution of potassium and lithium hydroxides. The lithium hydroxide is added as a catalytic agent and to increase the capacity and life of the cell.

Conventional zinc or ammonium chloride electrolyte dry cells become very inefficient as the temperature drops and become completely inactive at about —20° F. Lithium chloride or bromide in the electrolyte lowers the temperature at which these cells are still active. At —40° F. lithium chloride electrolyte dry cells still can deliver about 10 percent of capacity at 70° F.

Lithium chloride is one of the most hygroscopic of all inorganic compounds and because of this property is utilized in air conditioning and industrial drying. Increased use of lithium compounds for this purpose is expected.

Lithium fluoride and chloride are used as oxide scavengers and metal cleaners in welding or brazing aluminum and magnesium; the potential requirements for this purpose is large.

Lithium compounds are also used in preparing dense, oxygen-free, high-conductivity copper; organic synthesis, heat-treating metal, iron castings, powder metallurgy, cosmetics, medicinals, rutile-structure titania pigments; these uses, however, constitute only a small percentage of total consumption.

In addition, there are several other direct military uses for various lithium products.

An article reviewing recent developments in the lithium industry and the outlook for the industry has been published. An interesting estimated end-use pattern was given as follows: [4]

End use	Thousands of pounds, in terms of carbonate		End use	Thousands of pounds, in terms of carbonate	
	1951	1955 (est.)		1951	1955 (est.)
Pharmaceuticals	33	30	Aluminum welding and grazing	287	1,100
Alkaline storage batteries	393	610	Ceramics	779	1,600
Air conditioning and refrigeration	320	1,100	Defense and miscellaneous	393	760
Lubricating grease	816	3,300	Total	3,021	8,500

The Petroleum Administration for Defense made public the results of a survey covering the requirements of the grease industry for lithium compounds. The survey, based on data obtained from grease manufacturers, includes actual consumption figures for lithium compounds in 1951 and estimated requirements for 1952 and 1953, as well as actual and estimated production of lithium greases and end uses. The results of this survey follow:

Lithium hydroxide monohydrate required for manufacture of lithium greases, lbs. per year:

1951 actual	831,063
1952 estimate	1,676,717
1953 forecast	2,326,818

[4] Chemical Week, Lithium in U. S.: Vol. 71, No. 19, Nov. 8, 1952.

Production of lithium greases, lb. per year:

	Multipurpose	*Other*	*Total*
1951 actual	51, 543, 072	2, 580, 660	54, 123, 732
1952 estimate	98, 002, 788	4, 438, 272	102, 441, 060
1953 forecast	129, 635, 040	5, 711, 700	135, 346, 740

Pounds of lithium grease produced per pound of lithium hydroxide monohydrate consumed:

Average for 1951 65

Percentage breakdown by end use of greases made with lithium hydroxide:

	1951	*1952*
Industry	36. 0	26. 5
Agriculture and over-the-road transport	25. 0	22. 2
Service stations, passenger cars, and other uses (including military)	39. 0	51. 3

PRICES

Prices for lithium minerals are no longer quoted in the trade journals. The actual selling price of crude lithium minerals is generally determined by direct negotiation between buyer and seller. Spodumene flotation concentrates were sold to manufacturers of lithium compounds during the year at $10 to $12.50 per short-ton unit (20 pounds) of contained lithia (Li_2O). The price of dilithium sodium phosphate was reported to be about $183 per short ton. However, during the latter part of the year most of this material was being converted to lithium carbonate by the producer, and little was sold on the open market.

Southern Rhodesia Geological Survey, Mineral Resources, Series 7, Lithium Minerals, 1952, reports the price of lepidolite, containing 3.5 percent Li_2O, f. o. b., as £6 to £8 per long ton. In the same report amblygonite is quoted at £33 to £34 per long ton, c. i. f., minimum 8 percent Li_2O, in bags. Ocean freight on lithium minerals from Southern Africa to Eastern United States ports is about $20 per long ton.

According to E&MJ Metal and Mineral Markets, lithium metal, 98 percent pure, was quoted throughout the year at $9.85 to $11 a pound, depending on quantity.

Despite the financial inflation, prices of most lithium compounds are approximately the same as they were 20 years ago, owing to expanding volume and improved technology.

Oil, Paint and Drug Reporter quoted the following prices of lithium compounds: Lithium benzoate, drums, $1.65–$1.67 a pound; lithium carbonate, N. F., barrels, bags, $1.05–$1.15 a pound to September 15, $1.15–$1.35 from September 15 to October, $0.80–$1.10 in October to end of year; lithium chloride, crystal, drums, $0.95–$1.25 a pound throughout the year; lithium citrate, N. F., barrels, drums, kegs, $1.05–$1.40 a pound throughout the year; lithium fluoride, barrels, pound, $1.80–$2 to September 15, $1.85–$2 September 15 to the end of the year; lithium hydride, drums, works, $10.25–$14 a pound to February 4, $14–$26 from February 4, to October 6, $12–$14 from October 6 to end of year; lithium hydroxide monohydrate, drums, $0.80–$1.25 a pound to September 8, $0.97–$1 from September 8 to 28, $0.91–$1.05 from September 28 to end of year; lithium salicylate, drums, $1.60–$1.70 a pound throughout the year.

STOCKS

All the major producers reported a shortage of lithium minerals for conversion to compounds. Current production was being utilized immediately, and consumers were eager to obtain additional supplies. Stocks were at a very low level.

FOREIGN TRADE

Lithium minerals and compounds are not separately classified in import or export schedules, and therefore no official figures are available.

Virtually all imports of lithium are in the crude minerals lepidolite, petalite, and amblygonite originating in South-West Africa, Southern Rhodesia, and Mozambique.

At present only small quantities of special lithium fluxes or prepared lithium minerals and occasionally small quantities of lithium minerals and compounds are being exported. However, a much larger export market for lithium compounds may develop when domestic capacity is adequate.

Reports show that the most significant foreign trade, exclusive of the United States, constituted small shipments from Africa of amblygonite to United Kingdom and Germany and of lepidolite and spodumene to France.

There were reports of small shipments of spodumene from Geomines in the Belgian Congo to Belgium during 1951.[5] This material may have been used for experimental or testing work.

TECHNOLOGY

Lithium minerals are recovered from their ores by froth flotation and by hand picking. Both processes are relatively inefficient. An 80-percent recovery probably is the best that is accomplished in actual practice. Because of the many uses for lithium already developed and expanding requirements anticipated, emphasis in research is being placed on new and improved processes. The Bureau of Mines has done considerable work on the beneficiation of pegmatite ores and the recovery of lithium minerals and extraction of lithium compounds. During 1952 the Bureau initiated a project with the objective of separating and recovering spodumene and beryl from the pegmatite ore in the Kings Mountain district of North Carolina.

The tailing from the boron-mineral operation in the Kramer district at Boron, Calif., is a clay containing a fraction of 1 percent of lithia. The mineral has not been identified, but the Bureau undertook some experiments to determine whether the lithium could be extracted. These experiments have not been concluded.

Amblygonite occurs in the United States, but the size and erratic nature of the deposits give no assurance of a supply adequate to the needs of a plant processing this material alone. Spodumene and amblygonite frequently occur in the same pegmatite, and preliminary investigations indicate that both can be recovered simultaneously by flotation. The Bureau of Mines made an investigation to determine whether or not a commercial form of lithium could be extracted from

[5] Bureau of Mines, Mineral Trade Notes: Vol. 33, No. 4, October 1951, p. 35.

these minerals and their mixtures without controlling the composition of the material being treated. A publication issued during the year gave the results of the tests and described a new process for recovering lithium sulfate. On a laboratory scale amblygonite, spodumene, and several mixtures of these minerals were roasted with various proportions of lime and gypsum at several temperatures. The sinters were ground and leached with water to recover the portion of lithium converted into the sulfate. It was found that at a temperature of 1,050° C. optimum conditions over the whole range of composition of spodumene-amblygonite mixtures are approximately 1 part of mineral to 1 part of gypsum and 2 parts of lime.[6]

An article was published dealing with the use of the electron microscope in the study of lubricating greases. At the present time only with this instrument can details of the soap-fiber structure be obtained. The electron microscope enables researchers to examine the effects of process variables, testing procedures, and mechanical work on fiber structure. Greases are colloidal systems of solid-soap fibers and liquid oil. The gel structure of these systems largely determines the physical characteristics of the greases.

Use of the electron microscope as a tool in grease research has revealed the following interesting information about lithium greases:

1. Well-defined fibers of greases will be oriented in the bulk grease in a moving system.
2. Formation of long fibers in certain lithium greases when heated to the transition temperature is accompanied by pronounced gelling.
3. Fiber structure of lithium greases varies widely depending on the composition of the grease. There appears to be some correlation between fiber structure as revealed by the electron microscope and physical performance properties.
4. Certain lithium greases with well-defined fiber structures have very good mechanical stability.[7]

One steel company's tests and experience with multipurpose grease of the lithium-base type was summarized.[8] This grease is used in 3,000 of the 7,000 lubrication points in the mill and has reduced the number of greases stocked from 17 to 10 brands and types. Its use under the hazards of heat, speed, shock load, and water has effected savings in grease consumption and has reduced downtime, bearing cost, purchasing, and interruptions in production.

A series of lithium aluminosilicate [9] ceramics are produced from blends of lithium-bearing minerals and clay or other materials. It is claimed that these materials have a coefficient of thermal expansion that can be controlled by formulation of the ceramic and that they have excellent resistance to thermal shock.

A report describing a series of experiments on degassing copper and nickel alloys with lithium was published. In these experiments the lithium in sealed copper tubes was added to the pouring ladle or

---

[6] Kalenowski, L. H., and Runke, S. M., Recovery of Lithium From Spodumene-Amblygonite Mixtures: Bureau of Mines Rept. of Investigations 4863, 1952, 5 pp.

[7] Brown, John A., Hudson, Charles N., and Loring, Lewis D., Electron-Microscope Study of Lithium Greases: Petrol. Eng., vol. 24, No. 2, February 1952, pp. C31–C36.

[8] Binz, A. D., Better Lubrication Boosts Production: Steel, vol. 132, No. 4, Jan. 26, 1953, pp. 88, 90, 92.

[9] Stark, R. E., and Dilks, B. H., Jr., New Lithium Ceramics Have High Thermal Shock Resistance, Controlled Thermal Expansion, and Chemical Resistance at High Temperatures: Materials and Methods vol. 35, No. 1, January 1952, pp. 98–99.

crucible after the melt had been deoxidized with magnesium. The alloys treated were Monel, nickel-bronze, leaded bronze, and nickel-silver. It was found that an average addition of about 0.005 percent lithium efficiently degassed these alloys and resulted in castings that polished more easily and had improved surface finish.[10]

Several patents were granted during the year on products and processes involving lithium. One describes a method of producing lithium hydride.[11] The method involves mixing a lithium halide with a reducing agent, such as magnesium, calcium, barium and the hydrides of calcium and barium; heating the mixture in an atmosphere of hydrogen above the melting temperature of the lithium halide but below the dissociation temperature of lithium hydride in hydrogen to form a molten mass containing the reducing agent; and exposing the molten mass in the form of a thin film to the action of hydrogen to convert the lithium halide to lithium hydride.

Another patent describes a process for producing lithium sulfate from lithium phosphates.[12] In this process lithium phosphates, lithium-sodium phosphates, or mixtures of these are reacted with sulfuric acid in the presence of water. This solution is partly evaporated, thereby crystallizing lithium sulfate and forming a phosphoric acid solution.

A patent was issued on a low-temperature vitreous-enamel frit containing 5 to 15 mol percent lithia.[13]

As one phase of the research being conducted on heat-transfer agents and possible containers, the Babcock & Wilcox Co. made a study of liquid lithium systems.[14] In this study liquid lithium was circulated at temperatures of about 960°, 1,400°, 1,500°, and 1,600° F. and velocities up to 55 feet per second. The container was 25 Cr–20 Ni stainless alloy. Testing time varied with the temperature of operation, ranging from approximately 369 and 564 hours for the 2 highest temperatures to 1,000 hours for the 3 lowest temperatures. Metal transport was of such severity that plugging with metal crystals terminated the runs at 1,600° F. before the desired 1,000 hours' duration was obtained.

In a similar study by other researchers commercial soft-steel tubes containing lithium were heated at various temperatures up to 1,100° C.[15] Permeability was obvious, even at temperatures below 700° C., by spectrographic analysis of the exterior of the tube. However, tubes previously annealed in hydrogen at 900° C. for a number of hours showed no permeability even at 1,100° C., and steel quenched from 1,100° C. in cold mercury did not exhibit permeability even at 900° C.

---

[10] Metal Industry (London), Degassing With Lithium: Vol. 80, No. 10, Mar. 7, 1952, pp. 191–192.
[11] Alexander, Peter P. (assigned to Metal Hydrides, Inc.), Production of Lithium Hydride: U. S. Patent 2,606,100, Aug. 5, 1952.
[12] May, Frank Henderson (assigned to American Potash & Chemical Corp.), Process of Producing Lithium Sulfate From Lithium Phosphates: U. S. Patent 2,608,465, Aug. 26, 1952.
[13] Donahey, John W. (assigned to Foote Mineral Co.), Low-Temperature Vitreous Enamel: U. S. Patent 2,608,490, Aug. 26, 1952.
[14] Dana, A. W., Jr., Baker, O. H., and Ferguson, M., Erosion and Corrosion Studies of Liquid-Metal Systems. Investigation of Constant Temperature, Forced Circulation, Liquid Lithium Systems: Babcock & Wilcox Co. Tech. Rept. III, Aug. 21, 1952, 73 pp.
[15] Hérold, Albert, Miller, Pierre, and Albrecht, Pierre [Permeability of Steel to Lithium]: Compt. rend., vol. 235, Sept. 29, 1952, pp. 658–659; Nuclear Science Abs., Abs. 169, vol. 7, No. 1, Jan. 15, 1953, p. 23.

A patent was granted for a luminescent material consisting essentially of manganese-activated zinc-lithium silicate, the manganese activator being approximately 2 to 5 percent by weight of the material.[16]

Experiments on the production of pure lithium by distillation in a glass system were carried on at Knolls Atomic Power Laboratory, Schenectady, N. Y., operated by General Electric Co. for the Atomic Energy Commission.[17] In these experiments lithium metal was placed in a stainless-steel cup fitted with a baffled chimney to prevent spattering of the molten metal. The distillation was carried out in a Pyrex glass tube, using an electronic heater (induction heating). It was found that the walls of the tube above the metal crucible must be kept relatively cool to prevent rapid reaction between the glass and the volatile metal deposited there. A delicate heat balance and careful design of the system are therefore required.

RESERVES

Several lithium minerals are or have been commercially important. They are: Spodumene, lepidolite, amblygonite, petalite, zinnwaldite, triphylite-lithiophilite, and the compound dilithium sodium phosphate. With the exception of zinnwaldite and dilithium sodium phosphate, all of these are recovered only from pegmatites or veins closely related to pegmatites.

Because of its larger reserves, spodumene probably is the most important source of lithium. Measured reserves of spodumene are relatively small when compared with projected demand, but the numerous domestic deposits have not been thoroughly explored. The consensus is that domestic reserves will prove to be adequate to domestic needs for many years.

WORLD REVIEW

Although the United States is the largest producer and consumer of lithium in its various forms, lithium minerals also are produced or consumed in several other countries.

Canada.—Important lithium-bearing pegmatites occur in Quebec and Manitoba. Northern Chemicals, Ltd., has done some development work on a deposit near Cat Lake, 90 miles northeast of Winnipeg, Manitoba, but no current commercial production has been reported. A small camp was built a few years ago and a road to the property was partly completed by the Province, but future plans for the deposit appear to be uncertain. Developments relating to this project in the past several years were reviewed in a recent article.[18]

Southern Rhodesia.—Amblygonite, lepidolite, petalite, and spodumene occur in Southern Rhodesia. Probably the largest concentration is in the Bikita tin field, particularly the southern part in a large pegmatite about 2,000 yards long and 900 feet (average) wide. So far, only amblygonite and lepidolite have been sold, chiefly as a byproduct of the exploitation of the alluvial beryl deposits contained in

16 McKeag, Alfred H. (assigned to General Electric Co.), Manganese-Activated Zinc-Lithium Silicate Phosphor: U. S. Patent 2,615,850, Oct. 28, 1952.
17 Epstein, Leo F., and Howland, W. H., The Distillation of Lithium Metal: Science, vol. 114, No. 2965, Oct. 26, 1951, pp. 443–444.
18 The Precambrian Lithium in Manitoba. What About It?: Vol. 26, No. 1, January 1953, pp. 17, 39.

the same mass. Lepidolite also has been produced from an old quarry known as the Bikita quarry originally worked for tin. The faces and floor of this quarry are formed almost entirely of a pale, lilac-colored, fine-grained lepidolite mixed with a little quartz. The mineral occurs in small quantities throughout the tin field and forms a conspicuous capping of a small hill 2,800 yards north of the Bikita quarry known as the Mauve Kop because of the unusually deep mauve color of the lepidolite. Several small masses of amblygonite have been found on the Bikita claims in the vicinity of the Bikita quarry.

A large mass of petalite occurs north of the Bikita quarry on the Al Hayat claims, measuring about 500 yards long and 100 to 200 feet wide, as well as small masses elsewhere. In the Salisbury district lepidolite has been located at the Augustus claims on Willesdon farm, about 14 miles northeast of Salisbury. Here lepidolite associated with beryl and spodumene occurs in a large greisenized pegmatite and forms irregular masses over a strike of 350 feet. The lithia contents in 3 analyses reportedly were 3.07, 3.48, and 3.80 percent.

A long strike of lepidolite is indicated at the Hotspur claims on Glenforest farm.

East of Salisbury, in the Enterprise mineral belt, small occurrences of lepidolite have been located ½ mile northeast of the Ceylon mines in a narrow greisen dike and near the northern boundary of the Alderley farm, west of the Mabfeni River.

Coarsely crystallized lepidolite occurs in some abundance at the Pope claims on the western boundary of the Chishawasha farm, about 12 miles east of Salisbury, in a large greisenized pegmatite containing tantalite, microlite, beryl, and topaz. Spodumene and petalite are reported a mile north of the Pope claims on the Partronage tin and tantalum claims. Lepidolite and zinnwaldite are reported to occur in some of the greisenized pegmatites. In the Odzi gold belt of the Untali district at the Grand Dyke claims, 4½ miles east-southeast of Odzi Siding. In this same belt, 24 miles east-southeast of Odzi, lepidolite also occurs with tourmaline and fluorspar. In the Mtoko districts, 20 miles north of Mtoko, pegmatites have been opened up at the Matake and Benson claims for the production of beryl. These bodies contain a little lepidolite, and some contain spodumene and amblygonite associated with tantalite and probably tinstone.

Dikes of lepidolite-bearing greisen occur in the Insiza district over a strike of approximately a mile in the western part of Huntley's farm, 3 miles east of Filabusi Post Office. These also contain a little beryl and molybdenite. This deposit is shown on the geological map attached to Southern Rhodesia Geological Survey Bulletin 27. Lepidolite also is reported on the Embizene claims on Forfar farm, about 35 miles south of Gwelo. In the Matobo district lepidolite has been reported about 300 yards east-northeast of the Antelope mine (Southern Rhodesia Geological Survey Bull. 21, p. 111) in a greisen dike about 300 yards long and 10 to 15 feet wide. The mineral is a very pure mass, the chief impurity being topaz in tiny crystals.

It is also reported from the Leopard claims on Ntabazamanyoni Hill, about 3 miles north of the Antelope mine.

In the Mazoe district on Ruia Falls estate, about 32 miles northeast of Bindura Township, greisenized pegmatites have been opened in a search for beryl, but lepidolite and spodumene were found to be more abundant than the beryl. Small quantities of lepidolite also occur in the vicinity of Shamva on Tafuna Hill and near Bindura. Isolated occurrences are reported elsewhere in Southern Rhodesia, as for example, the north Inyanga district and a locality 6 miles north of Gadzonna in the Hartley district.[19]

According to the Chamber of Mines, production of lithium minerals in 1952 was as follows: Amblygonite, 90 short tons; lepidolite, 1,233 short tons; petalite, 112 short tons; spodumene, 45 short tons.

South-West Africa.—The Quarterly Information Circular of the Union of South Africa reports production of lithium minerals in Southwest Africa in short tons, 1950–52, as follows:

	1950	*1951*	*1952*
Amblygonite	292	578	714
Lepidolite	9, 318	11, 090	7, 914
Petalite	180	174	1, 174

Mozambique.—Production of lepidolite in Mozambique in 1950 was reported to have been 244 short tons and in 1951 was 307 short tons. Figures for 1952 are not yet available.

Other Countries.—Small tonnages of various lithium minerals have been reported in several countries, including Argentina, Spain, Portugal, Sweden, Uganda, Union of South Africa, Finland, British East Africa, and Brazil.

[19] Southern Rhodesia, Geological Survey, Mineral Resources. Lithium Minerals: Salisbury, ser. 7, Sept. 8, 1952.

Magnesium

By H. B. Comstock[1]

TECHNICAL advances in magnesium fabrication in 1952 paved the way for increased uses and applications of this lightest of structural metals. The rolling of magnesium sheet at two new rolling mills introduced continuous coil rolling under tension. These new mills were capable of producing wider sheet, with closer thickness tolerance and a better finish, as rolled than was previously possible. The new rolling techniques resulted in a new low base price for hot-rolled magnesium plate and brought it to the same price per square foot as aluminum plate of the same gage. A heavy press program initiated by the Air Force provided for the construction of larger extrusion and forge presses than any previously in use. Although these presses were designed primarily for the forming of magnesium and aluminum alloys for use in aircraft construction, equipment capable of producing massive extrusions and forgings would logically lead to civilian applications for the type of shapes such presses are capable of producing.

The 160-percent increase in domestic production over 1951 was primarily a result of the operation of six Government-owned magnesium plants throughout 1952; the Dow Chemical Co., only private magnesium producer in the United States, also increased primary magnesium output during 1952 through expanded operations at its Freeport, Tex., plant. Despite the accelerated production rate during 1951 and 1952, it was not until March 1952 that supply and demand for primary magnesium under the rearmament program came into balance and all civilian orders from producers could be filled.

TABLE 1.—Salient statistics of the magnesium metal industry in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Production:						
Primary magnesium [1] ....short tons..	78,227	10,003	11,598	15,726	40,881	105,821
Secondary magnesium [1] ....do....	9,891	7,553	5,962	9,476	11,526	11,477
Average quoted price per pound, primary [2]..cents..	20.5	20.5	20.5	22.0	24.5	24.5
Actual domestic consumption........short tons..	[3] 48,357	9,698	11,947	18,051	35,710	43,847
Exports [4] ....do....	11,557	444	708	908	761	1,163
World production........do....	122,000	34,000	39,000	45,000	[5] 89,000	167,000

[1] Ingot equivalent.
[2] Magnesium ingots (99.8 percent) in carlots. Before Dec. 1, 1947, in New York. Subsequently, f. o. b. Freeport, Tex. (Source: Metal Statistics, 1953).
[3] 1944–47 average.
[4] Primary magnesium and alloys.
[5] Revised figure.

[1] Commodity-industry analyst.

TABLE 2.—Production of primary magnesium in the United States, 1948–52, by months, in short tons

Month	1948	1949	1950	1951	1952
January	883	988	1,002	1,876	7,425
February	830	884	913	1,709	7,794
March	887	988	948	1,885	8,893
April	801	958	957	2,043	8,800
May	797	987	972	2,194	9,093
June	766	950	1,175	2,512	8,670
July	792	985	1,332	2,998	9,529
August	809	970	1,400	3,418	9,771
September	819	974	1,635	4,166	8,422
October	873	941	1,690	5,147	8,990
November	814	969	1,760	6,010	9,122
December	932	1,004	1,942	6,923	9,312
Total	10,003	11,598	15,726	40,881	105,821

PRODUCTION

Production of primary magnesium in 1952 rose to 105,800 tons, which was 2½ times the production in 1951. Output from the Dow Chemical Co. plant at Freeport, Tex., was 24 percent of 1952 production. This plant had been the sole producer of primary magnesium during the period 1946–50. The remaining 76 percent of the output of primary magnesium in 1952 was produced in 6 of the 7 Government-owned magnesium plants, which had been reactivated in 1951. The seventh, a silicothermic plant at Luckey, Ohio, was not reactivated. Beryllium was produced at that location in 1952.

By the end of 1952, the 6 operating Government-owned plants had produced 43 percent of the maximum quantity of primary magnesium ingot provided for under the defense production contracts executed for their reactivation. Four of the plants (at Velasco, Tex.; Painesville, Ohio; Canaan, Conn.; and Manteca, Calif.) had reported production of 50 percent or more of the quantity of magnesium required under their contracts. The electric power shortage in the Northwest forced shutdown of three-fourths of the Spokane, Wash., plant furnaces on August 31, 1952, and this silicothermic plant was held to one-fourth production capacity for the remainder of 1952. The annual capacity of the Spokane plant was rerated August 1, 1952, by General Services Administration, from 24,000 tons to 20,000 tons.

The rated annual capacity of the Freeport, Tex., electrolytic plant of the Dow Chemical Co. was increased by added facilities in 1952 from 23,000 tons to 26,000.

Table 3 shows the date on which each of the six reactivated plants started production and the percentage of rated annual capacity obtained from each plant during 1952.

Secondary.—Magnesium scrap has a particularly high reclamation value. Each time the metal is melted the grain size is progressively reduced, making it easier to anneal and roll than primary magnesium alloy. Total recovery of secondary magnesium, including its use as an alloying ingredient and as secondary magnesium incorporated in primary ingot, was 11,477 short tons in 1952 compared with 11,526 short tons in 1951. Of this quantity, 9,048 tons was recovered from 10,005 tons of magnesium-base scrap. The remaining 2,429 tons was recovered from aluminum scrap. Old scrap constituted about 70 percent of the scrap consumed. Of the 1952 recovery, 6,411 tons was in ingot form, 716 tons in castings, 1 ton in magnesium alloy shapes, 3,022 tons in aluminum-base alloys, 40 tons in zinc and other alloys, 1,273 tons in anodes and strip for cathodic protection, and 14 tons in chemicals and other nonrecoverable forms.

More magnesium scrap was consumed in 1952 than was received, as shown in table 5, Stocks of magnesium scrap at the end of 1952 were 384 tons lower than at the beginning of the year.

TABLE 3.—Production of magnesium in reactivated Government-owned magnesium plants during 1952

	Date production started	Rated annual capacity (tons)	Production (tons)	Percent of capacity production
Electrolytic process:				
Velasco, Texas	Apr. 16, 1951	36,000	38,028	106
Painesville, Ohio	July 27, 1951	18,000	18,214	102
Silicothermic process:				
Canaan, Conn.[1]	Mar. 27, 1951	5,000	4,063	82
Manteca, Calif.	June 8, 1951	10,000	9,178	92
Spokane, Wash.[2]	Aug. 15, 1951	[3] 24,000	8,592	38
Wingdale, N. Y.[1]	Nov. 15, 1951	5,000	2,814	56
Total		98,000	80,889	83

[1] These plants had not attained rated capacity by the close of 1952.
[2] Shutdown to one-fourth capacity on Aug. 31, 1952, due to electric power shortage in the Northwest. General Services Administration decreased rated capacity to 20,000 tons on August 1.
[3] During 1952 rated annual capacity reduced to 20,000 tons.

TABLE 4.—Magnesium recovered from scrap processed in the United States, 1951–52, in short tons

Recoverable magnesium-alloy content of scrap processed			Magnesium recovered [1] from scrap processed		
Kind of scrap	1951	1952	Form of recovery	1951	1952
New scrap:			Magnesium-alloy ingot [2] (gross weight).	5,662	6,411
Magnesium-base	3,727	2,529	Magnesium-alloy castings (gross weight).	1,675	716
Aluminum-base	1,639	1,711	Magnesium-alloy shapes	25	1
Total	5,366	4,240	In aluminum alloys	3,393	3,022
Old scrap:			In zinc and other alloys	55	40
Magnesium-base	5,366	6,519	Chemical and other dissipative uses.	101	14
Aluminum-base	794	718	Cathodic protection	615	1,273
Total	6,160	7,237	Grand total	11,526	11,477
Grand total	11,526	11,477			

[1] Includes alloying elements.
[2] Figures include secondary magnesium incorporated in primary magnesium ingot.

CONSUMPTION AND USES

Total consumption of primary magnesium in 1952 amounted to 43,847 tons, an increase of 8,137 tons above 1951 consumption and 61,974 tons below 1952 production.

About three-fourths of the magnesium consumed in 1952 was used in fabricating items for defense. In March 1952 supply and demand for primary magnesium came into balance for the first time during the rearmament program. After defense requirements were met there were enough stocks of the metal for the producers to fill all civilian orders that month. Before March 1952, manufacturers of magnesium products for civilian use were receiving about half of the quantity of magnesium they ordered.

Due to military requirements for magnesium castings in 1952 (particularly large castings for aircraft) and due to a shortage of facilities for producing wrought products, the use of cast magnesium was 97 percent greater during 1952 than the combined use of magnesium sheet, extrusions, and forgings. The guided-missile program for 1952 increased the demand for very large magnesium castings. Airborne radar equipment accounted for a considerable quantity of increased requirements of thin magnesium castings for defense in 1952.

TABLE 5.—Actual domestic consumption of primary magnesium (ingot equivalent and magnesium content of magnesium-base alloys) by uses, 1944–47 (average) and 1948–52, in short tons

Product	1944–47 (average)	1948	1949	1950	1951	1952
Structural products:						
Castings:						
Sand	16, 247	1, 930	3, 088	3, 090	10, 179	14, 513
Die	623	213	127	242	994	2, 777
Permanent mold	16, 884	12	44	573	646	1, 115
Wrought products:						
Sheet	1, 526	1, 261	2, 155	3, 357	5, 761	5, 569
Extrusions (structural shapes, tubing)	2, 886	2, 529	3, 364	3, 400	5, 241	3, 756
Forgings	176	103	200	104	735	12
Total structural	38, 342	6, 048	8, 978	10, 766	23, 556	27, 742
Other products:						
Powder	3, 513	(1)	--------	56	482	1, 553
Aluminum alloys	4, 196	2, 171	1, 759	3, 722	5, 994	8, 598
Other alloys	29	43	39	255	401	960
Scavenger and deoxidizer	266	418	404	473	1, 332	1, 229
Chemical	189	407	224	373	447	566
Cathodic protection	1, 823	385	235	1, 937	2, 364	2, 100
Other [2]	--------	226	308	469	1, 134	1, 099
Total other products	10, 016	3, 650	2, 969	7, 285	12, 154	16, 105
Grand total	48, 358	9, 698	11, 947	18, 051	35, 710	43, 847

[1] Less than 0.5 ton.
[2] Includes primary metal consumed in making secondary alloy.

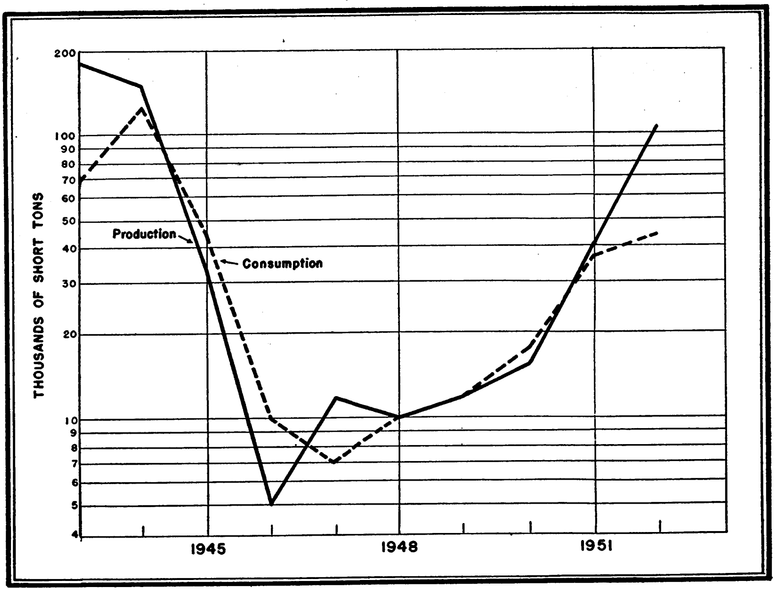

FIGURE 1.—Domestic production and consumption of primary magnesium, 1943–52.

At the beginning of 1952, rolling and forging facilities were inadequate to fill the increased requirements for magnesium sheet skin and forgings for aircraft. At that time only two rolling mills were in operation; both were four-high hand mills limited to rolling sheet to a maximum width of 48 inches. Construction of the rolling mill, which was started at Detroit, Mich., in 1951, was completed during 1952 and the mill started operation in September. This rolling mill consisted of three stands of mills ranging from 28 to 84 inches, with an estimated capacity of 100 tons per month of sheets and plates in standard lengths, widths, and gages. Construction of a new 66-inch hand mill, which was begun in 1951 at Madison, Ill., was completed in June, and production of sheet started that month.[2]

In the automotive industry, the progress that had been made in developing an appreciable market for truck-body construction was reported to have been retarded in 1952 by the scarcity of thin-gage magnesium sheet for commercial uses. However, some interest in magnesium castings was shown by manufacturers of civilian automobiles during 1952; for example, 1 manufacturer of civilian automobiles replaced 13 zinc castings with 13 magnesium castings, saving a total weight of 27 pounds, and with lower metal and machining costs.[3]

Use of magnesium as a reducing agent in production of titanium and zirconium increased in 1952; titanium-sponge production was more than doubled; and zirconium production, largely for use by the Atomic Energy Commission, also increased from that obtained in 1951.

Requirements for magnesium in aluminum, zinc, and other alloys during 1952 increased an estimated 49 percent above 1951 requirements for magnesium in those alloys.

Curtailment of civilian consumption of magnesium during the first quarter of 1952 was responsible for the estimated 11-percent decrease below 1951 in the use of magnesium for cathodic protection of oil pipelines and steel tanks.

STOCKS

At the close of 1952 consumers' stocks of primary magnesium were slightly below 1 month's supply at the rate of consumption during the year, and producers' stocks were about 6 weeks' supply. Government agencies continued to hold surplus quantities of magnesium left from stocks accumulated during World War II, and purchases were continued during 1952, as in 1951, for the National Stockpile.

TABLE 6.—Stocks and consumption of new and old magnesium scrap in the United States in 1952, gross weight in short tons

Scrap item	Stocks beginning of year	Receipts	Consumption			Stocks end of year
			New scrap	Old scrap	Total	
Cast scrap	1,581	7,014	373	7,086	7,459	1,136
Solid wrought scrap	109	1,277	1,231		1,231	155
Borings, grindings, drosses, etc	139	1,330	1,315		1,315	154
Total	1,829	9,621	2,919	7,086	[1] 10,005	1,445

[1] Includes 805 tons consumed in making magnesium castings, 2 tons in wrought products, 563 tons in aluminum alloys, 45 tons in other alloys, 7,089 tons in magnesium alloy ingot, 1,464 tons in cathodic protection and 37 tons in dissipative uses.

[2] Hatscheck, R. L., Magnesium, More Rolling Mills: Iron Age, vol. 170, No. 10, Sept. 4, 1952, p. 90.
[3] E&MJ Metal and Mineral Markets, Oct. 23, 1952, p. 7.

PRICES

The base price of domestic primary magnesium ingot remained stable at 24.5 cents per pound throughout 1952.

In November 1952, a new low base price of 50 cents a pound was announced for hot rolled magnesium plate, with all plate from 3/16- to 1-inch thicknesses listed at the same per-pound price. This was more than a 20-percent reduction from formerly published prices and brought magnesium plate to the same price per square foot as comparable aluminum plate.[4]

The price of remelt magnesium ingot remained at 31 cents per pound throughout 1952.

FOREIGN TRADE[5]

Imports.—During 1952 imports of magnesium decreased to 300 tons, less than nine percent of the quantity of imports in 1951. Most of this metal was scrap, from which duty was suspended on October 1, 1950. Tariff rates on other classifications of magnesium during 1952, remained as follows: Metallic, 20 cents per pound; alloys, powder, sheets, tubing, wire, manufactures, etc., 20 cents per pound on magnesium content plus 10 percent ad valorem. The imports were received from 7 countries in 1952, as compared with 28 countries in 1951. Of the 300 tons of metal and scrap imported, 164 tons was from Norway, 56 from Canada, 39 from Japan, 20 from the Philippine Islands, 19 from India, and one each from the United Kingdom and the Bahamas.

TABLE 7.—Magnesium imported for consumption and exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Imports						Exports					
	Metallic and scrap		Alloys (magnesium content)		Sheets, tubing, ribbons, wire, and other forms (magnesium content)		Metal and alloys in crude form, and scrap		Primary forms, n. e. c.		Powder	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948	678	$184,066	(1)	$57	(1)	$943	274	$122,374	170	$149,891	(2)	(2)
1949	2,560	537,113	(1)	80	(1)	28	432	184,707	276	214,732	(2)	(2)
1950	843	218,129	3	5,056	22	38,280	586	245,539	322	213,641	(2)	(2)
1951	3,871	998,214	18	29,525	90	190,050	575	308,865	186	228,427	(2)	(2)
1952	252	81,635	1	1,940	47	88,001	(3) 1,066	(3) 618,005	(3) 97	(3) 245,211	43	$59,843

1 Less than 1 ton.
2 Data not separately classified before Jan. 1, 1952.
3 Due to changes in items included in each classification, data are not strictly comparable with earlier years.

Exports.—Total exports of magnesium in 1952 were 1,206 tons, a 58-percent increase above the 761 tons shipped in 1951. Export control of this strategic metal was exercised by the Office of International Trade throughout 1952. Of the primary metal, alloys, and scrap

4 Daily Metal Reporter, Jan. 23, 1953, p. 73.
5 Figures on imports and exports compiled by Mae B. Price and Elsie D. Page of the Bureau of Mines, from records of the U. S. Department of Commerce.

exported during 1952, 370 tons was delivered to Mexico, 165 to United Kingdom, 110 to Switzerland, 101 to Canada, 90 to Venezuela, 83 to Sweden, 67 to Germany, 55 each to Spain and Yugoslavia, 38 to Saudi Arabia, 5 to Union of South Africa, 3 each to India and Japan, 2 each to Ceylon, Mozambique, and Colombia, 1 each to Cuba and French Pacific Islands, and 10 to other countries.

Japan received 27 tons of the magnesium powder exported; Sweden received 9 tons; Canada, 3 tons; Belgium and Luxembourg 3 tons; and other countries, 1 ton.

TECHNOLOGY

During 1952 great stress was laid upon research to provide improved fabrication processes for magnesium. Design engineers working with magnesium explored a number of new fields of application of magnesium alloys. An outstanding example of these investigations was the successful production of magnesium castings 16 feet long and adhering to exacting tolerances. These castings for aircraft wing sections, which were believed to be the largest aircraft castings ever developed, were expected to result in more rapid and economical production than was possible for conventional aircraft wings fabricated by attaching aluminum skins to spar and ribs with rivets or spotwelds.[6]

Advanced techniques in fabrication and use of magnesium sheet were noted in 1952, as two large rolling mills at Detroit, Mich., and Madison, Ill., came into production. Before their installation the largest magnesium ingot used in the two-high hand mills for rolling sheet in commercial quantities weighed 140 pounds, and the maximum width of the sheet was 48 inches. The coil-rolling technique of the new hot breakdown mills provided for rolling sheet in widths from 18 to 84 inches, utilizing ingots weighing 2,000 pounds each. Coil rolling permitted easy handling of longer sheets than flat sheets produced on the hand mills. Heavy sheets and plates finished on the four-high mills adhered to closer thickness tolerances than had been possible from the two-high mills. All hot-rolled magnesium sheet produced in the new mills was rolled under tension, which resulted in a smoother and more even surface than it was possible to obtain on the hand mills. Availability of thin-gage magnesium sheet for commercial uses at the close of 1952 was expected to promote a marked increase in its use in body construction of automotive equipment. Research before 1951 had developed the use of magnesium in truck bodies to the point of commercial application before defense orders required curtailment of civilian use of magnesium.

The research that had been done during 1947–52 on development of magnesium casting alloys containing zirconium was largely responsible for the success in 1952, in production of the large 16-foot aircraft wing sections. Zirconium was found to be primarily useful as an alloy constituent because of its grain-refining quality, which made it possible to cast alloys that had otherwise been very difficult to handle in the foundry. This grain-refining action also improved the ductility and toughness of magnesium alloys at both room and slightly elevated temperatures.[7]

During 1952 investigations were carried forward into improvement of thorium-magnesium alloys, which showed exceptional strength

[6] Iron Age, Cast Wings: Vol. 170, No. 7, August 1952, p. 176.

[7] Stricter, F. P., Magnesium Casting Alloys Containing Zirconium: Metal Progress, vol. 63, No. 3, March 1953, pp. 75–82.

up to 600° F. and a degree of usefulness at 700° F., a temperature at which the rare-earth alloys would generally not be considered for use. This offered a solution to the need for alloys with improved creep strength in service above 400° F. Development work progressed toward commercial applications of castings designed from this alloy in the newer jet engines.[8]

Research completed during 1952 pointed to development of increased use of magnesium for cathodic protection of marine equipment. Bars of magnesium weighing 60 pounds each were welded to the hull of a 13,000-ton tanker for 12 months. At the close of the year, inspection of the ship in drydock indicated that there was not only no rust on the hull but that older scale had been detached.[9]

During 1952 the increased use of magnesium in small fittings for hydraulic systems in aircraft encouraged research, which was expected to lead to the application of light, strong magnesium fittings in home plumbing to replace brass fittings. Magnesium was preferable to brass for these fittings not only to save weight, but because the magnesium fittings were found to have less shrinkage than brass.

The large potential domestic supply of magnesium was a determining factor in research during 1952, for development of magnesium alloys with improved physical properties. The Bureau of Mines carried research into the phase system of magnesium-lithium-aluminum alloys to develop information of the cause of rapid deterioration of such alloys at room temperature which might lead to the elimination or modification of the deterioration. Enough valuable information had been acquired to encourage continued investigation of such alloys of high strength-to-weight ratio and exceptional formability.

WORLD REVIEW

Estimated world production of primary magnesium in 1952 was 151,000 metric tons (167,000 short tons), an increase of about 87 percent above the 1951 total. The United States maintained its lead in production and consumption of magnesium, both for military and civilian uses. World markets continued to gain in 1952, with heavier exports of the primary metal coming from the United States, Canada, and Norway.

TABLE 8.—World production of magnesium metal, by countries,[1] 1946–52, in metric tons[2]

[Compiled by Lee S. Petersen]

Country [1]	1946	1947	1948	1949	1950	1951	1952
Canada	145	136	(3)	(3)	1,600	4,000	[4] 5,000
France	704	1,043	546	492	446	875	1,090
Germany, West	------	------	17	------	------	------	------
Italy	1,005	------	------	------	122	677	976
Norway	------	------	------	------	------	120	1,300
Switzerland	200	------	------	------	250	250	300
United Kingdom [5]	1,700	2,200	2,400	2,600	3,000	5,000	4,600
United States	4,823	11,198	9,075	10,521	14,266	37,086	95,999
Total (estimate)	24,000	32,000	31,000	35,000	41,000	81,000	151,000

[1] Magnesium is also produced in China, Taiwan, and U. S. S. R., but production data are not available; estimate by author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous magnesium chapters.
[3] Data not available; estimate by author of chapter included in total.
[4] Estimate.
[5] Primary metal and remelt alloys.

[8] McDonald, J. C., Rare-Earth Metals Improve Elevated Temperature Properties of Magnesium Castings: Materials and Methods, vol. 36, No. 1, July 1952, pp. 162–165.
[9] Wall Street Journal, vol. 140, No. 102, Oct. 20, 1952, p. 20.

Canada.—Primary magnesium was produced in Canada in 1952 at Haley, Ontario, by Dominion Magnesium Ltd., and at Arvida, Quebec, by Aluminum Co. of Canada. The Haley plant employed the silicothermic process, utilizing dolomite as the source of magnesium. The electrolytic plant at Arvida produced magnesium from magnesium chloride obtained from brucite taken from Alcan's mine at Wakefield, Quebec.[10] Plans were announced in 1952 by Aluminum Co. of Canada for expansion of the annual capacity of the Arvida plant from 3,000 metric tons to 4,000. This expansion program was the result of an agreement entered into in 1952, between Aluminum Co. of Canada and the United Kingdom, whereby Alcan would supply Britain with 2,640 metric tons of magnesium a year for 20 years, beginning in 1954.[11]

Canada's largest and most modern magnesium foundry was officially opened at Haley in September 1952.[12]

Magnesium alloys were available in Canada in 1952 in the form of castings and extrusions, plate, and tube with a small supply of forgings. There were no facilities in Canada for rolling sheet.[13]

Italy.—The plant at Bolzano supplied requirements for primary magnesium in Italy in 1952. This plant, with an annual capacity of approximately 3,000 metric tons, was closed during the period 1947 through 1949. Exports of magnesium during 1951, estimated at 5,000 metric tons, represented in a large measure, recovery of secondary magnesium from scrap accumulated during World War II. The Bolzano plant exported about half of its output of primary magnesium in 1952.

Japan.—No primary magnesium was produced in Japan in 1952. Increased consumption of the metal caused consideration of the feasibility of reactivating the Ube plant of Riken Kinzoku, the only primary magnesium plant intact in Japan; but resumption of production would have required Government financial aid and a large supply of electrical energy. In addition to consumption in pyrotechnics and light-metals alloys, magnesium was used in limited quantities in Japan during 1952 as a reducing agent for production of titanium and for refining gray cast iron to produce nodular cast iron.

Norway.—The only plant producing primary magnesium in Norway in 1952 was the electrolytic plant in south Norway and operated by Heröya Elektrokjemiske Fabrikker, a subsidiary of Norsk Hydro-Elektrisk. This plant started production late in 1951 and reported 120 metric tons that year. Utilizing seawater and dolomite (the latter mined at Bodo in northern Norway) as raw materials, the operators planned to produce 5,000 metric tons yearly by 1953. In October 1952 production was estimated at the rate of 4,000 metric tons a year.[14] Reports indicated almost all of Norway's magnesium output in 1952, was exported, about 50 percent to the United States and 50 percent to Britain.

Switzerland.—One magnesium plant at Valais Canton, with an annual productive capacity of 500 metric tons, was reported in opera-

[10] Canadian Chemical Processing, Magnesium Makers Take on Steam: Vol. 36, No. 6, June 1, 1952, pp. 34–37.

[11] Daily Metal Reporter, Aluminum Co. of Canada to Boost Magnesium Output: Vol. 52, No. 129, July 4, 1952, p. 1.

[12] Sanderson, F., New Magnesium Foundry Starts Up: Iron Age, vol. 170, No. 12, Sept. 25, 1952, p. 85.

[13] Smallman-Tew, R., Magnesium in Aircraft: Canadian Metals, vol. 15, No. 7, June 1952, pp. 22–24

[14] Metal Bulletin (London), Magnesium—Norwegian Output: No. 3734, Oct. 14, 1952, p. 27.

tion during 1952. This was sufficient productive capacity to supply the country's requirements for primary magnesium in 1952.

United Kingdom.—During 1952, the only plant producing primary magnesium in the United Kingdom, was the electrolytic plant at Clifton Junction, Manchester, with an annual capacity of 4,000 metric tons. The Secretary for Overseas Trade disclosed in the House of Commons, before the summer recess in 1952, that the Aluminum Co. of Canada was to supply 2,640 metric tons of magnesium a year to the United Kingdom for 20 years, beginning in 1954. The Secretary of Overseas Trade stated that the cost of producing magnesium in Britain would be substantially higher than that of the magnesium imported from Canada.[15]

On February 1, 1952 the price of primary magnesium ingot in the United Kingdom was increased from 2/ 4 1/d (33 cents) per pound to 2/ 10 1/d (40 cents) per pound. In announcing the increase the Government stated the higher cost of imported supplies and delivery charges were responsible.[16]

---

[15] Mining Journal (London), Magnesium: Vol. 239, No. 6104, Aug. 15, 1952, p. 181.
[16] Metal Bulletin (London), Magnesium: No. 3664, Feb. 1, 1952, p. 21.

Magnesium Compounds

By Donald R. Irving [1] and Frances P. Uswald [2]

DOMESTIC production of crude magnesite, caustic-calcined and refractory magnesia, and dead-burned dolomite decreased during 1952. Production of high-grade magnesias and magnesium carbonate also decreased. Magnesium chloride production was more than double the 1951 figure, as demand from the magnesium-metal industry continued to increase.

TABLE 1.—Salient statistics of magnesite, magnesia, and dead-burned dolomite in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Crude magnesite:						
Mined:						
Short tons	470,675	(1)	287,315	429,392	670,167	510,750
Value	$3,525,322	(1)	[2] $1,950,153	[2] $3,091,135	[2] $4,506,712	$2,871,548
Average per ton	$7.49		$6.79	$7.20	$6.72	$5.62
Caustic-calcined magnesia:						
Sold or used by producers:						
Short tons	89,263	33,209	32,505	41,447	49,981	38,055
Value [3]	$5,169,235	$3,380,528	$3,109,381	$4,136,898	$4,810,379	$3,769,466
Average per ton [4]	$57.91	$101.80	$95.66	$99.81	$96.24	$99.05
Refractory magnesia:						
Sold or used by producers:						
Short tons	278,922	330,069	250,389	335,440	432,197	386,873
Value	$8,508,181	$13,444,587	$10,477,856	$14,915,854	$18,400,131	$17,255,837
Average per ton [4]	$30.50	$40.73	$41.85	$44.47	$42.57	$44.60
Dead-burned dolomite:						
Sold or used by producers:						
Short tons	1,245,607	1,544,755	1,318,708	1,759,443	1,966,460	1,928,025
Value	$11,539,081	$17,847,182	$15,930,226	$21,725,560	$26,375,313	$25,965,459
Average per ton	$9.26	$11.55	$12.08	$12.35	$13.41	$13.47

[1] Figures withheld to avoid disclosure of individual company operations.
[2] Partly estimated; most of crude is processed by mining companies, and very little enters open market.
[3] Includes specialty magnesias of high unit value.
[4] Average receipts f. o. b. mine shipping point.

DOMESTIC PRODUCTION

Magnesite.—Crude magnesite production in the United States decreased 24 percent in quantity and 36 percent in value in 1952 compared with 1951, according to reports by producers. Most of the decrease was attributable to a strike which closed most domestic iron and steel plants for 2 months or longer.

Magnesia.—Refractory magnesia sold and used by producers decreased 10 percent in quantity from the alltime high reported for 1951 and decreased 6 percent in value in 1952. The decrease in production, while not proportional to that reported for crude magnesite, was attributable to the steel strike. The iron and steel industry consumed 100,641,000 long tons of iron ore during 1952, a 12-percent decrease from the 1951 record high. The rated annual

[1] Commodity-industry analyst.
[2] Statistical clerk.

iron and steel production capacity on December 31, 1952, was 117,547,470 short tons of steel compared with 108,587,670 short tons on December 31, 1951, indicating a future high demand for refractory magnesia.

Caustic-calcined magnesia sold or used by producers decreased 24 percent in quantity and 22 percent in value in 1952 compared with 1951. The average value per ton of caustic-calcined magnesia is derived from reports by producers of all grades of caustic-calcined magnesia in order to avoid disclosure of individual company operations. Most of the material is sold for a considerably lower price per ton than the average value shown in table 1.

The proportion of magnesia derived from processes utilizing raw sea water, sea-water bitterns, and well brines as a raw-material source (usually with dead-burned dolomite as a causticizer) has been increasing for the past several years, compared with the proportion derived from magnesite, brucite, and dolomite. In 1952, 88 percent of the caustic-calcined magnesia and 40 percent of the refractory magnesia was derived from sea water and well brines compared with 65 percent and 35 percent, respectively, in 1948. Magnesia sold or used by producers in the United States, 1951–52, by kind and source is given in table 2.

TABLE 2.—Magnesia sold or used by producers in the United States, 1951–52, by kind and source

Magnesia	From magnesite, brucite, and dolomite		From well brines, raw sea water, and sea-water bitterns [1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1951						
Caustic-calcined	7,689	$889,624	42,292	$3,920,755	49,981	$4,810,379
Refractory	295,243	10,610,788	136,954	7,789,343	432,197	18,400,131
Total	302,932	11,500,412	179,246	11,710,098	482,178	23,210,510
1952						
Caustic-calcined	4,528	761,268	33,527	3,008,198	38,055	3,769,466
Refractory	232,766	8,057,848	154,107	9,197,989	386,873	17,255,837
Total	237,294	8,819,116	187,634	12,206,187	424,928	21,025,303

[1] Magnesia made from a combination of dolomite and sea water is included with that from sea water.

Dolomite.—Dead-burned dolomite sold by producers decreased only 2 percent in 1952, from 1951, despite the steel strike, because of increased consumption in Government-owned plants producing magnesium metal for defense requirements. The iron and steel industry remained the principal consumer of dead-burned dolomite in 1952, with an estimated 70 percent of the total output (table 3).

Additional information on dolomite may be found in the Stone and Lime chapters of this volume.

Brucite.—Basic Refractories, Inc., 845 Hanna Bldg., Cleveland 15, Ohio, continued to produce brucite from its mine at Gabbs, Nev. A sharp increase in production was reported in 1952, with much of it derived from low-grade ore and rejects processed in a heavy-medium separation plant installed in 1951.[3]

[3] Lenhart, W. B., Heavy-Media Separation Used in Processing Refractory Materials: Rock Products, vol. 55, No. 7, July 1952, pp. 60–62.

TABLE 3.—Dead-burned dolomite sold in and imported into the United States, 1943–47 (average) and 1948–52

Year	Sales of domestic		Imports [1]		Year	Sales of domestic		Imports [1]	
	Short tons	Value	Short tons [2]	Value		Short tons	Value	Short tons [2]	Value
1943–47 [3]	1,245,607	$11,539,081	166	$5,091	1950	1,759,443	$21,725,560	2,127	$86,425
1948	1,544,755	17,847,182	2,427	91,613	1951	1,966,460	26,375,313	2,719	128,207
1949	1,318,708	15,930,226	1,851	72,680	1952	1,928,025	25,965,459	2,342	123,596

[1] "Dead-burned" basic refractory material consisting chiefly of magnesia and lime.
[2] Includes weight of immediate container.
[3] Average.

Olivine.—Annual data on olivine, an iron-magnesium silicate, formerly appearing in the Minor Nonmetals chapter of this series are included in this Magnesium Compounds chapter in order to consolidate related materials under one heading. Olivine is a neutral or slightly basic mineral and its major use is for refractories. Data on olivine sold or used by producers in the United States for 1952 is withheld in order to avoid disclosure of individual company operations.

Harbison-Walker Refractories Co., 1800 Farmers Bank Bldg., Pittsburgh, Pa. continued to produce olivine from its Addie Quarry near Addie, N. C. The Wray Mine near Green Mountain, N. C., formerly leased to United Feldspar Minerals Corp., was operated part of the year by C. P. Wray Heirs, Burnsville, N. C. and the remainder of the year by C. R. Wiseman (lessee), Spruce Pine, N. C. The H. P. Scheel Co. operated its Big Slide mine, near Sedro-Wooley, Wash., and reported a mill was being constructed at the mine. The olivine was used in the production of refractories and foundry sand.

Serpentine.—A small quantity of serpentine was used in 1952 in the manufacture of refractories.

Other Magnesium Compounds.—Production of extra-light and light magnesias, U. S. P. and technical grades, decreased 12 percent in 1952, compared with 1951, while sales decreased 9 percent (table 4).

TABLE 4.—Specified magnesium compounds produced, sold, and used by producers in the United States, 1951–52 [1]

Product[1]	Plants	Produced (short tons)	Sold		Used (short tons)
			Short tons	Value	
1951					
Specified magnesias (basis 100 percent MgO), U. S. P. and technical:					
Extra-light and light	5	2,251	2,221	$1,114,037	(2)
Heavy	2	(2)	(2)	(2)	
Total	[3] 5	(2)	(2)	(2)	(2)
Precipitated magnesium carbonate	10	60,530	8,415	1,177,999	51,987
1952					
Specified magnesias (basis 100 percent MgO), U. S. P. and technical:					
Extra-light and light	5	1,986	2,012	1,100,078	(2)
Heavy	2	(2)	(2)	(2)	
Total	[3] 5	(2)	(2)	(2)	(2)
Precipitated magnesium carbonate	7	43,267	5,380	870,003	37,882

[1] In addition, magnesium chloride, hydroxide, nitrate, phosphate, sulfate, and acetate were produced; figures withheld to avoid disclosure of individual company operations.
[2] Figures withheld to avoid disclosure of individual company operations.
[3] A plant producing more than 1 grade is counted but once in arriving at total.

Production and sales of heavy magnesias, U. S. P. and technical grades, and precipitated magnesium carbonate decreased sharply. Production of magnesium chloride more than doubled as demand from the magnesium-metal industry continued to increase.

The mines and plants producing magnesite, brucite, and other magnesium compounds in 1952 in the United States are listed in table 5.

TABLE 5.—Mines and plants producing magnesite, brucite, and other magnesium compounds in the United States, 1952

Company	Location of mine or plant	Products	Raw materials
CALIFORNIA			
Kaiser Aluminum & Chemical Corp.	Moss Landing	Refractory magnesia. Caustic-calcined magnesia. Magnesium hydroxide.	Sea water. Dead-burned dolomite.
Westvaco Chemical Div., Food Machinery & Chemical Corp.	Newark	Refractory magnesia. Caustic-calcined magnesia. Magnesium hydroxide.	Sea-water bitterns. Dead-burned dolomite. Magnesite.
	Western Mine (near Livermore).	Magnesite	
	Chula Vista	Magnesium chloride, crystals.	Sea-water bitterns.
Marine Magnesium Div., Merck & Co., Inc.	South San Francisco.	Magnesium oxides, extra-light, light, and heavy; magnesium hydroxide; precipitated magnesium carbonate.	Sea water. Sea-water bitterns. Dead-burned dolomite.
ILLINOIS			
Johns-Manville Products Corp.	Waukegan	Basic magnesium carbonate	Dolomite.
MICHIGAN			
The Dow Chemical Co.	Ludington	Magnesium chloride, crystals. Magnesium chloride, cell feed.	Well brines.
	Midland	Epsom salt	Well brines. Calcined dolomite.
Michigan Chemical Corp.	St. Louis	Caustic-calcined magnesia; precipitated magnesium carbonate; magnesium hydroxide; magnesium oxide, extra-light and light.	Well brines. Dead-burned dolomite.
Morton Salt Co.	Manistee	Precipitated magnesium carbonate.	Well brines.
The Standard Lime & Stone Co.	do	Refractory magnesia	Do.
NEVADA			
The Standard Slag Co.	Gabbs	Magnesite	
		Refractory magnesia. Caustic-calcined magnesia.	Magnesite.
Basic Refractories, Inc.	do	Magnesite	
		Brucite	
		Refractory magnesia	Magnesite, brucite.
NEW JERSEY			
J. T. Baker Chemical Co.	Phillipsburg	High-purity magnesium chemicals.	Magnesium carbonate.
Johns-Manville Corp.	Manville	Precipitated magnesium carbonate.	Calcined dolomite.
Northwest Magnesite Co.	Cape May	Refractory magnesia	Sea water. Calcined dolomite.
OHIO			
Diamond Alkali Co.	Fairport	Refractory magnesia	Dolomite.

TABLE 5.—Mines and plants producing magnesite, brucite, and other magnesium compounds in the United States, 1952—Continued

Company	Location of mine or plant	Products	Raw Materials
PENNSYLVANIA			
Philip Carey Mfg. Co	Plymouth Meeting	Precipitated magnesium carbonate; magnesia, extra-light.	Dolomite.
Keasbey & Mattison Co	Ambler	Precipitated magnesium carbonate; magnesia, extra-light and heavy.	Do.
TEXAS			
The Dow Chemical Co	Freeport	Caustic-calcined magnesia Magnesium chloride, cell feed Magnesia, heavy	Sea water.
WASHINGTON			
Laucks Chemical Co	Tonasket	Epsom salt	Lake brine.
Northwest Magnesite Co	Chewelah	Magnesite	
		Caustic-calcined magnesia Refractory magnesia	Magnesite.
WEST VIRGINIA			
The Standard Lime & Stone Co.	Millville	Refractory magnesia	Dolomite.

PRICES

The prices quoted for various magnesium compounds in 1952, compared with January 1951 quotations, are given in table 6.

TABLE 6.—Prices quoted on selected magnesium compounds, carlots, 1951–52

Commodity	Unit	Container	F. o. b.	Source	January 1951	January 1952	December 1952
Magnesite:							
Dead-burned, grain	Short ton	Bulk	Chewelah, Wash.	(1)	$36.30	$36.30	$36.30
Dead-burned, grain	do	Bags	do	(1)	41.80	41.80	41.80
Caustic-calcined, oxychloride cement grade, powdered.	do	do	Newark, Calif.	(2)	75.00	75.00	75.00
Periclase: Kiln-run, 90 percent.	do	Bulk	do	(2)	55.00	55.00	[3] 57.00
Epsom salt: Tech. grade	100 lb	Bags		(4)	2.15	2.15	2.15
Magnesia, calcined:							
Tech. grade	Pound	Ctns.	Works	(4)	.32–.3475	.32–.3475	.32–.3475
Synthetic, rubber grade.	do	do	do	(4)	.31	.31	.31
U. S. P., light	do	do		(4)	.34–.36	.34–.36	.34–.36
U. S. P., heavy	do	Bbl.		(4)	.36–.38	.36–.38	.36–.38
Magnesium carbonate:							
Tech. grade	do	Bags	(5)	(4)	.095	.095	.095
U. S. P. grade	do	do	(5)	(4)	.1125	.1125	.1125
Magnesium chloride: Powdered.	Short ton	Bbl.	Works	(4)	50.00	50.00	50.00
Magnesium hydroxide: Medicinal grade.	Pound			(4)	.29–.30	.29–.30	.265–.30

[1] E&MJ Metal and Mineral Markets.
[2] Westvaco Chemical Division, Food Machinery and Chemical Corp.
[3] Effective April 1.
[4] Oil, Paint and Drug Reporter.
[5] Magnesium carbonate is quoted freight allowed to New Jersey (except to Atlantic, Burlington, Cape May, Cumberland, Gloucester, Ocean, and Salem Counties) and to Philadelphia County, Pa. Freight is equalized with New York City on all other destinations.

FOREIGN TRADE [4]

Imports of "dead-burned and grain magnesite and periclase" in 1952 decreased 15 percent in tonnage and 17 percent in value, compared with 1951. Austria supplied 74, Italy 10, Canada 8, Norway 6, and the United Kingdom 2 percent of the imports. Imports of "lump and ground caustic-calcined magnesite" decreased in 1952 (table 7). Imports of other magnesium compounds in 1952 are shown in table 8.

TABLE 7.—Magnesite imported for consumption in the United States, 1950–52, by countries

[U. S. Department of Commerce]

Country	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
CRUDE MAGNESITE						
Brazil	2	$28				
Canada					4	$184
Greece	1	22				
India					11	290
Philippines	5	75				
Total	8	125			15	474
LUMP CAUSTIC-CALCINED MAGNESITE						
Canada	8	$467	8	$467		
India	399	14,696	1,963	71,792	839	$32,050
Netherlands	546	25,911	1,277	58,732		
Yugoslavia	55	2,400			828	28,391
Total	1,008	43,474	3,248	130,991	1,667	60,441
GROUND CAUSTIC-CALCINED MAGNESITE						
Austria	6	$245	496	$19,949	303	$10,003
Canada					8	516
Germany			32	1,267		
Greece	44	1,720	209	7,800		
India	1,059	40,063			22	1,297
Netherlands			204	10,405	16	941
United Kingdom	9	1,247	3	382	4	528
Total	1,118	43,275	944	39,803	353	13,285
DEAD-BURNED AND GRAIN MAGNESITE AND PERICLASE						
Austria	11,839	$622,927	11,314	$516,886	18,011	$785,657
Brazil			56	1,995		
Canada	2,104	188,690	3,995	365,263	2,074	204,518
Germany			1,000	47,628		
India					1	21
Italy	177	6,009	3,808	195,377	2,379	92,029
Norway			1,000	41,833	1,504	64,112
United Kingdom			7,612	227,422	500	15,400
Total	14,120	817,626	28,785	1,396,404	24,469	1,161,737

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 8.—Magnesium compounds imported for consumption in the United States, 1948–52

[U. S. Department of Commerce]

Year	Oxide or calcined magnesia		Magnesium carbonate, precipitated		Magnesium chloride (anhydrous and n. s. p. f.)		Magnesium sulfate (epsom salt)		Magnesium salts and compounds, n. s. p. f.[1]		Manufactures of carbonate of magnesia	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948	-------	-------	282	$82,305	6	$767	-------	-------	9	$7,809	(2)	$49
1949	(3)	$2	192	61,385	6	852	358	$9,928	9	7,601	-------	-------
1950	-------	-------	234	51,043	8	835	1,962	45,233	158	24,851	3	1,479
1951	-------	-------	194	59,847	3	292	2,547	59,373	562	90,826	96	31,914
1952	7	496	182	53,841	2	172	4,606	113,518	614	139,977	1	437

[1] Includes magnesium silicofluoride or fluosilicate and calcined magnesium sulfate.
[2] 200 pounds. [3] 50 pounds.

TECHNOLOGY

Various aspects of basic refractory raw materials and applications were reported in a number of articles published in 1952. Much of the literature dealt with chromite-magnesia refractories. The durability of these refractories was said to depend on control of the chromite-magnesia ratio, the composition of the gangue, and the grain sizes of the chromite and magnesia fractions.[5] On the basis of experiments it was inferred that the firing expansions of certain chromite-magnesia products resulted from oxidation of the chromite grains. The expansion was reduced by the addition of serpentine to the batches.[6]

Applications, performance in open-hearth furnaces, and new developments in production of chromite-magnesia brick were discussed.[7] Chromite-magnesia roofs in large open-hearth furnaces were stated to have metallurgical and cost advantages over roofs made from silica refractories, including lower brick consumption, lower labor cost, increased steel output, improved quality, and improved heat transfer.[8] The relative merits of basic and silica brick in the basic open-hearth steel furnace were discussed. In the use of basic brick, a trend was noted toward the use of nonspalling magnesia refractories to replace chromite-magnesia.[9] The use of basic refractories for steelmaking furnaces, cupolas, and crucibles, and reasons for changing to a comparatively unproved basic cupola operation from a smoothly operating acid cupola were discussed, and data were presented on the suitable types of refractories.[10] Results of life tests on basic open-hearth furnace linings were evaluated and

[5] Bashforth, G. R., Some Experiences in the Use of Chrome-Magnesite Refractories: Metallurgia (Manchester, England), vol. 45, No. 267, January 1952, pp. 12–16.

[6] Lovell, G. H. B., The Firing Expansions of Certain Chrome-Magnesite Products: Trans. British Ceram. Soc. (Stoke-on-Trent, England), vol. 51, 1952, pp. 369–386.

[7] Iron & Coal Trades Review, Chrome-Magnesite Refractories in All-Basic Open-Hearth Furnaces: Vol. 165, No. 4407, Sept. 26, 1952, pp. 697–700.

[8] Lange, Werner, [Development and Experiences With Basic Chrome Ore-Magnesite Roofs in Large Open-Hearth Tilting Furnaces]: Stahl u. Eisen (Düsseldorf, Germany), vol. 72, No. 16, Mar. 13, 1952, pp. 284–287.

Zimmer, K. O., [Economy of Chromite-Magnesite and Silica Linings of a 70-ton Open-Hearth Furnace]: Radex-Rundschau (Radenthein, Austria), No. 6, November 1952, pp. 227–234.

[9] Lynam, T. R., Silica Versus Basic Bricks: British Steelmaker (London), vol. 18, February 1952, pp. 79, 81.

[10] Holt, J. P., Basic Cupola Operation: Am. Foundryman, vol. 21, No. 1, January 1952, pp. 39–43.

Holt, J. P., Guide for Selection of Basic Refractories: Am. Foundryman, vol. 22, No. 5, November 1952, pp. 63–68, 102.

Demler, M. W., Basic Refractories for Cupola Service: Canadian Metals, vol. 15, No. 8, 1952, pp. 33–34.

variables affecting lining life were enumerated.[11] A selected bibliography and the history of the all-basic open-hearth furnace were given in a special report of the Iron and Steel Institute (London).[12] Electric-furnace refractories and open-hearth zebra roof experience were reviewed.[13] Operating data on several high-magnesia open-hearth bottoms were presented which indicated that rammed bottoms performed more satisfactorily in the first year than sintered magnesia and slag bottoms. Ramming mixtures with 80, 84, and 96 percent magnesia were used, with progressively more satisfactory performance as the percentage of magnesia increased.[14] From a study of various properties of test pieces prepared by mixing sea-water magnesia clinker with raw or calcined chromite, it was determined that the porosity and resistance to spalling of the fired test pieces increased and apparent density and compressive strength decreased as the proportion of clinker was increased.[15] Research and service tests disclosed that chemically bonded magnesia-chromite brick were superior for checkers in glass furnaces and that European glass manufacturers had obtained up to 30 years' service for one set of bottom blocks by covering them with a single course of magnesia brick.[16] The advantages of using high-purity periclase refractories in the hot zone of kilns burning portland cement, dolomite, magnesite, and periclase, and the methods of manufacturing and bonding the refractories were discussed.[17] Methods were described for making magnesia refractory ware for use in investigations on high-temperature alloys.[18] Developments in the design and operation of the Higgins arc furnace for producing fused magnesia and other refractory products were reviewed.[19]

Investigation of mortar compositions containing monoaluminum and monomagnesium phosphates indicated they were equivalent to or superior to commercial mortars for which comparable data were available.[20] A review of patents on refractory magnesia products was published during 1952.[21]

A detailed description of the process of recovering magnesia from sea water and analysis of the product was published.[22] Satisfactory

---

11 Hutter, Luis, [Progress in the Basic Lining of Open-Hearth Furnaces]: Stah :u. Eisen (Düsseldorf, Germany), vol. 72, No. 21, Oct. 9, 1952, pp. 1285–1298.
Aikens, R. E., Mixer Linings at Columbia-Geneva Steel Div.: Jour. Metals, vol. 4, No. 4, June 1952, pp. 577–578.

12 Archibald, W. A., and others, The All-Basic Open-Hearth Furnace: Iron and Steel Inst. (London), Spec. Rept. 46, 1952, 86 pp.

13 Fedock, M. P., Bottom Ramming Materials: Jour. Metals, vol. 4, No. 3, March 1952, pp. 427–429.
Harley, T. H., Open-Hearth Zebra Roof Experience Analyzed: Jour. Metals, vol. 4, No. 11, November 1952, p. 1146.

14 Kramer, H. M., Recent Experience With Rammed Hearths at Bethlehem: Open-Hearth Proc., Am. Inst. Min. and Met. Eng., vol. 35, 1952, pp. 97–102.

15 Nagai, Shoichiro, Ota, Zenzo, and Tanemura, Fumikaza, [Chromite-Magnesia Refractories Which Use Sea-Water Magnesia, I]: Jour. Ceram. Assoc. Japan (Tokyo), vol. 60, No. 668, 1952, pp. 60–65; Ceram. Abs., June 1, 1952, p. 110.
Nagai, Shoichiro, Ota, Zenzo, Tanemura, Fumikaza, and Nozaki, Nobuo, [Chromite-Magnesia Refractories Which Use Sea-Water Magnesia, II]: Jour. Ceram. Assoc. Japan (Tokyo), vol. 60, No. 676, 1952, pp. 422–425; Ceram. Abs., Apr. 1, 1953, p. 63.

16 Abbey, R. G., [Refractory Trends in the Glass Industry]: Radex-Rundschau (Radenthein, Austria), No. 7, December 1952, pp. 275–282.

17 Austin, L. W., Periclase Refractories in Rotary Kilns: Trans. Am. Inst. Min. and Met. Eng., vol. 193, Tech. Pub. No. 3389–H (in Min. Eng., vol. 4, No. 10, October 1952, pp. 980–983).

18 Greenaway, H. T., Preparation of Laboratory Ware in Magnesia by a Modification of the Slip-Casting Technique: Metallurgia (Manchester, England), vol. 45, No. 269, March 1952, pp. 159–160.
Stanfield, G. K., Pure Oxide Laboratory Crucibles: Chem. Age (London), vol. 66, No. 1711, Apr. 26, 1952, pp. 641–643.

19 Upper, J. A., Arc-Furnace Practice in the Manufacture of Aluminous Abrasives and Refractories: Jour. Electrochem. Soc., vol. 99, No. 3, 1952, pp. 57–58.

20 Kingery, W. D., Fundamental Study of Phosphate Bonding in Refractories, IV; Mortars Bonded With Monoaluminum and Monomagnesium Phosphate: Jour. Am. Ceram. Soc., vol. 35, No. 3, March 1952, pp. 61–63.

21 Reinhart, Friedrich, [Refractory Magnesite Products]: Sprechsaal für Keramic-Glas-Email (Coburg, Germany), vol. 85, Jan. 20, 1952, pp. 27–28.

22 Gilpin, W. C. and Heasman, N., Magnesia From Sea Water: Refractories Jour., vol. 28, July 1952, pp. 302–307.

results were reported by substituting finely ground magnesite for silica flour as a general mold and core wash in foundries.[23] Experimental procedures and results of electrical conductivity and density measurements of various mixtures of fused magnesium chloride and other chlorides were reported.[24] The theory and practice involved in the preparation and application of a nickel-magnesia cermet coating and its possible use for protecting the sheet metal parts of jet-propelled mechanisms were discussed.[25]

The properties of olivine and its use for steel castings were discussed in an article published in 1952.[26] Results of experiments on the chlorination of olivine ore were summarized.[27]

An article was published indicating that, where color is not a factor, serpentine can be substituted for talc in ceramic bodies without impairment of properties.[28]

Numerous articles of a more theoretical nature were published during 1952.[29]

WORLD REVIEW

Estimated world production of crude magnesite was the same in 1952 as in 1951. Production data, by countries, are given in table 9.

Austria.—A review of the Austrian magnesite industry was given in a report of the Special Mission for Economic Cooperation, Industry Division, Vienna, Austria, prepared by E. G. Rothblum and made available in June 1953.[30] The production data for caustic-calcined and refractory magnesia, and magnesia brick (1948–52), compiled from data of the Austrian Supreme Mining Board, are given in table

[23] Urane, S. G., Magnesite for Moldings: Am. Foundryman, vol. 21, No. 3, March 1952, pp. 49–50.

[24] Huber, R. W., Potter, E. V., and St. Clair, H. W., Electrical Conductivity and Density of Fused Binary Mixtures of Magnesium Chloride and Other Chlorides: Bureau of Mines Rept. of Investigations 4858, 1952, 14 pp.

[25] Montgomery, E. T. and Lytle, J. A., Nickel-Magnesia Cermet Coatings: U. S. Air Force, Air Research and Development Command, WADC Tech. Rept., No. 52-166, June 1952, 12 pp.

[26] Sissener, J., and Langum, B., Practical Aspects of Olivine as Molding Material: Am. Foundryman, vol. 21, No. 4, April 1952, pp. 138–142.

[27] Ketzlach, Norman and Moulton, R. W., Olivine as a Source of Magnesium: Trend in Engineering at the Univ. of Washington, vol. 4, No. 1, January 1952, pp. 21–24.

Greenfield, H. H. and Moulton, R. W., The Chlorination of Olivine Ore: Trend in Engineering at the Univ. of Washington, vol. 4, No. 3, July 1952, pp. 22–24, 28.

[28] Schatzer, L. [Use of Serpentine in Ceramic Bodies]: Silikattech, vol. 3, No. 6, 1952, pp. 261–262; Ceram. Abs., Mar. 1, 1953, p. 50.

[29] Atlas, Leon [The Polymorphism of $MgSiO_3$] and Solid-State Equilibria in the System $MgSiO_3$-$CaMgSi_2O_6$: Jour. Geol., vol. 60, No. 2, March 1952, pp. 125–147.

Britton, H. T. S., Gregg, S. J., and Willing, E. G. S., The Precipitation of Magnesia From Sea Water by Calcined Dolomite: Jour. Appl. Chem. (London), vol. 2, part 12, December 1952, pp. 701–703.

Britton, H. T. S., Gregg, S. J., and Winsor, G. W., The "Activity" of Lime and of Magnesia in Relation to Their Temperature of Preparation: Jour. Appl. Chem. (London), vol. 2, part 12, December 1952, pp. 693–697.

Duwez, Pol, Odell, Francis, and Brown, Frank H., Jr., Stabilization of Zirconia With Calcia and Magnesia: Jour. Am. Ceram. Soc., vol. 35, No. 5, May 1, 1952, pp. 107–113.

Jura, George and Garland, C. W., Experimental Determination of the Surface Tension of Magnesium Oxide: Jour. Am. Chem. Soc., vol. 74, No. 23, Dec. 5, 1952, pp. 6033–6034.

Kahler, F., Haas, H., and Fischer, C. [Spectro-chemical Analysis of Magnesite]: Radex-Rundschau (Radentheim, Austria), No. 1, February 1952, pp. 33–45.

Kogl, Franz [Determination of the Mineralogical Constituents of Sintered Magnesite]: Silikattech, vol. 3, No. 7, 1952, pp. 311–312.

Moteki, Kesakichi and Murotani, Tadao [Ferric Oxide as a Mineralizer in Sintered Magnesia, I]: Jour. Ceram. Assoc. Japan (Tokyo), vol. 60, No. 667, 1952, pp. 17–21; Ceram. Abs., June 1, 1952, p. 117.

Moteki, Kesakichi [Ferric Oxide as a Mineralizer in Sintered Magnesia, II]: Jour. Ceram. Assoc. Japan (Tokyo), vol. 60, No. 671, 1952, pp. 185–186; Ceram. Abs., Oct. 1, 1952, p. 183.

Moteki, Kesakichi [Effects of Calcium Oxide and Silica on the Compounds Formed and the Microstructure of Magnesia Clinker]: Jour. Ceram. Assoc. Japan (Tokyo), vol. 60, No. 677, 1952, pp. 481–485; Ceram. Abs., May 1, 1953, p. 84.

Parravano, G., Solidstate Reaction Between Magnesium and Chromium Oxides: Jour. Am. Chem. Soc., vol. 74, No. 23, Dec. 5, 1952, pp. 6123–6125.

Schreiner, H. [Hydrate Formation in Sintered Magnesites]: Radex-Rundschau (Radentheim, Austria), No. 6, November 1952, pp. 255–260.

Schwartz, Bernard, Thermal Stress Failure of Pure Refractory Oxides: Jour. Am. Ceram. Soc., vol. 35, No. 12, Dec. 1, 1952, pp. 325–333.

Todd, S. S., Low-Temperature Heat Capacities and Entropies at 298.16° K. of Magnesium Orthotitanate and Magnesium Dititanate: Jour. Am. Chem. Soc., vol. 74, No. 18, Sept. 20, 1952, pp. 4669–4670.

[30] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 3, September 1953, pp. 60–69.

10. Exports of crude magnesite were mostly to Germany, and were small, increasing from 135 metric tons in 1947 (none in 1948) to 1,000 metric tons in 1952. Exports of caustic-calcined and refractory magnesia, and magnesia brick, 1948–52, by country of destination, are given in tables 11 to 13. Imports of these products were minor during 1948–52, as shown in table 14.

TABLE 9.—World production of magnesite, by countries,[1] 1948–52, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
North America: United States	(3)	260,646	389,536	607,962	463,342
South America:					
Brazil	850	43,110	(4)	(4)	(4)
Venezuela	1,900	1,800	1,400	1,600	(4)
Europe:					
Austria	405,600	520,500	543,817	664,296	742,259
Czechoslovakia	(4)	(4)	[5] 173,000	(4)	(4)
Germany, West	(4)	11,264	1,311	(4)	32,134
Greece	12,168	17,090	26,256	63,859	81,591
Italy	1,002	735	274	246	(4)
Norway	1,740	1,108	1,850	1,453	1,000
Spain	9,897	6,691	7,632	13,733	12,625
Yugoslavia	51,721	87,934	59,269	89,915	37,782
Asia:					
Cyprus (exports)	1	20	20	20	20
India	49,103	92,018	53,707	118,650	(4)
Korea, Republic of			(4)	(4)	328
Turkey	3,621	6,370	450	505	750
Africa:					
Kenya		10	181		
Southern Rhodesia	5,722	7,640	8,615	14,814	10,952
Tanganyika (exports)			83	2,716	
Union of South Africa	10,660	10,487	11,782	18,773	24,409
Oceania:					
Australia	32,963	34,129	35,960	39,762	48,441
New Zealand	549	568	346	589	(4)
Total [5]	2,400,000	2,700,000	3,000,000	3,800,000	3,800,000

1 Unless otherwise stated, quantities in this table represent crude magnesite mined. In addition to countries listed, magnesite is also produced in Canada, China, Poland, and U. S. S. R., but data on tonnage of output are not available; estimates by senior author of chapter included in total.
The Canadian production was actually magnesitic dolomite and brucite, valued as follows: 1948: C$1,587,709; beginning in 1949, value includes magnesium metal: 1949: C$1,536,200; 1950: C$1,717,879; 1951: C$2,437,773; 1952: C$2,914,272.
2 This table incorporates a number of revisions of data published in previous magnesite chapters.
3 Figure withheld to avoid disclosure of individual company operation; included in total.
4 Data not available; estimate by senior author of chapter included in total.
5 Estimate.

TABLE 10.—Production of caustic-calcined and refractory magnesias and magnesia brick, Austria, 1948–52, in metric tons

Year	Caustic-calcined magnesia	Refractory magnesia	Magnesia brick
1948	53,279	133,445	93,248
1949	77,915	179,409	109,017
1950	74,563	182,470	111,820
1951	77,695	215,212	134,826
1952	[1] 88,822	[1] 259,697	[2] 163,400

1 According to a report drafted by E V. Spielmann, Vienna, May 11, 1953.
2 Unofficial.

SOURCE: Austrian Supreme Mining Board.

TABLE 11.—Exports of caustic-calcined magnesia from Austria, 1948–52, in metric tons

Country of destination	1948	1949	1950	1951	1952
Argentina	-------	-------	65	42	30
Australia	-------	15	-------	-------	-------
Belgium-Luxembourg	253	75	119	193	240
Bulgaria	-------	-------	-------	-------	59
Czechoslovakia	1,324	1,926	2,549	3,426	3,177
Denmark	1,436	223	221	268	70
Finland	15	-------	15	-------	-------
France	3,141	3,239	2,492	2,866	2,673
Germany:					
East	-------	-------	2,601	5,415	4,807
West	5,313	23,650	34,993	44,145	44,094
Great Britain	497	351	280	177	236
Hungary	-------	750	2,183	879	1,379
Italy	865	1,408	2,092	2,562	1,886
Netherlands	134	326	307	668	139
New Zealand	10	-------	-------	-------	-------
Norway	411	317	34	-------	45
Rumania	-------	-------	22	7	-------
Sweden	15	138	-------	15	15
Switzerland	1,864	1,055	1,289	1,271	1,215
Trieste	-------	-------	-------	-------	15
United States	-------	-------	6	505	272
Total	15,278	33,473	49,268	62,439	60,352
Total proceeds in 1,000 schillings [1]	8,589	18,819	32,691	41,579	45,063

[1] Rate of exchange: 1948, none quoted; 1949, 14.40 schillings equaled US$1; 1950–52, incl., 21 to 26 schillings equaled US$1.

SOURCE: Austrian Central Statistical Office, annual reports

TABLE 12.—Exports of refractory magnesia from Austria, by countries of destination, 1948–52, in metric tons

Country of destination	1948	1949	1950	1951	1952
Argentina	54	17	828	688	660
Belgium-Luxembourg	1,954	1,055	995	1,617	2,841
Brazil	198	148	30	-------	-------
Chile	218	130	12	600	1,439
Czechoslovakia	268	664	497	26	51
Denmark	230	289	257	406	436
Finland	172	106	230	3,015	765
France	11,351	9,868	7,178	11,295	13,422
Germany:					
East	-------	-------	239	87	4,866
West	16,735	16,084	23,624	15,898	21,547
Great Britain	5,046	1,481	377	1	494
Greece	36	25	64	170	96
Hungary	2,330	3,410	1,218	63	115
India	202	24	108	100	-------
Italy	4,579	6,041	6,694	6,884	11,880
Netherlands	111	355	222	3,422	287
Norway	147	85	124	110	47
Peru	-------	801	790	1,198	-------
Poland	4,109	5,034	6,477	3,726	2,761
Rumania	438	1,181	887	565	1,039
Spain	7	-------	-------	-------	-------
Sweden	1,215	1,011	1,085	881	1,526
Switzerland	2,728	1,236	1,740	21,455	3,171
Trieste	217	652	-------	100	-------
Turkey	41	-------	93	7	70
United States	-------	22,571	7,887	4,150	8,169
Yugoslavia	1,813	7,671	8,434	7,094	5,323
Other	37	17	263	183	600
Total	54,236	79,956	70,353	83,741	81,605
Total proceeds, in 1,000 schillings [1]	29,645	47,388	63,490	83,819	100,928

[1] Rate of exchange: 1948, none quoted; 1949, 14.40 schillings equaled US$1; 1950–52, incl., 21 to 26 schillings equaled US$1.

SOURCE: Austrian Central Statistical Office, annual reports.

TABLE 13.—Exports of magnesia brick from Austria in 1948–52, by countries, in metric tons

Country of destination	1948	1949	1950	1951	1952
Argentina	298	22	1,418	1,255	627
Belgian Congo		68		50	19
Belgium-Luxembourg	8,563	6,371	6,250	7,433	9,023
Chile	305	23	138	99	68
Czechoslovakia	1,558	5,363	2,662	877	1,373
Denmark	828	1,587	1,593	2,836	2,224
Finland	923	643	1,590	1,620	1,850
France	17,107	22,993	16,791	22,169	27,541
Germany:					
East			1,033	1,504	2,414
West	9,678	13,601	17,407	24,784	28,314
Greece	435	118	704	548	628
Hungary	2,049	3,673	4,076	4,039	4,826
Italy	5,423	4,822	8,198	11,081	17,358
Netherlands	1,456	1,218	1,433	2,601	3,083
Norway	589	527	621	597	583
Poland	2,125	6,518	6,753	4,450	7,063
Rumania	951	4,345	4,982	1,000	3,996
South Africa	171	139	60	1,003	1,360
Spain	76	88			
Sweden	8,032	9,816	10,162	9,306	9,833
Switzerland	1,583	992	1,219	1,598	1,884
Trieste	146	30			
Turkey	858	416	1,937	643	1,658
Yugoslavia	5,291	5,294	5,386	2,747	7,551
Other	128	904	1,000	2,572	3,882
Total	68,573	89,571	95,413	104,812	137,158
Total proceeds, in 1,000 schillings [1]	89,468	126,994	199,191	259,320	400,247

[1] Rate of exchange: 1948, none quoted; 1949, 14.40 schillings equaled US$1; 1950–52, incl., 21 to 26 schillings equaled US$1.

SOURCE: Austrian Central Statistical Office, annual reports.

TABLE 14.—Imports into Austria of caustic-calcined and refractory magnesias and magnesia brick, 1948–52, in metric tons

	1948	1949	1950	1951	1952
CAUSTIC-CALCINED MAGNESIA					
Germany			1	2	22
United Kingdom				2	
Total			1	4	22
Total value, 1,000 schillings [1]			8	17	32
REFRACTORY MAGNESIA					
Czechoslovakia		2,741	399	294	3,598
Germany, West					513
Total		2,741	399	294	4,111
Total value, 1,000 schillings [1]		1,292	186	294	4,116
MAGNESIA BRICK					
Belgium-Luxembourg		7			
Total value, 1,000 schillings [1]		10			

[1] Rate of exchange: 1948, none quoted; 1949, 14.40 schillings equaled US$1; 1950–52, incl., 21 to 26 schillings equaled US$1.

SOURCE: Austrian Central Statistical Office, annual reports.

Brazil.—Harbison-Walker Minerios, S. A., formed in 1951 to exploit magnesite deposits near Alencar, Ceará, continued development work during 1952.[31]

Magnesita, S. A., operating mines and kilns at Brumado, Bahia, reported orders for 12,000 metric tons of refractory magnesia per year from manufacturers of refractory brick in Europe. The com-

[31] Brick & Clay Record, vol. 122, No. 1, January 1953, p. 67.

pany stated it was unable to obtain adequate transportation from the mines to the port of Salvador over the East Brazil Railway, with the result that only a small fraction of the scheduled shipments were being made. The East Brazil Railway was being electrified and re-equipped to provide better transportation. In 1945, the Department of Mineral Production stated the magnesite reserves in Bahia were "enormous and compare favorably. . . . with the world's biggest known deposits."[32]

Canada.[33]—Magnesia firebrick and chromite firebrick which are permitted duty-free entry under Canadian tariff item 281 were transferred from the customs category of "a class or kind not made in Canada" to that of "a class or kind made in Canada" effective May 21, 1952, according to the Canadian Department of National Revenue. This ruling did not affect the duty rate but made such imported firebrick subject to dumping-duty penalties if sold in Canada at less than the fair market value in country of export. The ruling also indicated that production in Canada was sufficient to supply 10 percent or more of domestic needs.

A mixture of magnesium chloride and magnesium sulfate was said to occur in some alkali deposits and lakes in Saskatchewan, associated with sodium sulfate. The MgO content of the larger lakes is from 3 to 5 times that of sea water, and a preliminary estimate from a survey of 6 lakes indicated reserves of more than 13 million tons equivalent of MgO.[34]

Imports of refractory and caustic-calcined magnesia and exports of dead-burned refractories are given in tables 15 and 16.[35]

Greece.—Output of calcined magnesia (92 percent MgO) totaled 26,678 metric tons valued at US$1,040,442 in 1952, compared with 20,732 metric tons valued at US$794,508 in 1951. Exports of crude magnesite and calcined magnesia, 1951–52, are shown in tables 17 and 18.[36] The magnesite deposits of Euboea and the Chalkidike Peninsula were described and their importance to the Italian steel industry was emphasized.[37]

TABLE 15.—Imports of refractory and caustic-calcined magnesia into Canada in 1952, by countries

Country of origin	Short tons	Value, C$ [1]
India	27	3,715
Norway	1,236	52,754
United Kingdom	191	16,732
United States	8,824	444,958
Total	10,278	518,159

[1] Rate of exchange, 1952: C$1 ranged from US$0.9923 to US$1.0407.

SOURCE: Dominion Bureau of Statistics, preliminary reports on production and trade, 1952.

[32] Mining Journal (London), Brazilian Magnesite: Vol. 239, No. 6123, Dec. 26, 1952, p. 734.
[33] Foreign Commerce Weekly, Firebrick: "Made in Canada" Ruling: Vol. 47, No. 7, May 19, 1952, p. 11.
[34] Williams, A. J., Saskatchewan's Industrial Minerals: Trans. Am. Inst. Min. & Met. Eng., Tech. Pub. 3286–H (in Min. Eng., vol. 4, No. 4, April 1952, p. 398).
[35] Bureau of Mines, Mineral Trade Notes; Vol. 37, No. 2, August 1952, p. 52.
[36] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 6, June 1953, pp. 54–55.
[37] Capparucci, Riccardo [The Magnesite Deposits of Greece]: L'Industria Mineraria (Rome), vol. 3, No. 6, June 1952, pp. 203–205.

TABLE 16.—Exports of dead-burned refractories from Canada, 1952

Country of destination	Short tons	Value, C$ [1]
Mexico	40	1,960
New Zealand	11	594
Sweden	22	1,196
United States	2,887	163,967
Total	2,960	167,717

[1] Rate of exchange, 1952: C$1 ranged from US$0.9923 to US$1.0407.

SOURCE: Dominion Bureau of Statistics, preliminary reports on production and trade, 1952.

TABLE 17.—Exports of magnesite from Greece, 1951–52

Country of destination	1951		1952	
	Metric tons	Value, 1,000 drachmas [1]	Metric tons	Value, 1,000 drachmas [1]
Germany	600	107,649	12,040	2,210,863
United Kingdom	3,461	581,364	525	99,750
Others	14,602	2,807,119	4,318	845,960
Total	18,663	3,496,132	16,883	3,156,573

[1] 15,000 drachmas equals US$1.

SOURCE: Greek Ministry of Commerce, Statistical Service.

TABLE 18.—Exports of calcined magnesia from Greece, 1951–52

Country of destination	1951		1952	
	Metric tons	Value, 1,000 drachmas [1]	Metric tons	Value, 1,000 drachmas [1]
Germany	9,390	5,832,390	8,122	4,950,580
Netherlands	10,401	6,231,926	10,877	5,843,479
United States	90	60,450		
Others	2,856	1,928,751	3,957	2,262,631
Total	22,737	14,053,517	22,956	13,056,690

[1] 15,000 drachmas equals US$1.

SOURCE: Greek Ministry of Commerce, Statistical Service.

Italy.—Results of chemical analyses, microscopic examinations, X-ray powder spectrograms, and differential heating curves of crystalline magnesite from the Ortler region were discussed.[38]

Netherlands.—Imports of crude magnesite in 1952 are given in table 19. Imports of refractory magnesia, 1951–52, are given in table 20; exports are given in table 21.[39]

Southern Rhodesia.[40]—Exports of magnesite, 1951–52, are given in table 22.

[38] Sersale, Riccardo, and Gregorio, Elvira [Technological Characteristics of Iron-Containing Magnesites From the Ortler]: La Ricerca Scientifica (Rome), Vol. 22, No. 11, November 1952, pp. 2164–2173.
[39] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, pp. 37–38.
[40] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 2, August 1953, p. 52.

TABLE 19.—Crude magnesite imports into the Netherlands, by countries, 1952

Country of origin	Metric tons	Value, guilders [1]
Greece	75	7,000
India	104	9,000
United Kingdom	24	10,000

[1] 1 guilder equals about US$0.263.

SOURCE: Netherlands Central Bureau of Statistics.

TABLE 20.—Refractory magnesia imports into the Netherlands, by countries, 1951–52

Country of origin	1951		1952	
	Metric tons	Value, guilders [1]	Metric tons	Value, guilders [1]
Austria	322	71,000	296	83,000
Belgium-Luxembourg			10	5,000
Germany, West			209	47,000
Greece	1,870	309,000	14,415	2,683,000
India	9,019	1,526,000	1,546	293,000
United Kingdom			28	10,000
Yugoslavia	7,622	1,227,000	2,845	557,000
Others		13,000		

[1] 1 guilder equals about US$0.263.

SOURCE: Netherlands Central Bureau of Statistics.

TABLE 21.—Exports of refractory magnesia from The Netherlands, by destination, 1952

Country of destination	Metric tons	Value, 1,000 guilders [1]
Belgium-Luxembourg	460	116
Czechoslovakia	58	16
Denmark	1,173	308
Egypt	59	15
Finland	660	172
France	87	28
Germany, West	9,572	2,245
Netherland Antilles	123	45
New Zealand	56	17
Norway	453	115
Portugal	98	26
Sweden	1,052	259
Union of South Africa	197	63
United Kingdom	2,025	490
Other	99	31
Total	16,172	3,946

[1] 1 guilder equals about US$0.263.

SOURCE: Netherlands Central Bureau of Statistics.

TABLE 22.—Exports of magnesite from Southern Rhodesia, 1951–52

Country of destination	1951		1952	
	Short tons	Value £ [1]	Short tons	Value £ [1]
Belgian Congo	58	408		
Northern Rhodesia			115	347
Union of South Africa	13,010	22,728	14,545	28,373
Total	13,068	23,136	14,660	28,720

[1] £ equals US$2.80.

SOURCE: Central African Statistical Office, Salisbury.

Union of South Africa.—The principal deposits in the Union of South Africa were described in Memoir 38, Magnesite in the Union of South Africa, published by the Union of South Africa Government Printer.[41]

Yugoslavia.—Discovery of a new magnesite deposit said to contain sufficient magnesite for domestic requirements and a surplus for export was announced.[42]

[41] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 4, October 1952, p. 33.
[42] Engineering and Mining Journal, vol. 153, No. 7, July 1952, p. 163.

Manganese

By Gilbert L. DeHuff[1] and Edgar J. Gealy[1]

POSITION of the United States with respect to manganese supply improved substantially during 1952, owing principally to a large increase in imports of manganese ore, but unfortunately also in some measure to interruption of steel-industry operations by a prolonged strike. Had there been no such interruption, consumption of manganese ore probably would have set new records. As it was, consumption of ore and of alloys was lower than in 1951. Domestic production of ore, under the stimulus of Government purchase programs, was higher than in 1951 but did not attain the levels of the 8 years immediately preceding. The net result of the above factors showed in the high industry stocks at the close of the year.

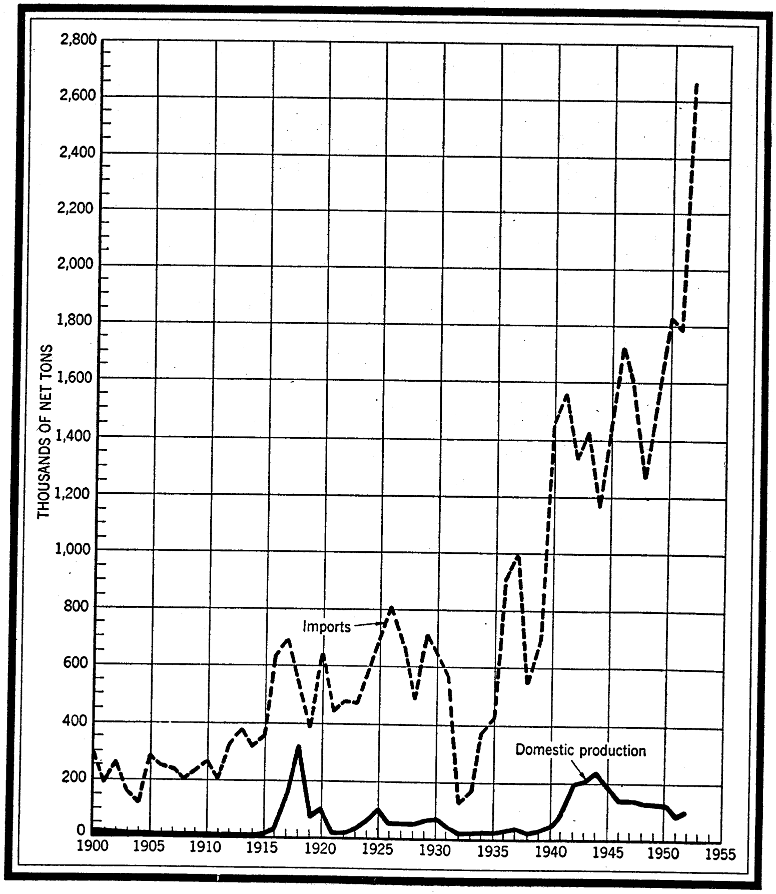

FIGURE 1.—General imports and domestic production (mine shipments) of manganese ore, 1900–52.

[1] Commodity-industry analyst.

TABLE 1.—Salient statistics of manganese in the United States, 1943–47 (average) and 1948–52, gross weight in short tons

	1943–47 (average)	1948	1949	1950	1951	1952
Manganese ore (35 percent or more Mn):						
Mine shipments:						
Metallurgical ore	174,074	119,828	110,928	122,944	[1] 95,255	100,999
Battery ore	7,745	10,845	14,983	11,507	9,752	14,380
Miscellaneous ore	259	427	224			
Total mine shipments	182,078	131,100	126,135	134,451	[1] 105,007	115,379
General imports	1,468,103	1,256,597	1,544,584	1,834,925	[1] 1,767,580	2,668,557
Consumption	1,444,620	1,538,398	1,360,042	1,650,429	1,892,609	1,809,189
Ferromanganese:						
Domestic production	626,295	647,617	577,345	719,680	791,260	758,721
Imports for consumption	31,092	98,220	65,014	109,948	119,764	64,095
Exports	7,413	19,696	6,627	580	633	1,453
Consumption	654,375	670,774	617,645	774,852	883,841	796,826
Spiegeleisen:						
Domestic production	139,926	112,610	78,167	42,375	77,017	58,666
Imports for consumption	2,104		1,737	8,595		44
Exports	2,145	51		363	85	34
Consumption	143,545	102,392	75,841	76,280	80,556	69,029

[1] Revised figure.

DOMESTIC PRODUCTION

Throughout the year, General Services Administration continued to purchase low-grade manganese ores of domestic origin, amenable to beneficiation to National Stockpile specifications, delivered to depots at Deming, N. Mex., Butte, Mont., and Philipsburg, Mont. Minimum acceptable manganese content was 15 percent for deliveries to Deming and Philipsburg and 12 percent to Butte. Participation in the Montana programs was limited further to ores containing at least 90 percent of the manganese in the form of carbonate. In July, GSA published regulations, similar to those previously issued for Deming, governing purchase of low-grade manganese ores at a new depot to be established at Wenden, Ariz. However, purchases did not begin until 1953. Also in July, GSA announced its "carload-lot" program for the purchase of domestic manganese ores, meeting specifications, shipped in lots of one or more carloads by small producers whose production is less than 10,000 long dry tons per calendar year. A base price of $2.30 per long-dry-ton unit for ore containing 48 percent manganese was established, with premiums and penalties for variations in analysis and a minimum acceptable manganese content of 40 percent. By the end of the year shippers throughout the country had begun to take advantage of this new program. In September the regulations for the Deming and Wenden depots were amended to permit acceptance of ores with higher lead and zinc contents than previously allowed, provided such ores could be nodulized to bring the content of these impurities within the initial specifications.

Defense Minerals Exploration Administration continued to aid promising exploration projects for manganese ore by providing loans to be repaid out of production, to the extent of 75 percent of the approved cost of the project.

In addition to the shipments of various grades of manganese-bearing ores given in tables 3 to 5, battery ores containing 35 percent or more manganese were produced in California and Montana, and synthetic battery ore was made from domestic ores at plants in Nevada and

TABLE 2.—Manganiferous raw materials shipped by producers in the United States, 1943–47 (average) and 1948–52, in short tons

Year	Metallurgical ore				Battery ore (25 percent or more Mn)	Miscellaneous ore	
	Manganese ore (35 percent or more Mn)	Ferruginous manganese ore (10 to 35 percent Mn)	Manganiferous iron ore (5 to 10 percent Mn)	Manganiferous zinc residuum		35 percent or more Mn	10 to 35 percent Mn
1943–47 (average)	174,074	221,827	1,193,187	235,079	8,291	259	215
1948	119,828	139,580	1,198,523	291,383	10,845	427	2,462
1949	110,928	24,885	1,052,231	158,902	14,983	224	1,279
1950	122,944	115,269	972,328	183,842	11,507	------	------
1951	[1] 95,255	106,203	1,117,761	267,751	9,752	------	------
1952	100,999	106,307	902,711	215,255	14,380	------	------

[1] Revised figure.

TABLE 3.—Metallurgical manganese ore shipped from mines in the United States, 1943–47 (average) and 1948–52, by States, in short tons

State	1943–47 (average)	1948	1949	1950	1951	1952
Alabama	16	------	------	138	------	------
Arizona	3,105	240	223	222	173	203
Arkansas	4,207	212	2,851	1,224	3,718	2,246
California	8,762	------	280	37	------	3,589
Colorado	141	------	------	------	------	------
Georgia	932	------	------	------	------	------
Idaho	7	------	------	------	------	------
Missouri	36	------	------	------	------	------
Montana	136,212	119,339	107,399	119,694	[1] 91,080	90,772
Nevada	6,868	------	------	------	58	105
New Mexico	1,220	------	------	1,320	226	2,360
North Carolina	28	------	------	------	------	------
Oklahoma	53	------	------	------	------	------
Oregon	29	------	------	------	------	------
South Carolina	366	------	------	------	------	------
South Dakota	2	------	------	------	------	------
Tennessee	592	37	175	133	------	126
Texas	------	------	------	------	------	56
Utah	24	------	------	120	------	95
Virginia	7,192	------	------	56	------	1,011
Washington	4,270	------	------	------	------	436
Wyoming	12	------	------	------	------	------
Total	174,074	119,828	110,928	122,944	[1] 95,255	100,999

[1] Revised figure.

TABLE 4.—Ferruginous manganese ore shipped from mines in the United States, 1943–47 (average) and 1948–52, by States, in short tons

State	1943–47 (average)	1948	1949	1950	1951	1952
Arizona	187	------	------	------	224	------
Arkansas	8,365	1,165	5,555	6,359	1,429	896
California	2,620	------	386	640	------	56
Colorado	17	------	------	------	------	76
Georgia	1,613	------	------	------	------	------
Michigan	20,409	------	------	------	------	------
Minnesota	75,309	------	3,482	16,206	14,728	31,502
Montana	3,073	4,135	5,517	6,810	7,598	9,357
Nevada	8,334	8,707	4,964	8,942	1,250	7,947
New Mexico	85,740	122,879	------	74,348	79,605	52,934
North Carolina	23	------	------	------	------	------
South Carolina	65	------	------	------	------	------
Tennessee	1,716	------	------	------	------	------
Utah	10,452	2,694	4,981	1,964	1,369	3,397
Virginia	4,663	2,462	1,279	------	------	------
Washington	------	------	------	------	------	142
Total	222,586	142,042	26,164	115,269	106,203	106,307

Oregon. Manganiferous zinc residuum was produced from New Jersey zinc ores.

TABLE 5.—Manganiferous iron ore shipped from mines in the United States, 1943–47 (average) and 1948–52, by States, in short tons

State	1943–47 (average)	1948	1949	1950	1951	1952
Michigan	9,474			117,619		22,095
Minnesota	1,183,713	1,198,523	986,720	853,632	1,117,522	880,616
New Mexico			65,511		239	
Utah				1,077		
Total	1,193,187	1,198,523	1,052,231	972,328	1,117,761	902,711

Shipments of concentrating-grade ore (not included in the production data) were made to GSA depots in Deming, N. Mex., and Butte and Philipsburg, Mont. These ores originated in Arizona, California, Nevada, New Mexico, Montana, and Utah. An additional purchase depot was under construction at Wenden, Ariz., in the latter part of the year.

Montana continued to occupy the dominant position as the leading manganese-ore-producing State, supplying 86 percent of the domestic production for 1952. The bulk of the material originated with Anaconda Copper Mining Co., which processed carbonate ore from the Emma and Butte Hill mines into nodules containing (dry) 57.5 percent manganese. Ten other States—California, New Mexico, Arkansas, Virginia, Washington, Arizona, Tennessee, Nevada, Utah, and Texas, in descending order—reported shipments of metallurgical manganese ore.

Battery-grade manganese ore was produced by Trout Mining Division of American Machine & Metals, Inc., and Taylor Knapp Co. in Montana. The Teekay Mines, Inc., subsidiary of Taylor Knapp Co., reached full production of battery-grade concentrates from the Ladd mine in California. Synthetic battery-ore was produced throughout the year from domestic ores by Continental Chemical Co., subsidiary of Ray-O-Vac Co., at Salem, Oreg., and by Western Electrochemical Corp. at Henderson, Nev.

Ferruginous manganese ores were shipped from New Mexico, Minnesota, Montana, Nevada, Utah, Arkansas, Washington, Colorado, and California, in the above order. Manganiferous iron ore was shipped from Minnesota and Michigan.

New operations, designed to produce manganese ore from domestic sources, included Manganese, Inc., which began production of nodules containing 45 percent manganese at Henderson, Nev., Westmoreland Manganese, Inc., constructing a mill in Independence County, Ark., to produce large tonnages of manganese concentrates, and Manganese Chemicals Corp., beginning construction of a semicommercial plant at Riverton, Minn., to extract manganese from Cuyuna range ore by the ammonium carbamate process. In late 1952, DMPA contracted with Mangaslag, Inc., for the erection of a pilot plant in Luzerne County, Pa., using the process developed by the Bureau of Mines in cooperation with the American Iron and Steel Institute for recovering manganese from open-hearth slags.

TABLE 6.—Manganese and manganiferous ores shipped from mines, in the United States in 1952, by States

	Metallurgical			Battery			Total			
	Shippers	Short tons		Shippers	Short tons		Shippers	Short tons		Value
		Gross weight	Manganese content		Gross weight	Manganese content		Gross weight	Manganese content	
Manganese ore: [1]										
Arizona	5	203	83				5	203	83	(2)
Arkansas	5	2,246	1,007				5	2,246	1,007	(2)
California	7	3,589	1,436	1	4,492	1,640	8	8,081	3,076	(2)
Montana	1	90,772	52,168	2	9,298	4,052	3	100,070	56,220	(2)
Nevada	2	105	41	1	590	332	3	695	373	(2)
New Mexico	15	2,360	942				15	2,360	942	(2)
Tennessee	1	126	50				1	126	50	(2)
Texas	1	56	28				1	56	28	(2)
Utah	1	95	49				1	95	49	(2)
Virginia	5	1,011	429				5	1,011	429	(2)
Washington	2	436	206				2	436	206	(2)
Total	45	100,999	56,439	4	14,380	6,024	49	115,379	62,463	[3] $8,251,774
Ferruginous manganese ore: [4]										
Arkansas	1	896	269				1	896	269	(2)
California	1	56	10				1	56	10	(2)
Colorado	1	76	15				1	76	15	(2)
Minnesota	1	31,502	3,342				1	31,502	3,342	(2)
Montana	2	9,357	2,171				2	9,357	2,171	(2)
Nevada	9	7,947	1,895				9	7,947	1,895	(2)
New Mexico	1	52,934	5,788				1	52,934	5,788	(2)
Utah	4	3,397	908				4	3,397	908	(2)
Washington	1	142	28				1	142	28	(2)
Total	21	106,307	14,426				21	106,307	14,426	667,245
Manganiferous iron ore: [5]										
Michigan	1	22,095	1,164				1	22.095	1,164	(6)
Minnesota	4	880,616	50,845				4	880,616	50,845	(6)
Total	5	902,711	52,009				5	902,711	52,009	4,449,740

[1] Containing 35 percent or more manganese (natural).
[2] Not available; estimate included in total.
[3] Estimate.
[4] Containing 10 to 35 percent manganese (natural).
[5] Containing 5 to 10 percent manganese (natural).
[6] Figure withheld to avoid disclosure of individual company operations.

CONSUMPTION AND STOCKS

Steel capacity continued to expand in 1952; and the steel industry's operations were at a high rate, except for the shutdown period brought about by the summer's strike. A result was that consumption of manganese ore and manganese alloys was lower in 1952 than in 1951. Total consumption of manganese ore decreased 4 percent from that of 1951. Domestic mines supplied 5 percent and foreign sources 95 percent compared with 7 and 93 percent, respectively, in 1951 and 1950. The manufacture of dry cells took 2 percent of the total, chemicals consumed 1 percent, and the remaining 97 percent was used in metal industries. Industry stocks of ore increased 129 percent to 1,249,389 short tons at the end of 1952, but average grade again decreased.

Allocation of manganese ore continued throughout the year under Mineral Order 2, but with modification in March which permitted delivery and acceptance of foreign ores to alloy producers without formal allocation authority.

TABLE 7.—Apparent consumption of manganiferous raw materials in the United States in 1952

	Ore containing 35 percent or more Mn		Ore and residuum containing 10 to 35 percent Mn		Ore containing 5 to 10 percent Mn	
	Short tons	Mn content (percent)	Short tons	Mn content (percent)	Short tons	Mn content (percent)
Domestic shipments	115,379	54.14	321,562	14.53	902,711	5.35
Imports for consumption	2,203,594	45.43	154,349	26.35		
Total available for consumption	2,318.973	45.86	475,911	18.36	902,711	5.35

TABLE 8.—Consumption of manganese ore and manganese alloys in the United States, 1951–52, and stocks Dec. 31, 1952, gross weight in short tons

Category of use and form in which consumed	Quantity consumed		In stock Dec. 31, 1952 [1]	
	1951	1952	At plant, including bonded warehouses	In bonded warehouses only
Manganese alloys and manganese metal:				
Manganese ore:				
Domestic	116,864	84,097	10,839	
Foreign	1,593,891	1,629,895	1,152,368	549,440
Total manganese ore	1,710,755	1,713,992	1,163,207	549,440
Ferromanganese, silicomanganese, and manganese metal			52,221	27,408
Spiegeleisen			3,434	
Steel ingots and steel castings: [2]				
Manganese ore:				
Domestic	653	10	15	
Foreign	1,937	1,288	201	
Total manganese ore	2,590	1,298	216	
Ferromanganese:				
High-carbon	773,776	684,745	120,307	
Medium-carbon	51,235	52,429	7,873	
Low-carbon				
Total ferromanganese	825,011	737,174	128,180	

For footnotes, see end of table.

TABLE 8.—Consumption of manganese ore and manganese alloys in the United States, 1951–52, and stocks Dec. 31, 1952, gross weight in short tons—Con.

Category of use and form in which consumed	Quantity consumed		In stock Dec. 31, 1952 [1]	
	1951	1952	At plant, including bonded warehouses	In bonded warehouses only
Spiegeleisen	60,204	52,876	23,614	----------
Silicomanganese	77,916	76,602	12,797	----------
Manganese metal and misc. alloys	1,335	1,246	117	----------
Steel castings: [3]				
Manganese ore:				
Domestic	7	5	272	----------
Foreign	910	647	254	----------
Total manganese ore	917	652	526	----------
Ferromanganese:				
High-carbon	34,701	33,630	6,879	----------
Medium-carbon } Low-carbon }	2,748	3,576	1,009	----------
Total ferromanganese	37,449	37,206	7,888	----------
Spiegeleisen	6,820	5,539	1,438	----------
Silicomanganese	11,851	13,442	2,391	----------
Manganese briquets	2,337	2,073	417	----------
Manganese metal and misc. alloys	250	266	38	----------
Pig iron:				
Manganese ore:				
Domestic	5,930	5,143	4,057	----------
Foreign	101,024	26,798	50,018	----------
Total manganese ore	106,954	31,941	54,075	----------
Dry cells:				
Manganese ore:				
Domestic	3,191	4,720	1,061	----------
Foreign	40,936	35,177	16,745	11,938
Total manganese ore	44,127	39,897	17,806	11,938
Chemicals:				
Manganese ore:				
Domestic	4,733	5,251	153	----------
Foreign	22,533	16,158	13,406	----------
Total manganese ore	27,266	21,409	13,559	----------
Miscellaneous products:				
Ferromanganese:				
High-carbon	14,655	17,203	4,958	----------
Medium-carbon } Low-carbon }	6,726	5,243	1,805	----------
Total ferromanganese	21,381	22,446	6,763	----------
Spiegeleisen	13,532	10,614	3,813	----------
Silicomanganese	3,003	2,615	548	----------
Manganese briquets	16,405	14,554	4,043	----------
Grand total:				
Manganese ore:				
Domestic	131,378	99,226	16,397	----------
Foreign	1,761,231	1,709,963	1,232,992	561,378
Total manganese ore	[4] 1,892,609	[4] 1,809,189	[5] 1,249,389	561,378
Ferromanganese:				
High-carbon	823,132	735,578	}	
Medium-carbon } Low-carbon }	60,709	61,248	142,831	(6)
Total ferromanganese	883,841	796,826	[7] 142,831	(6)
Spiegeleisen	80,556	69,029	32,299	----------
Silicomanganese	92,770	92,659	[7] 15,736	(6)
Manganese briquets	18,742	16,627	[7] 4,460	----------
Manganese metal and misc. alloys	1,585	1,512	[7] 155	----------
Producers stocks ferromanganese, silicomanganese, and manganese metal	----------	----------	52,221	27,408

[1] Excluding Government stocks.
[2] Includes only that part of castings made by companies that also produce steel ingots.
[3] Excludes companies that produce both steel castings and steel ingots.
[4] The greater part of the consumption of ore was used in the manufacture of ferromanganese and silicomanganese. Combining consumption of ore with that of ferromanganese and silicomanganese would result in duplication.
[5] Excludes small tonnages of dealers' stocks.
[6] Included in "Producers stocks ferromanganese, silicomanganese, and Mn metal."
[7] Excludes producers' stocks.

The consumption in 1952 of manganese as ferroalloys and directly charged ore per short ton of open-hearth, bessemer, and electric steel produced was 13.6 pounds compared to 13.2 pounds in 1951. Of the 13.6 pounds, 12.2 pounds was in the form of ferromanganese, 1.1 pounds silicomanganese, 0.25 pound spiegeleisen, and 0.05 pound ore, manganese metal and miscellaneous alloys. These data apply to the consumption of manganese in the production of steel ingots and that part of steel castings produced by companies that also produce steel ingots. The companies reporting in this part of the survey approximate those reporting production to the American Iron and Steel Institute. If the manganese consumed by those companies producing only castings is also taken into account, the total pounds of manganese consumed per short ton of steel in 1952 becomes 14.5, of which 12.8 represents ferromanganese, 1.3 silicomanganese, 0.3 spiegeleisen, and 0.1 ore, metal, miscellaneous alloys, and briquets.

Electrolytic Manganese and Manganese Metal.—Electro Manganese Corp., Knoxville, Tenn., was the only producer of electrolytic manganese during 1952, but Electro Metallurgical Co. produced manganese metal in electric furnaces. The latter product has a minimum purity of 96 percent manganese, the electrolytic manganese 99.9+ percent. Electro Manganese Corp. began construction of a new plant at Knoxville, Tenn., which will double its productive capacity. Electro Metallurgical Co. also began construction of a new ferroalloy plant at Marietta, Ohio, in which electrolytic manganese will be one of the products.

Bureau of Mines Report of Investigation 4861, Electrolytic Manganese Tests in Cooperation With Industry, was published in May. This summarizes results of industrial tests of various applications of electrolytic manganese made over a number of years by the Bureau of Mines in cooperation with members of the ferrous and nonferrous metal industries, and the manufacturers of welding-rod coatings. The results speak well for the future of electrolytic manganese.

Ferromanganese.—Production of ferromanganese in the United States was 758,721 short tons in 1952 compared with 791,260 tons in 1951. The following plants were active producers during the year: Anaconda Copper Mining Co., Anaconda and Black Eagle, Mont.; Bethlehem Steel Co., Johnstown, Pa.; Electro Metallurgical Co., Division of Union Carbide & Carbon Corp., Alloy, W. Va., Ashtabula, Ohio, Marietta, Ohio, and Niagara Falls, N. Y.; E. J. Lavino & Co., Reusens, Va., and Sheridan, Pa.; New Jersey Zinc Co., Palmerton, Pa.; Tennessee Coal, Iron & Railroad Co., Ensley, Ala.; Tennessee Products & Chemical Corp., Chattanooga, Tenn.; Tenn Tex Alloy & Chemical Corp., Houston, Tex.; United States Steel Co., Clairton, Duquesne, Etna, Pa. Manganese ore consumed in manufacturing ferromanganese totaled 1,448,232 short tons in 1952, of which 6 percent was of domestic origin and 94 percent foreign. In 1951 and 1950, the domestic contribution was 7 percent. Although the average grade of ore used in producing ferromanganese was lower than that of 1951, recovery of manganese increased to 88.6 percent. Recovery for 1951 was 86.2 percent; for 1950 it was 83.6 percent. Shipments of ferromanganese from producing furnaces decreased 7 percent in quantity but increased 10 percent in value from 1951.

TABLE 9.—Ferromanganese and spiegeleisen imported into and made from domestic and imported ores in the United States, 1951–52

	1951		1952	
	Gross weight (short tons)	Mn content (short tons)	Gross weight (short tons)	Mn content (short tons)
Ferromanganese: [1]				
Imported	119, 764	94, 946	64, 095	51, 029
Domestic production—total	791, 260	601, 758	758, 721	583, 731
From domestic ore [2]	73, 512	55, 906	55, 356	42, 591
From imported ore [2]	717, 748	545, 852	703, 365	541, 140
Total	911, 024	696, 704	822, 816	634, 760
Spiegeleisen.[3]				
Imported			44	[2] 8
Domestic production [4]	77 017	15, 735	58, 666	11, 663
Total	77, 017	15, 735	58, 710	11, 671
Total available supply of metallic manganese in ferromanganese and spiegeleisen		712, 439		646, 431
Open-hearth, bessemer, and electric [5] furnace steel produced	105, 199, 848		93, 168, 039	
	Percent		Percent	
Percent of available supply of metallic manganese in:				
Ferromanganese and spiegeleisen imported	13. 33		7. 90	
Ferromanganese made from imported ore	76. 62		83. 71	
Ferromanganese made from domestic ore	7. 85		6. 59	
Spiegeleisen made from domestic ore	2. 20		1. 80	
Ferromanganese and spiegeleisen made from domestic ore	10. 05		8. 39	
Spiegeleisen made and imported	2. 20		1. 81	
Percent of Mn in ferromanganese of domestic origin to total Mn in ferromanganese made and imported	8. 0		6. 7	
Percent of Mn in spiegeleisen of domestic origin to total Mn in spiegeleisen made and imported	100. 0		99. 9	

[1] Number of domestic plants making ferromanganese: 1951, 14; 1952, 15.
[2] Estimated.
[3] Number of domestic plants making spiegeleisen: 1951, 5; 1952, 3.
[4] No spiegeleisen produced from foreign ore.
[5] Includes crucible.

TABLE 10.—Ferromanganese produced in the United States and metalliferous materials consumed in its manufacture, 1943–47 (average) and 1948–52

Year	Ferromanganese produced			Materials consumed (short tons)			Manganese ore used per ton of ferromanganese made (short tons)
	Short tons	Manganese contained		Manganese ore (35 percent or more Mn natural)		Iron and manganiferous iron ores	
		Percent	Short tons	Foreign	Domestic		
1943–47 (average)	626, 295	78. 79	493, 496	1, 095, 262	128, 247	3, 040	1. 954
1948	647, 617	78. 42	507, 843	1, 209, 249	78, 702	5, 930	1. 989
1949	577, 345	78. 33	452, 249	1, 054, 445	114, 924	2, 540	2. 025
1950	719, 680	76. 96	553, 834	1, 311, 421	105, 382		1. 969
1951	791, 260	76. 05	601, 758	1, 416, 813	110, 607	11, 667	1. 930
1952	758, 721	76. 94	583, 731	1, 364, 618	83, 614	18, 227	1. 909

TABLE 11.—Manganese ore used in manufacture of ferromanganese in the United States, 1948–52, by source of ore

Source of ore	1948		1949		1950		1951		1952	
	Gross weight (short tons)	Mn content, natural (percent)	Gross weight (short tons)	Mn content, natural (percent)	Gross weight (short tons)	Mn content, natural (percent)	Gross weight (short tons)	Mn content, natural (percent)	Gross weight (short tons)	Mn content, natural (percent)
Domestic	78, 702	59. 26	114, 924	59. 13	105. 382	58. 02	110, 607	58. 34	83, 614	56. 95
Foreign:										
Africa	386, 503	46. 69	367, 339	46, 24	606, 248	46. 00	641, 013	44. 36	510, 452	45. 59
Brazil	159, 668	40. 81	138, 917	40. 76	128, 940	40. 82	146, 108	40. 83	118, 842	40. 03
Chile	5, 195	47. 91	3, 838	47. 78	7, 279	47. 68	8, 484	47. 15	12, 586	47. 21
Cuba	35, 328	42. 87	36, 344	38. 83	42, 893	39. 20	103, 263	39. 50	136, 436	39. 82
India	304, 607	47. 82	258, 372	46. 96	447, 749	48. 15	449. 780	48. 03	477, 428	46. 03
Indonesia	--------	------	--------	------	--------	------	801	46. 94	8, 291	43. 77
Mexico	40, 420	41. 79	27, 952	40. 81	25, 851	41. 48	40, 402	40. 81	51, 571	40. 84
New Caledonia	--------	------	--------	------	--------	------	--------	------	12, 092	46. 35
Philippines	7, 763	46. 13	10, 922	45. 12	5, 036	46. 84	5, 232	44. 76	7, 064	41. 19
Turkey	--------	------	--------	------	2, 928	45. 97	9, 505	42. 64	16, 053	39. 90
U. S. S. R	269, 765	46. 08	210, 761	44. 91	44, 497	43. 59	10, 097	46. 01	--------	------
Other	--------	------	--------	------	--------	------	2, 128	39. 66	13, 803	37. 36
Grand total	1, 287, 951	46. 61	1, 169, 369	46. 41	1, 416, 803	46. 77	1, 527, 420	45. 71	1, 448, 232	45. 07

TABLE 12.—Ferromanganese shipped from furnaces in the United States, 1943–47 (average) and 1948–52

Year	Short tons	Value	Year	Short tons	Value
1943–47 (average)	631, 310	$81, 024, 690	1950	731, 421	$116, 043, 055
1948	659, 193	90, 126, 657	1951	795, 745	122, 346, 198
1949	560, 180	86, 463, 708	1952	738, 088	133, 996, 006

Silicomanganese.—Consumption of silicomanganese in 1952 was 11.6 percent that of ferromanganese as compared to 10.5 percent in 1951. Analyses quoted for the alloy give a manganese content of 65 to 68 percent, carbon from 1½ to 3 percent, and silicon 12 to 20 percent, with the carbon content increasing as silicon decreases. Silicomanganese is being used increasingly by the steel industry as a furnace control agent, as a deoxidizer, and for manganese additions. It has been found to be particularly useful for manganese additions to low carbon or high manganese steels.

Spiegeleisen.—Production of spiegeleisen in the United States decreased 24 percent in 1952 to 58,666 short tons from 77,017 tons in 1951. Shipments from furnaces decreased 15 percent in quantity and 12 percent in value. Three companies produced spiegeleisen in three plants in 1952: Bethlehem Steel Co., Johnstown, Pa.; New Jersey Zinc Co., Palmerton, Pa.; and United States Steel Co., Clairton, Pa.

TABLE 13.—Spiegeleisen produced and shipped in the United States, 1943–47 (average) and 1948–52

Year	Produced (short tons)	Shipped from furnaces		Year	Produced (short tons)	Shipped from furnaces	
		Short tons	Value			Short tons	Value
1943–47 (average)	139, 926	140, 547	$4, 712, 258	1950	42, 375	65, 163	$3, 875, 823
1948	112, 610	108, 960	5, 261, 650	1951	77, 017	79, 168	5, 368, 989
1949	78, 167	53, 888	2, 972, 653	1952	58, 666	67, 129	4, 730, 631

Manganiferous Pig Iron.—Pig-iron furnaces used 1,109,385 short tons of manganese-bearing ores containing (natural) over 5 percent manganese in 1952. Of this quantity, 934,768 tons were of domestic origin and 174,617 tons foreign. Of the domestic ores used, 909,061 tons contained (natural) 5 to 10 percent manganese, 20,564 tons contained 10 to 35 percent manganese, and 5,143 tons contained more than 35 percent manganese. Of the foreign ores used, none contained less than 10 percent manganese, 147,819 tons contained (natural) 10 to 35 percent manganese, and 26,798 tons contained over 35 percent manganese.

Battery and Miscellaneous Industries.—Manufacturers of dry cells used 39,897 short tons of manganese ore during 1952, of which 4,720 tons were of domestic origin. Although the total ore used decreased 10 percent from that of 1951, the portion which was of domestic origin actually increased 48 percent. Chemical plants used 21,409 short tons, of which 5,251 tons were domestic. All of the above ore contained (natural) over 35 percent manganese. The principal use of chemical ore is in the manufacture of dyes, manganese sulfate for fertilizer, hydroquinone, and permanganates.

TABLE 14.—Foreign ferruginous manganese ore and manganiferous iron ore consumed in the United States, 1949–52, in short tons

Source of ore	Ferruginous manganese ore				Manganiferous iron ore			
	1949	1950	1951	1952	1949	1950	1951	1952
Africa	4,673	2,034	2	1,048	67,466	43,725		
Brazil				361				
Egypt		92,905	87,455	152,483				
Mexico	6							
Total	4,679	94,939	87,457	153,892	67,466	43,725		

PRICES

Manganese Ore.—Government prices for domestically mined manganese ore meeting specifications and regulations were calculated on the basis of $2.30 per long-ton unit for 48 percent of either contained or recoverable manganese. Prices of Indian manganese ore of 46 to 48 percent manganese content, as quoted by E&MJ Metal and Mineral Markets, began the year at $1.20 to $1.25 per long-ton unit of manganese, c. i. f. United States ports, duty extra, and closed at $1.20 to $1.22 after having reached $1.22 to $1.27. Long-term contracts for ore from various sources were quoted at the beginning of the year as nominal at 90 to 95 cents per long-ton unit, c. i. f. duty extra; and nominal at 90 to 93 cents, c. i. f. United States ports, duty extra, at the end of the year. Prices for foreign chemical ores remained essentially the same throughout the year at $75 to $80 per ton for ore of 85 percent manganese dioxide content, and $65 to $70 per ton for ore of 80 percent content, except for the close of the year when the latter figure increased to $65 to $75. Domestic chemical ore, containing 70 to 72 percent manganese dioxide was quoted at $45 to $50 for the year. Duty remained at one-fourth cent per pound of contained manganese, except material from Cuba and the Republic of the Philippines, which was exempt from duty, and that from Soviet Russia and certain neighboring countries, for which a 1-cent-per-pound duty applied.

Manganese Alloys.—The average value, f. o. b. producers' furnaces, for ferromanganese shipped during 1952 was $181.54 per short ton compared with $153.75 in 1951. According to Iron Age, the selling price of ferromanganese in carlots at eastern centers was held at $186.25 per gross ton from the end of 1951, until August when OPS allowed an increase of $40 per ton. The price then remained at $226.25 for the rest of the year, giving an average for the year of $202.08. The average value for spiegeleisen, f. o. b. domestic furnaces, was $70.47 per short ton compared with $67.82 for 1951. The quoted price on a gross-ton basis, as given by Iron Age, followed the same pattern as that of ferromanganese, holding at $75 until August, at which time it was increased to $85 where it remained to the end of the year. The average quoted price per gross ton was $78.66 in 1952 These alloys were under price control by the OPS throughout the year.

FOREIGN TRADE [2]

Imports of manganese ore for 1952 were the highest on record; but average grade continued to decrease, being 45.2 percent compared with 46.1 percent and 46.6 percent for 1951 and 1950, respectively. As in 1951, no ore was received from the Soviet Union.

Indian receipts, almost double those of 1951, exceeded 1 million short tons, thereby establishing an alltime record for imports of manganese into the United States from any country. The grade was down, however, to 44.9 percent manganese compared to 47.1 percent in 1951. The supply from India for 1952 was 39 percent of the total ore received.

Gold Coast of Africa was again the second largest source of imports, with 14 percent of the total, averaging 48.2 percent manganese, but its shipments of battery- and chemical-grade ores to the United States again decreased. Total imports from Gold Coast showed only a nominal increase over those of 1951.

Union of South Africa was a close third, with 12 percent of the import total and an average grade of 44.0 percent manganese. Tonnage was less, but grade better, than in 1951.

Imports from Cuba approached double those of 1951 and kept Cuba in fourth place. The grade (43.6 percent manganese) was lower than in 1951. A relatively small quantity of battery-grade ore was imported from Cuba. Imports from Brazil showed a similar increase in tonnage, also at expense of grade, which was 44.3 percent manganese in 1952. Mexico, in sixth place, increased its exports to the United States to approximately one and one-half times those of 1951. The grade (42.2 percent manganese) was down from that in 1951. Thirteen other countries supplied the remaining 15 percent of the total United States imports. Of these, French Morocco, Angola, Portuguese Asia, Belgian Congo, and Turkey were most important, in the order given.

Import data include receipts of ore classified as battery-grade totaling 57,452 short tons in 1952. Of this quantity, 48,155 tons came from Gold Coast, 4,743 from French Morocco, 4,288 from Cuba, and 266 from Chile; this ore averaged 55.2 percent manganese or 87.4 percent manganese dixoide, and it is known that these imports include some receipts of chemical ore. Imports for consumption of

[2] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 15.—Manganese ore (35 percent or more Mn) imported into the United States, 1951–52, by countries

[U. S. Department of Commerce]

Country	General imports [1] (short tons)				Imports for consumption [2]					
					Short tons				Value	
	Gross weight		Mn content		Gross weight		Mn content			
	1951	1952	1951	1952	1951	1952	1951	1952	1951	1952
Angola	[3] 38, 593	64, 559	[3] 18, 571	31, 501	32, 478	68, 387	16, 157	33, 655	$1, 100, 311	$3. 030, 600
Belgian Congo	9, 613	54, 144	4, 737	27, 000	10, 929	56, 321	5, 377	28, 032	421, 211	2, 496, 334
Brazil	[3] 94, 931	169, 372	[3] 43, 329	75, 052	97, 624	174, 241	44, 247	77, 448	1, 841, 810	4, 300, 963
British Malaya	34	----	18	----	34	----	18	----	785	----
Chile	21, 264	28, 311	10, 098	12, 596	23, 843	21, 733	11, 419	9, 646	753. 857	757, 713
Costa Rica	----	91	----	38	----	----	----	----	----	----
Cuba	147, 086	259, 230	65, 319	113, 051	147, 086	259, 230	65, 319	113, 051	4, 849, 172	8, 801, 648
French Morocco	[3] 46, 581	85, 316	[3] 24, 157	42, 608	44, 952	74, 191	23, 155	37, 159	1, 743, 330	3, 313, 136
French Pacific Islands	----	22, 459	----	10, 303	----	9, 628	----	4, 529	----	353, 533
Gold Coast	[3] 359, 883	368, 068	[3] 173, 060	177, 376	360, 326	282, 051	174, 755	135, 350	8, 541, 374	8, 204, 873
Greece	2, 524	8, 372	1, 189	3, 175	2, 524	1, 350	1, 189	547	83, 130	29, 446
India	565, 557	1, 028, 289	266, 586	461, 763	616, 892	772, 456	295, 105	352, 018	14, 180, 911	22, 329, 239
Indonesia	2, 278	13, 126	1, 093	5, 959	----	13, 878	----	6, 340	----	567, 414
Iran	3, 239	----	1, 426	----	3, 239	----	1, 426	----	110, 758	----
Mexico	92, 227	135, 718	39, 803	57, 214	99, 927	92, 251	43, 324	39, 258	2, 548, 180	2, 675, 885
New Zealand	----	545	----	265	----	545	----	265	----	24, 887
Peru	1, 516	3. 687	824	1, 736	1, 244	3, 755	709	1, 766	42, 833	140, 046
Philippines	12, 301	10, 587	5, 830	4, 677	12, 301	10, 587	5, 830	4, 677	351, 062	321, 594
Portugal	----	----	----	----	447	----	188	----	8, 567	----
Portuguese Asia	621	55, 815	261	23, 902	621	45, 777	261	19, 416	14, 679	1, 686, 791
Turkey	21, 673	41, 149	10, 331	18, 545	19, 615	18, 908	9, 213	8, 319	645, 706	666, 577
Union of South Africa	347, 659	319, 719	147, 999	140, 552	423, 985	298, 305	182, 086	129, 567	7, 630, 216	6, 110, 503
U. S. S. R	----	----	----	----	2, 586	----	1, 282	----	78, 742	----
Western Portuguese Africa, n. e. s	([4])	----	([4])	----	2, 206	----	1, 180	----	72, 996	----
Total	[3] 1, 767, 580	2, 668, 557	[3] 814, 631	1, 207, 313	1, 902, 859	2, 203, 594	882, 240	1, 001, 043	45, 019, 630	65, 811, 182

[1] Comprises ore received in the United States during year; part went into consumption, and remainder entered bonded warehouses.
[2] Comprises receipts during year for consumption and ore withdrawn from bonded warehouses during year.
[3] Revised figure.
[4] Less than 1 ton.

battery ore (including some chemical) totaled 58,482 short tons valued at $2,380,388 or $40.70 per short ton f. o. b. foreign ports. Of the total, Gold Coast supplied 49,185 tons valued at $1,934,306; French Morocco, 4,743 tons at $230,982; Cuba, 4,288 tons at $205,100; and Chile, 266 tons at $10,000.

Imports for consumption of ferromanganese in 1952 decreased 46 percent from 1951; exports increased 130 percent to 1,453 short tons. Exports of manganese ore and concentrates (10 percent or more manganese) were 9,749 short tons valued at $504,416.

TABLE 16.—Ferromanganese imported for consumption in the United States, 1950–52, by countries

[U. S. Department of Commerce]

Country	1950			1951			1952		
	Gross weight (short tons)	Mn content (short tons)	Value	Gross weight (short tons)	Mn content (short tons)	Value	Gross weight (short tons)	Mn content (short tons)	Value
Belgium-Luxembourg	215	170	$28,133						
Canada	24,029	19,099	3,315,823	67,374	52,878	$10,918,197	29,020	22,735	$5,473,927
Chile	110	87	14,494						
France	19,965	15,533	2,578,054	13,356	10,444	1,714,963	3,834	2,995	579,759
Germany	110	95	26,636	67	32	5,198	63	25	5,198
Japan	622	504	80,467	165	133	22,773			
Norway	60,223	48,378	9,542,794	38,637	31,344	7,358,514	30,296	24,674	8,550,625
Sweden	50	45	11,160						
U. S. S. R.	4,122	3,215	574,080						
United Kingdom	58	45	12,464						
Yugoslavia	444	322	53,670	165	115	26,494	882	600	149,435
Total	109,948	87,493	16,237,775	119,764	94,946	20,046,139	64,095	51,029	14,758,944

TABLE 17.—Spiegeleisen imported for consumption in the United States, 1943–47 (average) and 1948–52 [1]

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1943–47 (average)	2,104	$90,735	1950	8,595	$474,259
1948			1951		
1949	1,737	86,217	1952	44	3,658

[1] Does not include minor quantities of spiegeleisen under 1 percent carbon.

TABLE 18.—Ferromanganese exported from the United States, 1943–47 (average) and 1948–52

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1943–47 (average)	7,413	$1,037,547	1950	580	$139,876
1948	19,696	2,990,645	1951	633	206,614
1949	6,627	1,360,279	1952	1,453	474,686

TECHNOLOGY

The recovery of manganese from open-hearth slags in a form suitable for use in manufacturing standard ferromanganese was determined to be technically feasible by means of a pyrometallurgical process developed at Pittsburgh by the Bureau of Mines in cooperation with the American Iron and Steel Institute. The first step in this operation is blast-furnace production of a high-phosphorus spiegeleisen. This spiegeleisen is then blown in a basic-lined converter to produce a high-manganese slag of low phosphorus and iron content, control of the phosphorus and iron being obtained by a cyclic operating procedure. The slag product, which is essentially a high-grade synthetic metallurgical ore, is then used for normal production of ferromanganese. Fertilizer material and a high-purity iron for use as steel-furnace melting stock are possible byproducts. Satisfactory spiegeleisen, comparable to that produced when slag is used for feed, was obtained when material from the manganese deposits of Aroostook County, Maine, was fed to the furnace. Flux consumption was much higher than for the runs in which slag was the raw material.

On December 31, Defense Materials Procurement Agency announced that a contract had been signed with Magnaslag, Inc., for constructing and operating an experimental plant at Coxton, Luzerne County, Pa., to prove the commercial feasibility of the process, using slags for feed and anthracite for fuel. The plant is expected to attain a production rate of at least 1,000 long tons of ferromanganese per month. Slags for the feed to the plant will be supplied by major steel companies.

At College Park, Md., also under cooperative agreement with the American Iron and Steel Institute, the Bureau of Mines continued laboratory and pilot-plant investigation of the lime-clinkering carbonate-leach process for recovering manganese from slags. This process produces a lime clinker in a rotary kiln. The pulverized clinker is then reduced with hydrogen and leached with ammonium carbonate, and finally the manganese is precipitated as a carbonate ammonical by distilling off a portion of the ammonium carbonate.

It has been estimated that the quantity of open-hearth slag produced annually at integrated steel plants in the United States could provide nearly half of domestic needs. Since large reserves are already available in dumps situated right at the steel plants, the value of successful methods for the recovery of their manganese content is evident.

Research in the College Park laboratory continued on chemical methods for winning manganese from the low-grade deposits of Aroostook County, Maine. Leaching with dilute sulfuric acid showed promise for certain of the materials; manganese chloride volatilization for others. A résumé of the various methods investigated is given in Bureau of Mines Report of Investigation 4921, Maple Mountain–Hovey Mountain Manganese Project, Central District, Aroostook County, Maine.

The Bureau of Mines pilot plant at Boulder City, Nev., was completed and placed in operation for large-scale concentration and leaching tests of Artillery Peak and other low-grade materials, and encouraging results were had. By means of a combination of flotation and dithionate leaching, a product suitable for producing ferromanganese has been obtained from raw material containing 8 to 10 percent manganese.

Experimental work with electric furnaces at the Bureau's Albany, Oreg., station resulted in satisfactory production of standard-grade silicomanganese from rhodonite materials of the Northwest.

At Minneapolis the Bureau of Mines continued research toward recovery of a ferrograde product from the manganiferous carbonate slates and the lean brown and black manganiferous oxides of the Cuyuna range. Based on encouraging laboratory tests, a shaft-type furnace was constructed for experiments with these materials to produce a water soluble manganese sulfate by means of a sulfur dioxide-air roast.

Toward the close of the year a new manganese-chrome alloy, containing less than 1 percent nickel, was marketed as a substitute for the regular nickel-bearing (18–8) stainless steels, use of which has been restricted as a conservation measure for nickel. Both electrolytic manganese and low-carbon, low-phosphorus ferromanganese have been used in producing the new alloy.

WORLD REVIEW

The data in table 19 are from official statistics of the various countries, supplemented by information from semiofficial and other sources.

Brazil.—Development continued on the Amapa deposits in which Bethlehem Steel Corp. has a 49-percent interest through Industria e Commercio de Minerios (Icomi). As a result of core drilling, reserves of 10,000,000 tons of ore of 45- to 47-percent Mn grade have been estimated, with larger tonnages of lower grade. Mining will be by open pit, with crushing and screening near the mine. Negotiations proceeded during the year for a $67,500,000 loan from United States Export-Import Bank, successfully culminating in January 1953. Negotiations continued with regard to United States Steel Corp.'s concession to develop the Urucum deposits in the state of Mato Grosso. Reserves of manganese ore are estimated to be 34,000,000 metric tons, averaging 45.6 percent Mn. In addition the concession has iron-ore deposits estimated at 1.3 billion tons, averaging 55 percent Fe.[3] [4]

British Guiana.—Low-grade manganese ore has been discovered at a number of locations in northwestern British Guiana.[5] African Manganese Co., Ltd., and Union Carbide & Carbon Corp. together engaged in exploration of a concession and are said to have defined a possible area 5 miles long by a maximum width of 1,000 feet. Samples have averaged about 43 percent Mn with high silica content.[6] An independent survey was also being carried out in British Guiana by African Manganese Co., Ltd.[7]

Chile.—Production of ferromanganese totaled 8,164 metric tons in 1951 and 3,721 tons in the first 10 months of 1952. The 1952 output declined because one furnace was used exclusively to produce calcium carbide. Small quantities of medium-carbon ferromanganese and silicomanganese were produced on an experimental basis in 1952 and commercial-scale production of medium and low carbon ferromanganese was planned. Future supplies of manganese ore for the Huachipato plant were far from assured, as most of its ore comes from Manganesos Atacama, which looks to a somewhat uncertain future. Some fairly large deposits of low-grade ores have been located in the Corral

[3] Iron Age, vol. 171, No. 3, Jan. 15, 1953, pp. 37–38.
[4] Chemical and Engineering News, vol. 30, No. 48, Dec. 1, 1952, p. 5071.
[5] Mining Journal (London), vol. 238, No. 6081, Mar. 7, 1952, p. 243.
[6] Northern Miner, vol. 38, No. 45, Jan. 29, 1953. p. 10.
[7] Northern Miner, vol. 38, No. 26, Sept. 28, 1952, p. 12.

TABLE 19.—World production of manganese ore, by countries,[1] 1946–52, in metric tons [2]

[Compiled by Lee S. Petersen]

Country [1]	Percent Mn	1946	1947	1948	1949	1950	1951	1952
North America:								
Canada (shipments)			204	3				
Cuba	36–50+	130,764	50,397	29,073	62,503	79,209	154,091	[3] 251,677
Mexico	42–45	25,000	31,400	53,800	53,900	32,400	66,100	102,000
United States (shipments)	35+	130,303	119,409	118,931	114,427	121,971	95,260	104,670
South America:								
Brazil (exports)	38–50	149,149	142,092	141,253	149,896	148,339	119,900	[3] 160,000
Chile	40–50	21,885	19,352	22,119	28,870	33,530	36,578	[3] 38,000
Peru	62+					762	699	597
Europe:								
Greece	35+	15		900	150	320	[3] 3,000	[3] 8,500
Hungary	35–48	14,780	33,470	[3] 40,000	(4)	(4)	(4)	(4)
Italy	30	8,383	26,547	25,233	24,302	16,208	27,743	40,351
Portugal	35–45	5,932	2,444	280	508	798	7,615	11,065
Rumania	30–36	18,807	(4)	[3] 47,000	[3] 65,000	(4)	(4)	(4)
Spain	40+	29,589	22,428	18,525	18,651	19,002	20,790	[5] 29,292
Sweden	30+	1,525	773	28		58	(4)	(4)
U. S. S. R. (estimate)	41–48	1,700,000	1,800,000	1,800,000	1,500,000	2,000,000	2,500,000	2,500,000
Yugoslavia	30+	[3] 7,000	[3] 11,700	[3] 12,000	[3] 12,000	13,338	12,743	12,687
Asia:								
China	41	[6] 9,600	20,000	[3] 22,000	(4)	(4)	(4)	(4)
India	47–52	256,975	458,274	534,316	656,190	897,100	1,304,536	[7] 1,291,755
Iran [8]	36–46				[3] 4,200	[3] 9,360	(4)	9,327
Japan	32–40	29,394	33,194	55,000	100,000	134,066	198,000	[3] 180,000
Philippines	35–51		3,375	25,565	26,288	29,867	22,343	20,627
Portuguese India	32–50+	(4)	[7] 100	5,893	16,220	38,220	86,793	112,849
Turkey	30–50	2,370	5,833	8,327	22,576	32,178	50,517	101,808
Africa:								
Angola	50	1,900	700	400	18,600	9,308	46,192	55,094
Belgian Congo	50+	12,231	17,646	12,765	12,247	16,990	70,945	[3] 150,000
Egypt	30+	25	29	59,919	138,568	152,169	155,364	209,164
French Morocco	32–50	57,990	114,290	214,412	233,825	287,265	372,233	426,316
Gold Coast (exports) [9]	50+	777,583	598,655	640,088	752,963	722,784	819,018	794,187
Northern Rhodesia	30+			3,961	4,039	1,751	1,280	3,989
Southern Rhodesia				10	166			1,433
South-West Africa						993	6,560	26,507
Spanish Morocco	50			13	653	36	1,122	(5)
Tunisia	35–40		25					
Union of South Africa	40–50	237,897	288,213	276,393	655,175	790,937	758,870	874,637
Oceania:								
Australia		1,407	1,804	3,502	13,303	15,108	8,096	[3] 5,000
Fiji				71	102	203	[7] 641	(4)
New Caledonia	45–50				2,100	5,392	20,135	16,850
New Zealand		408	335	533	310	358	408	(4)
Papua		44	83	[10] 160	[10] 163	[10] 60	21	41
Total (estimate)		3,700,000	3,900,000	4,200,000	4,800,000	5,800,000	7,100,000	7,700,000

[1] In addition to countries listed, Argentina, Bulgaria, and Korea have produced manganese ore; data of output are not available, but estimates for them are included in totals. Czechoslovakia and Germany report production of manganese ore, but it is believed that the product so reported averages less than 30 percent Mn and therefore would be considered ferruginous manganese ore under the classification used in this report, hence the output is not included in this table.
[2] This table incorporates a number of revisions of data published in previous manganese chapters.
[3] Estimate.
[4] Data not available; estimate by authors of chapter included in total.
[5] Spanish Morocco included in figure for Spain.
[6] Incomplete data.
[7] Exports.
[8] Year ending March 20 of year following that stated. 1952 is a calendar year.
[9] Dry weight.
[10] Year ending June 30 of year stated.

Quemado district which appeared on cursory testing to be amenable to concentration, with high manganese recovery.[8]

Cuba.—Manganese ore that cannot now be exploited commercially were planned to be treated in a $60,000 pilot plant; the Government to bear half the cost, the Agricultural and Industrial Bank the remainder.[9]

[8] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 2, February 1953, pp. 17–21.
[9] Engineering and Mining Journal, vol. 153, No. 7, July 1952, p. 166.

Denmark.—Danish authorities have banned exports of bog manganese ore with greater than 10 percent Mn content, in order to conserve the ores for a domestic manganese sulfate industry. Bog ore had been exported yearly to the Ruhr before the ban.[10]

French Equatorial Africa.—An interesting deposit of manganese ore has been located near Tiore, the manganese occurring as pyrolusite in schists. A minimum of 700,000 tons grading from 25 to 50 percent Mn has been reported.[11] United States Steel Co. was interested with several French firms in forming a company to develop manganese ore deposits in Gabon.[12]

French Morocco.—In 1952 French Morocco produced 382,808 metric tons of metallurgical ore and 43,508 tons of chemical ore. Of the metallurgical ore exported, 79 percent was shipped to France and virtually all the remainder to the United States. Of the chemical ore exported, France received the largest portion, followed in decreasing order by West Germany, United States, United Kingdom, Netherlands, and small quantities elsewhere. Metallurgical ore produced at Imini was credited with a 50-percent manganese content and accounted for half of the country's 1952 output of metallurgical ore. Exports of metallurgical ore included 139,963 tons of sinter as follows: 98,579 tons of Imini (56-percent-grade) to France; 27,804 tons of Imini (56-percent) to the United States; and 13,580 tons of Bou Arfa (36-percent) to France.[13]

India.—A special heavy-medium-separation plant for treating manganese ore from the mines of the Central Provinces Manganese Ore Co., Ltd., was scheduled for initial operation in 1952.[14] The Central Provinces Mn Ore Co. is the largest manganese-mining concern in India and is responsible for 50 to 60 percent of the total Indian production.[15]

Israel.—Manganese ores occur in an area about 25 kilometers north of Elath. Israel's own manganese requirements will remain comparatively small in the foreseeable future.[16]

New Caledonia.—During the first half of 1952, a new manganese-ore-mining operation was begun near Voh by Lecomte. The mines of Paul Videault supplied the remainder of New Caledonia's output for the period.[17]

New Zealand.—The Otau mine, 30 miles south of Auckland, is believed to be the only manganese producer in New Zealand. It shipped 500 tons of ore to the United States in 1952. Previous shipments were to Australia.[18]

Northern Rhodesia.—Discovery of high-grade manganese ore 12 miles northwest of Fort Roseberry was reported late in 1952. G. & W. Base Minerals (Pty.), Ltd., controls the deposit and expects to produce 500 tons a month of ore assaying over 52 percent manganese by June 1953. A long strike length of narrow, high-grade manganese

---

[10] Metal Industry, vol. 80, No. 9, Feb. 29, 1952, pp. 174–175.
[11] Mining World, vol. 14, No. 12, November 1952, p. 67.
[12] American Metal Market, vol. 59, No. 250, Dec. 31, 1952, p. 1.
[13] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 17–19.
[14] Mining World, vol. 14, No. 2, February 1952, p. 67.
[15] South African Mining and Engineering Journal, vol. 62, No. 3075, part 2, Jan. 19, 1952, p. 901.
[16] Mining Journal (London), vol. 238, No. 6081, Mar. 7, 1952, p. 240.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 4, October 1952, p. 17.
[18] Mining World, vol. 14, No. 12, November 1952, p. 62.

veins has been determined. All manganese ore produced in Northern Rhodesia in 1952 was sold locally to copper and zinc refineries.[19]

Philippine Islands.—The manganese mine in Ivisan, Capiz, was reopened and shipped manganese ore to the United States.[20] General Base Metals, Inc., expanded its plant facilities in carrying out its program of mechanization of mine operations. Its principal mining claims are situated on the island of Bohol. Additional loading facilities have been installed at the company pier in Guindulman, Bohol, increasing daily loading capacity to a maximum of 1,200 tons.[21]

Sudan.—A bed of manganese ore was recently discovered in Upper Nile Province, reported to contain a fairly high percentage of manganese and to be 12 feet thick at the point of discovery.[22]

Union of South Africa.—South African Manganese Ltd. showed interest in acquiring additional properties and prospecting new fields.[23]

Yugoslavia.—A manganese deposit was reported to have been located near the town of Jossani. It is said to be close to surface and will be mined by open-pit methods.[24]

---

[19] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 20.
[20] Mining World, vol. 14, No. 9, August 1952, p. 68.
[21] Mining World, vol. 14, No. 9, August 1952, p. 63.
[22] Chemical Age, vol. 66, No. 1719, June 21, 1952. p. 945.
[23] Mining World, vol. 14, No. 2, February 1952, p. 53.
[24] Mining World, vol. 14, No. 9, August 1952, p. 75.

Mercury

By Helena M. Meyer [1] and Gertrude N. Greenspoon [2]

NEAR-RECORD imports of mercury featured the industry in 1952. Only in 1945, when the newly developed mercury dry cell took unprecedented quantities, and in 1949, when surplus supplies were obtained from Italy with Economic Cooperation Administration counterpart funds, were receipts from abroad greater than in 1952. Receipts in 1952 were predominantly from Italy and Spain, the two countries supplying roughly equal shares.

Consumption failed to reach anticipated levels, chiefly because a completed large plant, which was to use mercury cells for electrolytic production of chlorine and caustic soda and which was planned to be producing some months before the end of the year, did not get beyond the test-run stage. Total consumption dropped 25 percent but was relatively high in comparison with all but a few earlier years in the entire history of the industry. Expansion in chlorine and caustic soda capacity in 1952, through construction of new plants at Plymouth, N. C., and McIntosh, Ala., and at some already operating plants, tended to hold consumption at the relatively high level. Smaller rather than larger consumption characterized most other uses in 1952.

Production in the United States increased substantially in 1952 but continued low in relation to most earlier years since mercury mining assumed importance a century ago. California, as usual, dominated output and with Nevada supplied 86 percent of the United States total. Despite the stimulation of continuing high prices there were fewer producers in 1952 than in 1951.

Industry stocks continued abnormally high and were even increased (14 percent) during the year; except for those at the end of 1950 they were probably the greatest for all time, although precise data are not available before World War II. The placing in operation of new chlorine and caustic soda plants at Anniston and Muscle Shoals, Ala., and Calvert City, Ky., is expected in 1953 and should reduce industry inventories to more nearly normal levels.

Mercury is one of the items for which the stockpile objective is not yet complete, but of which further acquisitions were not of the highest urgency.

Mercury prices in 1952 were 5 percent lower than in 1951 but except for that year were at the highest annual level of all times. The price trend was generally downward until August, when it was reversed, and the highest monthly average of the year was reached in December. Purchases late in the year substantially reduced the quantities of metal available for sale and caused the strength in prices at the year end.

---

[1] Assistant chief, Base Metals Branch.
[2] Statistical assistant.

From a world viewpoint supplies of mercury were at about the same level as in 1951 and 1950. Spain's increase in plant capacity was not to be effective before 1953, and output in that country declined 12 percent. The output of Italy and Yugoslavia continued at approximately the 1951 level, which for the latter was very high in relation to its earlier production rate.

TABLE 1.—Salient statistics of the mercury industry in the United States, 1943–47 (average) and 1948–52

[Flasks of 76 pounds]

	1943–47 (average)	1948	1949	1950	1951	1952
Production	33,794	14,388	9,930	4,535	7,293	12,547
Number of producing mines	81	20	23	16	47	39
Average price per flask: New York	$126.09	$76.49	$79.46	$81.26	$210.13	$199.10
Imports for consumption	32,575	31,951	103,141	56,080	47,860	71,855
Exports	793	526	577	447	241	400
Consumption	45,392	46,253	39,857	49,215	56,848	42,556

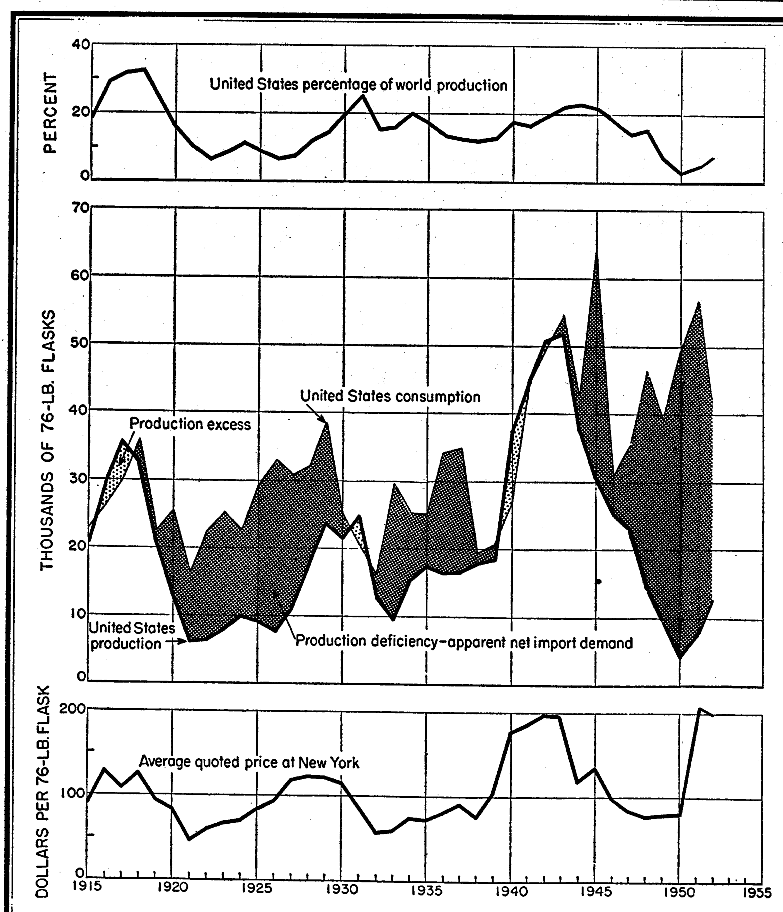

FIGURE 1.—Trends in production, consumption, and price of mercury, 1915–52.

Defense Minerals Exploration Administration.—The chapter on mercury in 1951 indicated that mercury was found to be ineligible for Defense Materials Procurement Agency production expansion assistance under provisions of the Defense Production Act. The Defense Minerals Exploration Administration, however, granted exploration assistance, amounting to 75 percent of costs, to approved mercury-exploration projects. The following applicants were awarded contracts with DMEA from the beginning of the program to the end of 1952:

State and contractor	*Project location*	*Value: Total*	*Value: Government participation*
Alaska: Clarence Wren, Frank Waskey, & Chas. Wolfe.	Bristol Bay recording district.	$25,614.00	$19,210.50
Arizona: Ord Mercury Mines.	Gila County	28,000.00	21,000.00
California:			
California Quicksilver Mines.	Lake County	39,440.00	29,580.00
New Idria Mining & Chemical Co.	San Benito County	243,349.00	182,511.75
Cordero Mining Co	Santa Clara County	200,828.00	150,621.00
Altoona Quicksilver Mining Co.	Trinity County	90,452.00	67,839.00
Nevada:			
W. F. Dunnigan	Esmeralda County	8,925.00	6,693.75
Aubrey Minney	Humboldt County	17,600.00	13,200.00
Oregon: Owen Pigmon	Crook County	20,460.00	15,345.00
Texas:			
J. E. Paulsel	Brewster County	75,900.00	56,925.00
Maravillas Minerals Co.	do	10,450.00	7,837.50
Amerimex Mining Co	Presidio County	80,000.00	60,000.00
Washington: Ray R. Whiting, Jr.	Yakima County	18,425.00	13,818.75

DOMESTIC PRODUCTION

Throughout 1952 production in the United States continued to be close to the rate in the fourth quarter of 1951 and for the year as a whole was 72 percent higher than in 1951. The output was the largest since 1948 but was small in relation to most earlier years of domestic production history, amounting to only 72 percent of the average annual quantity in 1935–39 and 29 percent of the average annual rate in World War II (1942–45, inclusive). The number of producing mines declined in 1952, contrary to the normal expectation that continuing high prices would bring more properties into production.

A total of 39 mines, compared with 47 in 1951, contributed to production in 1952; 11 properties each producing 100 flasks or more supplied 97 percent of the total production. The largest producers were as follows:

California.—Contra Costa County, Mount Diablo; Lake County, Abbott; San Benito County, Juniper and New Idria (including San Carlos); Santa Clara County, Guadalupe; Sonoma County, Culver-Baer, Mount Jackson (including Great Eastern), and Buckman.

Idaho.—Valley County, Hermes mine.

Nevada.—Humboldt County, Cordero mine.

Oregon.—Douglas County, Bonanza mine.

TABLE 2.—Mercury produced in the United States, 1949–52, by States

Year and State	Producing mines	Flasks of 76 pounds	Value [1]
1949:			
Alaska	1	100	$7,946
California	15	4,493	357,014
Nevada	5	4,170	331,348
Oregon	2	1,167	92,730
Total	23	9,930	789,038
1950:			
California	14	3,850	312,851
Nevada	1	680	55,257
Oregon	1	5	406
Total	16	4,535	368,514
1951:			
Arizona and Texas	3	77	$16,180
California	27	4,282	899,777
Idaho	1	357	75,016
Nevada	12	1,400	294,182
Oregon	4	1,177	247,323
Total	47	7,293	1,532,478
1952:			
Alaska	1	28	5,575
California	24	7,241	1,441,683
Idaho	1	887	176,602
Nevada	9	3,523	701,429
Oregon	4	868	172,819
Total	39	12,547	2,498,108

[1] Value calculated at average price at New York.

TABLE 3.—Mercury produced in the United States, 1943–47 (average) and 1948–52, by quarters, in flasks of 76 pounds

Quarter	1943–47 (average)	1948	1949	1950	1951	1952
First	8,910	5,300	1,440	1,700	880	3,050
Second	9,000	3,600	1,460	1,010	1,400	3,000
Third	8,460	3,150	} 6,980	{ 1,100	1,600	3,320
Fourth	7,550	2,050		630	3,270	3,130
Total: Preliminary	33,920	14,100	9,880	4,440	7,150	12,500
Final	33,794	14,388	9,930	4,535	7,293	12,547

For many years the grade of mercury ore treated in the United States trended downward, but the downtrend was interrupted in 1944–47, and in 1947 the average tenor of ore more than doubled that in 1941–42. The grade then dropped again to little more than half the 1947 average in 1951 but recovered 0.5 pound in 1952.

TABLE 4.—Mercury ore treated and mercury produced therefrom in the United States, 1927–52 [1]

[That material from old dumps which is not separable is included with ore]

Year	Ore treated (short tons)	Mercury produced: Flasks of 76 pounds	Mercury produced: Pounds per ton of ore
1927	99,969	10,711	8.1
1928	142,131	14,841	7.9
1929	248,314	19,461	6.0
1930	288,503	18,719	4.9
1931	260,471	22,625	6.6
1932	108,118	11,770	8.3
1933	78,089	8,381	8.2
1934	126,931	13,778	8.2
1935	135,100	15,280	8.6
1936	141,962	14,007	7.5
1937	186,578	16,316	6.6
1938	199,954	17,816	6.8
1939	191,892	18,505	7.3
1940	449,940	37,264	6.3
1941	652,141	43,873	5.1
1942	733,360	49,066	5.1
1943	613.111	50,761	6.3
1944	300,385	37,333	9.4
1945	209,009	29,754	10.8
1946	157,469	24,929	12.0
1947	139,311	22.823	12.5
1948	103,220	13,891	10.2
1949	71,977	9,745	10.3
1950	35,115	4,312	9.3
1951	81,067	6,934	6.5
1952	135,197	12,500	7.0

[1] Excludes mercury produced from placer operations and from clean-up activity at furnaces and other plants.

In addition to the mercury produced at the mines in 1952, at least 2,500 flasks was reported produced from old cells and other scrap, compared with 2,000 flasks in both 1951 and 1950. Additional unreported quantities doubtless were recovered.

REVIEW BY STATES

Alaska.—Mercury was reported produced in Alaska for the first time since 1949. At the Red Devil mine in the Sleitmute area, the Decoursey Mountain Mining Co., Inc., recovered 28 flasks of mercury from 70 tons of ore treated in a 45-ton rotary furnace.

California.—Production of mercury in California increased 69 percent over 1951 and was the largest since 1948; the State retained its rank as the leading mercury producer in the United States. California furnished 58 percent of the total production in 1952 compared with 59 percent in 1951 and 85 percent in 1950. The New Idria (including San Carlos) mine and San Benito County were the leading mine and county, respectively, in the State. Production came from 24 properties (compared with 27 in 1951) of which 7 reported production from cleanup, dump, or placer operations. In addition to San Benito County, output was reported from Contra Costa, Del Norte, Fresno, Lake, Napa, San Luis Obispo, Santa Clara, Sonoma, and Yolo Counties.

The Mount Diablo mine, where a rotary furnace was used, accounted for the production in Contra Costa County.

The small quantity produced in Del Norte County came from the Patricks Creek (Webb) mine.

All production in Fresno County was from the Archer mine.

The Abbott and Sulphur Bank mines were the producers in Lake County. At the Abbott mine, where a 40-ton rotary furnace was operated, production increased substantially over 1951. At the Sulphur Bank a very small quantity was produced from cleanup operations.

Mercury was recovered from old dumps at the James Creek and Oat Hill mines, Napa County. At the Knoxville mine mercury was recovered from dumps, and some ore was treated in a retort.

Seven properties contributed to the production in San Benito County, which more than tripled that in 1951. The New Idria (including San Carlos) mine was the leading producer in California and second largest in the United States. Operations were carried on throughout the year, and 22,971 tons of ore was treated in four 5- by 56-foot rotary furnaces; 2,805 flasks of mercury was produced. All of the ore mined and treated came from sections of the mine previously worked. The ore mined at the Juniper and North Star mines was treated in the New Idria plant. Other active properties in the county were the Valley View (Panoche), Aurora, and two others, at all of which retorts were in operation.

In San Luis Obispo County mercury was produced at the Rinconada and La Libertad mines. At the La Libertad, unproductive since 1948, production was begun in April, and the ore was treated both in a rotary furnace and a retort. A retort was in use also at the Rinconada property.

Mercury was reported produced in retorts at the Guadalupe mine in Santa Clara County. There was a small output from another property.

The Mount Jackson (including Great Eastern) mine, Sonoma County, was the third largest producer in the United States. This mine dominated output in the United States in the postwar period, during which other large mines were closed from time to time. Mercury was also produced at the Culver-Baer and Buckman (formerly Dewey-Buckman) mines; rotary furnaces were in operation at both properties. At the Culver-Baer, production was double that reported in 1951. Construction of the furnace plant at the Buckman was completed during the year, and output substantially exceeded that in 1951. A small quantity of metal was reported produced in a retort at the Ella B. Eureka mine by V. C. Harrison.

A very small quantity of mercury was recovered from cleanup operations at the Reed mine in Yolo County.

Idaho.—The Hermes mine, Valley County, continued to be the only producer in Idaho. The State ranked third in total production and the mine fourth, compared with fourth and fifth, respectively, in 1951. At the Hermes mine 887 flasks of mercury was produced in two 4- by 60-foot rotary furnaces.

Nevada.—Nevada ranked second in production in 1952, a position it has held since 1949. The Cordero mine, Humboldt County, was the leading producer in the State and in the United States as well. Output was also reported in Esmeralda, Mineral, and Nye Counties.

In addition to the Cordero, production in Humboldt County was reported from the Cahill mine, where a rotary furnace was operated until the mine closed March 1.

Mercury was produced in a retort in Esmeralda County.

At the Red Top and one other mine in Mineral County production of small quantities was reported. A report published recently described the quicksilver deposits in the Southern Pilot Mountains district, Mineral County. The first discovery of mercury in the district was made by Thomas Pepper and Charles Keough in June 1913 at the Lost Steers mine. An abstract of the report follows:[3]

The Pilot Mountains quicksilver district is in the southeastern part of Mineral County, Nev. Cinnabar was first discovered in 1913, and intermittent production to the end of 1949 yielded about 5,000 flasks of quicksilver.

Sedimentary and volcanic rocks of Mesozoic age underlie most of the area and are locally overlain and intruded by Tertiary igneous rocks. The sedimentary formations include the Middle Triassic Excelsior formation, the Upper Triassic Luning formation, and the Lower Jurassic Dunlap and Dunlap (?) formations. Jurassic thrust faulting and Tertiary normal faulting have produced moderately complicated structures.

The cinnabar mines and prospects, with one exception, are all below northward-dipping, low-angle thrust faults, the Cinnabar Canyon and Lost Steers thrusts. These faults probably constitute the major structural control for the cinnabar mineralization in the district. The cinnabar, the only important ore mineral, occurs as fillings of fractures and is disseminated in the gouge of the faults and through various country rocks. Most of it has filled open spaces, but some has replaced the more limy sediments.

All the known ore bodies lie within an area of about 4 square miles in the central part of the Pilot Mountains. Because the grade and character of each ore body reflect its environment, the deposits have been grouped into the following categories: (1) Deposits localized by normal faults in limestones at the head

[3] Phoenix, David A., and Cathcart, James B., Quicksilver Deposits in the Southern Pilot Mountains, Mineral County, Nevada: Geol. Survey Bull. 973-D, 1952, pp. 143-171.

of Cinnabar Canyon. These deposits are the largest and the richest of the district; they include the Mina Development Co. and Drew mines, which together have produced 80 percent of the quicksilver of the district. (2) Deposits in sandstone and conglomerate near Dunlap Canyon. These ore bodies, though smaller, are rich; they are localized beneath rolls in normal faults and are generally in the footwall side. (3) Deposits in chert on the south flank of the Pilot Mountains. Although these deposits are the smallest in the district, they are rich. They are localized along faults by a change in dip or strike at the intersection of faults with bedding planes, and they occur where the chert is most broken.

There are no appreciable reserves of low-grade ore in the district. Some mines have small amounts of known high-grade ore, and development work along the controlling structures, as well as additional prospecting in the district, may lead to the discovery of other ore bodies. The district should produce at least a few hundred flasks of quicksilver annually during periods of high prices.

The Jackpot, A&B, M&M, and Horse Canyon mines supplied the production in Nye County. At all properties, retorts were in use.

Oregon.—Production in Oregon in 1952 was 26 percent less than in 1951. This State has ranked third in total production since 1949 (it was second in 1948) but dropped to fourth place in 1952. At the Bonanza mine, Douglas County, which produced most of the State's output, 16,115 tons of ore was mined and treated in rotary furnaces to produce 846 flasks of mercury.

A report on the Bonanza-Nonpareil district, Douglas County, where the Bonanza mine is situated, was published recently. A partial abstract follows: [4]

The Bonanza-Nonpareil quicksilver district of Douglas County, Oreg., occupies a narrow belt, about 8 miles long, trending north-northeast. It lies entirely within the Umpqua formation of Eocene age. Mining began between 1865 and 1870 at both the Bonanza and Nonpareil mines, but both were abandoned after a small production. They were reopened at intervals, but until the Bonanza mine was acquired by the present operators in 1936 only a small tonnage of ore had been treated. Reliable figures for the early production are not available, but the total to 1937 did not exceed 2,000 flasks. The main (north) ore body at the Bonanza mine was discovered in 1939 and has supplied all the ore mined since that date. From 1937 to the end of 1944 the mine produced 24,471 flasks of quicksilver, of which approximately 22,500 flasks came from the newly discovered north ore body. Some of the ore ran as high as 120 pounds of mercury to the ton, but it averaged only 7 to 8 pounds.

Mercury was produced in retorts at the Maury Mountain and Lost Cinnabar No. 1 mines in Crook County and at the Deer Creek mine in Grant County.

CONSUMPTION AND USES

Consumption fell 25 percent below 1951, as consumers failed by a considerable margin to take anticipated quantities of mercury. A large, completed chlorine and caustic soda plant, which is to use mercury cells and which was planned to be in production some months before the end of the year, did not get beyond the test stage. This change of plans was the chief factor in the reduction in consumption as compared with expectations. As pointed out in previous chapters of this series, the use of mercury for new chlorine installations is not dissipative. If such a plant were dismantled at some time and the metal reused, for statistical purposes the mercury would be considered as secondary or scrap, and its reuse would not be counted as primary consumption.

---

[4] Brown, R. E., and Waters, A. C., Quicksilver Deposits of the Bonanza-Nonpareil District, Douglas County, Oreg.: Geol. Survey Bull. 955-F, 1951, pp. 225-251.

New chlorine and caustic plants, using mercury cells, at McIntosh, Ala., and Plymouth, N. C., began to produce in 1952, and capacity was expanded at some already operating plants.

TABLE 5.—Mercury consumed in the United States, 1943–47 (average) and 1948–52, in flasks of 76 pounds

Use	1943–47 (average)	1948	1949	1950	1951	1952
Pharmaceuticals	8,246	3,382	3,443	5,996	2,761	1,395
Dental preparations	[1] 691	[1] 994	[1] 963	[1] 1,458	[1] 803	[1] 1,027
Fulminate for munitions and blasting caps	1,470	441	149	289	494	337
Agriculture	3,507	7,048	4,667	4,504	7,737	[2] 5,886
Antifouling paint	1,711	996	1,683	3,133	2,500	1,178
Electrolytic preparation of chlorine and caustic soda	638	806	755	1,309	1,543	2,507
Catalysts	4,247	3,262	2,520	2,743	2,635	1,048
Electrical apparatus	[1] 9,099	[1] 6,471	[1] 7,323	[1] 12,049	[1] 10,250	[1] 8,018
Industrial and control instruments	[1] 4,140	[1] 5,653	[1] 5,016	[1] 5,385	[1] 6,158	[1] 6,412
Amalgamation	99	143	165	192	154	151
General laboratory	313	442	345	646	524	629
Redistilled	[1] 6,394	[1] 6,499	[1] 6,642	[1] 7,600	[1] 8,776	[1] 7,547
Other	4,381	10,116	6,186	3,911	12,513	6,421
Total	[3] 45,392	46,253	39,857	49,215	56,848	42,556

[1] A partial breakdown of the "redistilled" classification showed ranges of 53 to 28 percent for instruments, 22 to 9 percent for dental preparations, and 53 to 10 percent for electrical apparatus in the period 1943–51, compared with 48 percent for instruments, 5 percent for dental preparations, and 37 percent for electrical apparatus in 1952.
[2] Includes 3,378 flasks in paper and pulp manufacture, previously not separately available.
[3] The items, which were on a partial coverage basis in 1943–44, do not add to the total.

Consumption of mercury for the manufacture of industrial and control instruments and of dental preparations advanced in 1952, and increased quantities of metal were required to replace losses incurred in the manufacture of chlorine and caustic soda (as distinguished from the nondissipative use of putting mercury into place in a new chlorine plant or in one of higher capacity). Otherwise, less metal was required for mercury uses in 1952 than in 1951, outstanding drops being the cutting into half or less of consumption for pharmaceuticals, antifouling paint, and catalysts. A factor in the decrease was that some of the mercury consumed was recovered from a chemical plant where it was used in the process; having been accounted for previously, it was excluded from consumption statistics for 1952.

TABLE 6.—Mercury consumed in the United States, 1943–47 (average) and 1948–52, by quarters, in flasks of 76 pounds

Quarter	1943–47 (average)	1948	1949	1950	1951	1952
First	11,400	10,000	10,400	10,600	16,000	10,100
Second	13,400	15,700	7,600	11,300	11,600	9,500
Third	10,920	9,400	8,000	12,400	7,400	13,200
Fourth	9,800	10,300	13,900	15,300	21,600	10,200
Total: Preliminary	45,520	45,400	39,900	49,600	56,600	43,000
Final	45,392	46,253	39,857	49,215	56,848	42,556

STOCKS

Industry stocks continued at abnormally high levels for the third successive year, chiefly because of accumulations of metal for large chlorine-plant installations. The 14-percent increase in inventories at the end of 1952 was contrary to an anticipated sharp decline. This reversal was caused by failure of a new installation to be put into operation. If this plant is started in 1953, as expected, stocks should return again to more nearly normal levels.

TABLE 7.—Stocks of mercury in hands of producers and of consumers and dealers, 1948–52, in flasks of 76 pounds

End of year	Producers	Consumers and dealers	Total
1948	5,165	25,000	30,165
1949	5,354	15,600	20,954
1950	2,719	32,900	35,619
1951	1,072	29,100	30,172
1952	685	33,700	34,385

Stocks held by producers, usually small in relation to total industry inventories, declined 36 percent, continuing the downtrend since 1949 and amounting to only 13 percent of the quantity held by producers in that year.

In addition to the stocks shown in table 7, noteworthy quantities of mercury are held in the National Stockpile, but data on such quantities may not be disclosed.

Mercury was on the list of items for which stockpile objectives are not yet complete, but inventories of which, together with estimated United States supply during total mobilization and under rigid economic controls, could meet the needs of war without serious danger to national security. Although acquisition of such items must continue under existing contracts or by further contracting, such acquisitions are no longer of the highest urgency.[5]

PRICES

The average annual quotation of mercury in 1952 was $199.10 a flask and was, except for 1951, an alltime peak.

Mercury prices virtually trebled in the 7-month period following the outbreak of war in Korea (June 1950); the average for 1951 ($210) exceeded the previous peak of $196 in 1942 by 7 percent. Domestic production plus imports (general) in 1951 failed to cover consumption; but, after allowance for the abnormal accumulation in stocks (in anticipation of a new installation using mercury), the new metal made available was more than ample for all needs. Moreover, world production was excessive for world requirements. The monthly price quotation for December 1951 was $213.20 a flask. Prices trended generally downward from January 1952, when the average quotation was $206.35, to August, when it was $187.00; an uptrend beginning in the latter part of September was accelerated in November and December when the monthly averages were $201.82 and $214.89, respectively. The final quotation for 1952 was a range of $218 to $220 a flask.

Large purchases of mercury in the last months of 1952 reduced substantially but temporarily the availability of metal for sale and were a primary factor in strengthening prices.

[5] Munitions Board, Annual Stockpile Report to Congress: Feb. 15, 1953, p. 3.

TABLE 8.—Average monthly prices per flask (76 pounds) of mercury at New York and London, and excess of New York price over London price, 1950–52

Month	1950			1951			1952		
	New York [1]	London [2]	Excess of New York over London	New York [1]	London [2]	Excess of New York over London	New York [1]	London [2]	Excess of New York over London
January	$71.00	$63.23	$7.77	$195.00	$167.37	$27.63	$206.35	$205.14	$1.21
February	71.00	52.93	18.07	215.27	204.59	10.68	202.00	205.11	[3] 3.11
March	71.00	52.93	18.07	217.33	204.62	12.71	207.00	206.26	.74
April	71.00	52.16	18.84	215.60	204.66	10.94	203.77	206.03	[3] 2.26
May	70.35	49.42	20.93	212.92	204.65	8.27	199.62	204.59	[3] 4.97
June	70.00	47.68	22.32	210.00	204.66	5.34	195.24	203.28	[3] 8.04
July	73.44	47.26	26.18	206.80	204.62	2.18	189.81	181.79	8.02
August	78.00	55.66	22.34	195.85	204.52	[3] 8.67	187.00	180.90	6.10
September	84.20	62.46	21.74	206.25	204.52	1.73	190.68	179.48	11.20
October	89.52	72.82	16.70	216.96	204.57	12.39	191.00	180.15	10.85
November	99.35	81.05	18.30	216.30	204.65	11.65	201.82	189.36	12.46
December	126.24	100.89	25.35	213.20	204.24	8.96	214.89	198.52	16.37
Average	81.26	61.94	19.32	210.13	203.37	6.76	199.10	194.89	4.21

[1] Engineering and Mining Journal, New York.
[2] Mining Journal (London) prices in terms of pounds sterling are converted to American dollars by using average rates of exchange recorded by Federal Reserve Board.
[3] London excess.

Mercury prices were limited by the General Ceiling Price Regulation from January 26 to August 10, 1951, when an amendment to the regulation freed mercury and some other products from price control. No such price restrictions were in effect in 1952.

The price for mercury in London was £73 15s. (equivalent to $205.14) from the latter part of March 1951 through the week ended April 3, 1952, when it dropped 10s. per flask, remaining at that level for a month, and then dropping 5s. a flask to £73, which held from the week ended May 8 through June. The price declined £8 to £65 (equivalent to $181.23) in the week ended July 3, advanced 5s. in the following week, and remained at £65 5s. through the week ended August 14. It fell 15s. more in the week ended August 21, continued at the £64 10s. level through the week ended November 13 and then increased to £70 15s. (equivalent to $198.11) and continued at that level for the remainder of the year.

FOREIGN TRADE [6]

In 1952 imports of mercury for consumption were 50 percent greater than the large quantity that entered the country in 1951 and were the highest ever recorded except for the alltime peak of 103,141 flasks in 1949. The 1952 receipts would have supplied the country's total needs for more than 2 years of greater than average consumption before World War II.

Exports, of little consequence for many years with 1 or 2 exceptions, rose 66 percent in 1952 but continued insignificant in relation to imports.

Reexports, also regularly small, declined 62 percent from 1951 and were smaller than exports, an unusual relationship.

[6] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

Tariff.—A duty of 25 cents a pound ($19 a flask) on imports of mercury has been in effect since 1922.

Imports.—Of total imports for consumption of 71,900 flasks in 1952 (1951 in parentheses), 26,300 (21,900) came from Italy, 27,100 (12,000 revised) from Spain, 10,400 (6,500) from Yugoslavia, 7,900 (5,100) from Mexico, and the small remainder from countries that, so far as is known, produced no mercury in 1952.

TABLE 9.—Mercury imported for consumption in the United States, 1948–52

[U. S. Department of Commerce]

Country	1948		1949		1950	
	Pounds	Value	Pounds	Value	Pounds	Value
Canada	2	$4	484	$319	8,105	$9,407
Czechoslovakia	15,212	9,920				
Denmark					22,818	20,103
Italy	299,983	205,735	6,451,947	5,830,409	1,137,975	738,217
Japan	279,326	175,460	205,894	142,772	60,277	35,222
Mexico	265,140	179,266	234,935	179,206	264,460	180,418
Netherlands					43,724	32,289
Spain	1,473,137	931,201	704,074	448,592	2,163,123	1,265,719
Sweden					80,619	64,441
United Kingdom					60,800	49,600
Yugoslavia	95,448	65,273	241,371	160,635	420,155	298,856
Total: Pounds	2,428,248	1,566,859	7,838,705	6,761,933	4,262,056	2,694,272
Flasks	31,951		103,141		56,080	

Country	1951		1952	
	Pounds	Value	Pounds	Value
Bolivia	1,409	$1,744		
Canada	50,150	125,906	1,516	$7,398
French Morocco			3,803	8,250
Germany	19,006	39,904		
Honduras	760	2,140		
Italy	1,661,939	2,875,681	1,997,004	5,033,235
Japan	19,018	14,980		
Mexico	388,257	843,523	603,486	1,302,837
Netherlands	26,600	21,700	7,600	18,979
Spain	[1] 908,490	[1] 1,573,982	2,059,763	4,404,675
Sweden	[1] 51,695	[1] 107,370		
Switzerland	15,515	23,450		
United Kingdom	3,588	3,285	61	261
Yugoslavia	490,911	952,924	787,765	1,771,052
Total: Pounds	3,637,338	6,586,589	5,460,998	12,546,687
Flasks	47,860		71,855	

[1] Revised figure.

General imports afford a better measure than imports for consumption of material actually entering the country during a calendar period, being made up of imports for immediate consumption plus entries into bonded warehouses. In 1948 and 1946 the differences between the 2 types of imports amounted to nearly 10,000 flasks; in other years of the past decade, the differences have ranged from a few flasks to nearly 5,000.

Imports of mercury compounds are generally insignificant and were less than one-third the large quantity in 1951. Receipts of mercuric chloride were 7,400 pounds from Yugoslavia, 2,300 from Canada and 700 from the United Kingdom; of mercurous chloride, 6,000 pounds from Canada; of oxide (red precipitate), 2,800 pounds from the

TABLE 10.—Mercury imported (general imports) into the United States, in 1952, by months

[U. S. Department of Commerce]

Month	Flasks of 76 pounds	Month	Flasks of 76 pounds
January	2,709	August	3,940
February	6,012	September	2,335
March	4,588	October	20,447
April	6,645	November	4,206
May	4,991	December	3,468
June	4,701		
July	4,644	Total	68,686

TABLE 11.—Mercury imported (general imports) into the United States, 1948–52, in flasks of 76 pounds

[U. S. Department of Commerce]

	1948	1949	1950	1951	1952
Bolivia				19	
Canada	(1)	29	107	660	20
Denmark			300		
French Morocco					50
Germany				250	
Honduras				10	
Italy	4,994	84,628	18,073	17,633	26,026
Japan	3,746	2,777	793	250	
Mexico	4,063	3,506	3,986	[2] 4,989	7,971
Netherlands			825		100
Spain	27,114	2,225	29,439	[2] 13,707	24,333
Sweden	75		1,061	[2] 680	
Switzerland				204	
United Kingdom	49			(1)	(1)
Yugoslavia	1,691	3,753	5,980	[2] 6,524	10,186
	41,732	96,918	60,564	[2] 44,926	68,686

[1] Less than ½ flask.
[2] Revised figure.

United Kingdom, 1,500 from Yugoslavia and 300 from Sweden; and of mercury preparations not specifically provided for, 3,700 pounds from Canada and 400 from the Netherlands.

Exports.—Of the exports of 400 flasks (241 in 1951), 77 (14) went to Brazil, 65 (none) to Belgian Congo, 64 (55) to Venezuela, 35 (22) to Colombia, 28 (40) to Canada, 26 (1) to Mexico, and smaller quantities to 20 other countries.

TABLE 12.—Mercury exported from the United States, 1943–47 (average) and 1948–52

[U. S. Department of Commerce]

Year	Pounds	Flasks of 76 pounds	Value	Year	Pounds	Flasks of 76 pounds	Value
1943–47 (average)	60,240	793	$107,702	1950	33,977	447	$37,985
1948	40,013	526	42,620	1951	18,311	241	57,502
1949	43,860	577	54,413	1952	30,369	400	85,974

Reexports were 259 flasks in 1952 (675 in 1951). Of the total, 190 (215) went to Canada, 25 (17) to Colombia, 21 (37) to Brazil, 13 (none) to Cuba, and the remainder in quantities of less than 10 flasks to 3 other countries.

TABLE 13.—Mercury reexported from the United States, 1943–47 (average) and 1948–52

[U. S. Department of Commerce]

Year	Pounds	Flasks of 76 pounds	Value	Year	Pounds	Flasks of 76 pounds	Value
1943–47 (average)	336,254	4,425	$677,867	1950	67,311	886	$63,839
1948	70,022	921	52,849	1951	51,326	675	111,274
1949	62,945	828	53,057	1952	19,689	259	46,721

TECHNOLOGY

At the furnace of Buckman Laboratories, Inc., Buckman mine, Sonoma County, Calif., transferred from the Contact mine in 1951, the usual "hot fan" that pulls the furnace gases through the Sirocco dust collector was replaced by a Rotoclone. In other words, the furnace gases first go through the Sirocco collector and then the Rotoclone. The Rotoclone is both a fan and a secondary dust collector. At this plant the combination was said to work very satisfactorily according to letters from C. N. Schuette and S. J. Buckman.

When mercury was first in demand in substantial quantities in the United States, a century ago, the predominant use by a wide margin was for the recovery of gold; later pigment requirements became important. These uses subsequently were replaced almost entirely by others. In recent years there has been much more stress on high purity for such applications as scientific instruments and industrial control apparatus, which depend much more on the physical than the chemical characteristics of mercury. Methods developed to perfect purification include vacuum distillation, acid washes, electrolytic processes, and the recently developed oxifiers and gold-adhesion filters.[7]

Mercury was selected as a superior medium for forming metal casts for various body cavities, as well as a contrast medium for studying fine arterial and lymphatic channels with the aid of X-rays.[8]

An article published in 1952 traces the history of the use of mercury-arc rectifiers in steel mills from the time the first rectifier was installed in 1937 at the South Chicago mill of the Republic Steel Corp. but makes special reference to the use of rectifiers for main roll drives. Considerable progress, accelerated by the economic advantages of rectifiers over motor-generator sets, was reported to have been made. Rectifiers were said to have been applied in the United States only to class I mills (continuous mills). For class II mills (reversing mills) rectifiers have been used in Europe and, for economical reasons, may be used in the future in the United States. Little prospect was seen that rectifiers would be used in future in class III mills (accelerating strip mills).[9]

It was said that there was a steadily growing volume of orders for sealed-tank air-cooled mercury-arc rectifiers in the United Kingdom and elsewhere.[10]

[7] Lawrence, James B., A Century of the Mercury Market: Purchasing, vol. 33, No. 5, November 1952, pp. 97–100.
[8] Science, Mercury as a Casting Medium: Vol. 116, No. 3008, Aug. 22, 1952, p. 207.
[9] Larson, H. E., Mercury-Arc Rectifiers for Main Roll Drives: Iron and Steel Eng., vol. 29, No. 11, November 1952, pp. 61–73.
[10] Mining Magazine (London), Mercury Arc Rectifiers: Vol. 86, No. 1, January 1952, p. 46.

Progress in the use of mercury-arc rectifiers was reviewed in another article.[11]

Descriptive articles on mercury chlorine cells were published in 1952.[12]

The Schiller mercury-steam station at Manchester, N. H., was said to be the most efficient fuel-burning station of its size in the world today.[13]

A number of articles dealing with color correction of quartz mercury-vapor lamps and other features of mercury lamps were published during the year.[14]

Relative costs of various methods of "high-bay" lighting in industrial plants were discussed in a recent article, which showed favorable costs per footcandle for mercury lamps.[15]

Loveland and Elving[16] summarized and evaluated the use that can be made of recording by the cathode-ray oscillograph in the study of phenomena occurring at the interface between a mercury electrode and the solution in contact with the electrode. The authors stated that, "The study of mercury electrodes, as compared to that of other electrodes, has the advantage that a constant reproducible electrode is assured whose past history—chemical, electrical, and metallurgical—will play no part in the observed phenomena." They concluded that current-time, current-potential, and potential-time methods of oscillographic observation of phenomena at stationary, dropping, and streaming mercury electrodes have demonstrated their value for investigating adsorption and redox phenomena and in the future should be of great significance as a means of clarifying some of the multitudinous problems prevalent in the field of electrode mechanisms and kinetics.

A report on an investigation of the cracking of an aluminum-magnesium alloy in contact with mercury was abstracted in Metallurgia in 1951.[17] The investigation was carried out on specimens from compressed air cylinders of aluminum-7 percent-magnesium alloy, a number of which had burst in service during which they were exposed to sea air on board ship. The mercurous nitrate test as applied to brass was used in an attempt to discover the cause of this bursting and structural heterogeneities. The mercurous nitrate test can serve as a means of detecting the presence of internal stresses which may bring about stress corrosion should an aluminum-magnesium alloy be otherwise rendered susceptible to it.

---

[11] Read, J. C., Mercury-Arc Rectifiers for Medium-Voltage Applications: Proc. Inst. Elec. Eng., vol. 99, part 1, No. 120, November 1952, pp. 252–270.

[12] Chemical Engineering, New Chlorine Cell Built in Four Layers: Vol. 59, No. 7, July 1952, pp. 265–266. Chemical Engineering, Acres of De Nora Chlorine Cells: Vol. 59, No. 8, August 1952, pp. 146–148.

[13] Noyes, William, Schiller Mercury-Steam Station Sets Record in First Two Years: Elec. World, vol. 138, No. 23, Dec. 8, 1952, pp. 32–34.

[14] Fraser, H. D., and Till, W. S., Color Correction and Other Important Improvements in Mercury Lamps: Illuminating Eng., vol. 47, No. 4, April 1952, pp. 207–213.

Burns, C. H., Freeman, G. A., and Rowten, D. W., Electrical Design Data for Mercury Vapor-Lamp Circuits: Illuminating Eng., vol. 47, No. 3, March 1952, pp. 149–158.

Felzer, Clement A., Mercury Vapor for Tunnel Lighting: Illuminating Eng., vol. 47, No. 8, August 1952, p. 422.

Noel, E. B., and Lindsay, E. A., Reflectorized Mercury Lamps and Their Industrial Applications: Illuminating Eng., vol. 47, No. 10, October 1952, pp. 547–552.

Beggs, Eugene W., Fluorescent-Mercury Lamp Produces Golden White Light: Elec. World, vol. 136, No. 25, Dec. 17, 1951, pp. 106, 110.

[15] Kahler, William H., New Economies in High-Bay Lighting: Mill & Factory, vol. 50, No. 6, June 1952, pp. 90-93.

[16] Loveland, J. West, and Elving, Philip J., Cathode-Ray Oscilloscopic Investigation of Phenomena at Polarizable Mercury Electrodes: Chem. Rev., vol. 51, No. 1, August 1952, pp. 67–117.

[17] Jacquet, P. A. and Weill, A. R., The Cracking of an Aluminum-Magnesium Alloy in Contact with Mercury: Metallurgia, vol. 44, No. 264, October 1951, p. 206.

Mercury as marketed is one of the purest metals obtainable by normal methods of production and as required for certain purposes has the highest purity of all. Base metals dissolve readily in mercury, forming oxide skins on exposure to air. Articles published during the year deal with methods of cleaning mercury and of bringing it to the purity required for special purposes.[18]

A method of retrieving spilled mercury [19] is by sprinkling powdered dry ice over the mercury and allowing it to freeze. The resultant mixture can be swept up easily, preferably with stiff paper.

The poisonous nature of mercury vapor and dust and precautions that can assure safe laboratory conditions were recently described.[20]

WORLD REVIEW

There was little change in the rate of world output in 1952 compared with 1951 and 1950, the noteworthy percentage increase in the United States and the smaller rise in Italy counterbalancing the drop in Spain; Yugoslavia's production continued virtually unchanged at the high rates of 1950–51.

TABLE 14.—World production of mercury, by countries,[1] 1946–52, in flasks of 34.5 kilograms (76 pounds)[2]

[Compiled by Helen L. Hunt]

Country [1]	1946	1947	1948	1949	1950	1951	1952
Algeria	340	346	381	115	------	------	(3)
Austria	(3)	(3)	(3)	6	44	31	(3)
Bolivia (exports)	------	------	1	------	------	19	(3)
Chile	827	445	467	754	319	114	(3)
China	1,189	290	[4] 290	[4] 290	[4] 1,450	[4] 4,000	(3)
Czechoslovakia	841	[5] 768	800	[4] 800	(3)	(3)	(3)
Honduras	------	------	------	------	------	11	(3)
Italy	50,822	53,984	38,233	44,527	53,346	53,839	55,869
Japan	1,372	1,622	1,689	2,461	1,312	1,847	2,997
Mexico	11,661	9,700	4,786	5,250	3,713	8,064	8,702
Peru	5	------	------	------	------	(3)	(3)
Spain	41,801	55,608	22,684	32,289	51,808	44,480	39,135
Turkey	------	98	27	------	------	(3)	(3)
Union of South Africa	764	------	------	------	------	------	------
United States	25,348	23,244	14,388	9,930	4,535	7,293	12,547
Yugoslavia	8,876	9,457	10,936	12,764	14,368	14,649	14,620
Total [4]	154,000	168,000	107,000	121,000	143,000	148,000	150,000

[1] Mercury is also produced in Rumania and U. S. S. R., but production data are not available; estimate by authors of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous mercury chapters.
[3] Data not yet available; estimates by authors of chapter included in totals.
[4] Estimate.
[5] Byproduct of pyrites production in Slovakia only.

Bolivia.—The Bolivian Tin & Tungsten Corp. exported 638 kilograms (19 flasks) of mercury to the United States in 1951, the first export of mercury reported since 1945, except for 1 flask in 1948.

[18] Lawrence, J. B., Mercury—The Purest Metal: Instruments, vol. 25, No. 3, March 1952, pp. 310–312, 363.
Wheeler, E. L., Apparatus for Triple Distillation of Mercury: Anal. Chem., vol. 24, No. 4, April 1952, pp. 751–752.
Yorke, S. G., An Improved Automatic Mercury-Distillation Apparatus: Jour. Appl. Chem., vol. 2, part 2, February 1952, pp. 77–79.
[19] Erwood, E. J., Better Way to Recover Spilled Mercury: Chem. Eng., vol. 59, No. 10, October 1952, pp. 174–175.
[20] Lawrence, J. B., How Poisonous Is Mercury?: Chem. and Eng. News, vol. 29, No. 35, Aug. 27, 1951, pp. 3529–3531.

Chile.—Mercury is produced in Chile associated with gold. Past production and descriptions of the deposits are contained in a report published in 1950. An abstract follows:[21]

Quicksilver has been mined intermittently in Chile since the end of the 18th century, but only in small quantities for local use until recently, when the large mine at Punitaqui started producing an average of 2,000 flasks annually for export.

The deposits, most of which are small, are in a narrow strip about 500 kilometers long, extending from Copiapó to Illapel, in north-central Chile. They are with few exceptions in the Porfiritica formation, consisting of Mesozoic andesitic rocks, and are generally near intrusive bodies of granodiorite, which is a facies of the Andean diorite complex. Most of the ore was localized in shattered and crushed zones along steep faults, some of which were formed by strike-slip shearing.

The principal ore minerals are coarse-grained cinnabar, mercurian tetrahedrite, and powdery cinnabar mixed with oxides of iron and antimony in the weathered veins. The mercurian tetrahedrite and powdery cinnabar are the most characteristic minerals of the deposits. A little native mercury occurs in places. The coarse-grained cinnabar and mercurian tetrahedrite are hypogene minerals, and the powdery cinnabar mixture, which is closely associated with copper carbonates and limonite, is of supergene origin, having been formed by the weathering of the mercurian tetrahedrite. Vein minerals associated with the mercury minerals are, roughly in the order of deposition: calcite, specular hematite, magnetite, barite, quartz, pyrite, chalcopyrite, calcocite, and products of weathering such as azurite, malachite, and limonite. Some of the pyrite encloses gold.

Reserves had been measured at only one mine, where exploitation of mercury depended on profitable extraction of gold and copper. Reserves even of inferred ore at other places in Chile are small and economically marginal. The quicksilver districts are described in detail.

India.—Following the outbreak of war in Korea, buyers in India intensified their procurement of mercury. There is little doubt that the metal was largely for the account of speculators, because the quantities involved greatly exceeded India's normal annual requirements. Reports were to the effect that more than a year's supply was on hand at the war's outset and that the large purchases brought stocks up to enough for from 5 to 10 years' needs. The quantities imported in 1950 and 1951 totaled about 42,000 flasks, of which nearly 37,000 was credited to Italy and 3,400 to the United Kingdom. One report placed India's annual requirements at little more than one-tenth of the large entries.[22] In 1945 to 1949, inclusive, imports of mercury into India averaged 5,000 flasks annually.[23]

Importers of mercury obtained the foregoing quantities at considerably under peak prices for the post-Korean period but were prevented from taking large profits when the Government embargoed exports of metal. Exports of mercury in the form of salts and compounds appeared to offer a solution to the problem until these were made subject to export licensing on November 26, 1951.[24]

Efforts of holders of mercury to obtain permission to reexport the metal resulted in the Government agreeing in October 1952 to the release of a reported 10,000 flasks. An export duty of 300 rupees (about $63) was levied. The price for mercury in India was 350 rupees (about $73.50) and rose to about 400 ($84.00), which with the tax brought the price in India to 700 rupees or nearly $150 a flask.[25]

[21] McAllister, J. F., Hector, Flores W., and Carlos, Ruiz F., Quicksilver Deposits of Chile: Geol. Survey Bull. 964–E, 1950, 40 pp. (Bull. 964, pp. 361–400).
[22] Metal Bulletin (London), No. 3683, Apr. 8, 1952, p. 22.
[23] Statistical Summary of the Mineral Industry, London, H. M. Stationery Office, 1952, 342 pp.
[24] Deimel, Henry L. (Counselor for Economic Affairs), Report on Mercury in India: State Department Dispatch 1236, New Delhi, India, Dec. 3, 1951, 1 p.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, pp. 16–17.

Italy.—Italian production continued little changed from the rate maintained in 1950 and 1951, rising 4 percent. Of the exports of 33,500 flasks, the following distribution was made: United States, 27,800 flasks; United Kingdom, 3,700; Poland, 600; and other, 1,400. Stocks of mercury at the end of the year were 18,200 flasks.

Mexico.—Production in 1952 rose 8 percent above 1951 and was the highest since 1947, reflecting, in large part, at least, stimulation from high prices.

According to a recent report, the only known valuable mineral deposits at Canoas, in southeastern Zacatecas, are the mercury deposits, discovered in 1878. An abstract of the report follows: [26]

The Canoas quicksilver deposits and the manner in which the structure that controlled their localization is reflected by later structures suggest a method of scientific prospecting for deposits that may be buried elsewhere beneath similar rocks.

The deposits at Canoas, in the desert country of southeastern Zacatecas, Mexico, have produced about 30,000 flasks (870,000 kg) of quicksilver since their discovery in 1878. The mines are at an altitude of 2,250 m above sea level in the top of the Mesa de Canoas, which is part of an isolated group of mountains composed of rhyolitic volcanic rocks. These mountains rise about 250 m above the general level of the central plateau of Mexico, which is here underlain chiefly by Jurassic and Cretaceous limestone.

The rhyolite is the most widespread rock in the mapped area, forming all the mesas. It generally inundated the entire region. Flow layering is remarkably well developed in it, consisting of layers 2 to 5 mm thick separated by discontinuous fracture planes that stand open a fraction of a millimeter and are coated with a white powder of feldspar and tridymite. Contours of the contact between the overlying rhyolite and the underlying latite and perlite reveal a pronounced dome, and the field evidence indicates that this dome was formed tectonically after the formation of the perlite.

The only valuable mineral deposits known at Canoas are the quicksilver deposits; they have been found only in the top of the latite dome, which was much fractured during the doming process. The latite at the top of the dome has been subjected to two alterations. Much of it was altered to halloysite by acid solution. It was then further altered by alkaline solutions which deposited abundant opal and some montmorillonite, chalcedony, and cinnabar. During the alkaline mineralization, which may have been colloidal, a second period of fracturing occurred. The localization of the ore was controlled primarily by the latite dome itself and secondarily by the major zones of fracturing within it.

The ore zone consists essentially of a stockwork in the crest of the dome, at least 400 by 250 m in horizontal extent and grading downward, between 20 and 40 m in depth, into six major lodes of diverse orientation that form its roots. The lodes are zones up to about 10 m wide in which the effects of fracturing, brecciation, alteration, and mineralization are more intense than in the surrounding rock into which the lodes grade laterally. The principal mines are at the places where two or more of these six major lodes intersect.

The near-surface stockwork has been mined to exhaustion in about a thousand holes, but the dumps, gob, and unmined ground probably constitute a reserve of several million tons of low-grade ore from which the quicksilver might be recovered at a profit by large-scale methods under favorable price conditions. One of the lode intersections has been inadequately explored to a depth of 82 m, but none of the others has been explored below a depth of 40 m. Adequate exploration of these lode intersections might result in the discovery of quicksilver ore, but because of the stockwork-with-roots structure of the ore zone, the lower parts of the deposits cannot be expected to yield more than a fraction of the amount of quicksilver already produced at Canoas.

---

[26] Gallagher, David, Geology of the Quicksilver Deposits of Canoas, Zacatecas, Mexico: Geol. Survey Bull. 975-B, 1952, pp. 47-85.

Peru.—For many years Peru was the leading mercury producing country in the world. An abstract of a report describing the mercury district, published in 1951, is as follows: [27]

The Huancavelica quicksilver district, the world's largest producer of quicksilver for over a century and a half, is in the Cordillera Occidental of south-central Peru. All the important mines of the district are in a north-trending belt about 1 mile (2 kilometers) wide and 5 miles (8 kilometers) long, but a few small mines and prospects are in north and south extensions of this main belt. During the Spanish colonial period the mines produced over 1,400,000 flasks of quicksilver, most of this coming from one mine, the Santa Bárbara. During the last hundred years little quicksilver has been produced, and in 1946 only one small mine was actively producing. It is not likely that the district will again become an important quicksilver-mining center unless new ore bodies are discovered or unless there prove to be unexhausted ore bodies in the inaccessible caved workings of the Santa Bárbara mine.

The Cordillera Occidental in central Peru is composed of Paleozoic, Mesozoic, and Tertiary sedimentary and volcanic rocks that have been folded, faulted, and intruded by various kinds of igneous rocks. In the Huancavelica district Jurassic limestones, Cretaceous sandstones, limestones, shales, and volcanic rocks, and Tertiary conglomerates, tuffs, and lavas constitute the sedimentary and volcanic rocks. Intruded into these are dacites and volcanic necks filled with pyroclastic material. The dominant structural feature is a north-trending anticline, which has a synclinal core bounded by high-angle reverse faults. Faulting accompanied and followed folding, and was itself followed by igneous intrusion and extrusion.

The quicksilver deposits are classified into three types: (1) deposits occurring in sandstone, (2) deposits occurring in limestone, and (3) deposits occurring in igneous rocks. Cinnabar is the principal ore mineral and occurs mainly as a filling between sand grains in the sandstone, in fractures and porous marly beds in the limestone, and as a filling in fractures in the igneous rocks. Other sulfide minerals are pyrite, arsenopyrite, realgar, and minor amounts of galena, sphalerite, and stibnite. Nonmetallic gangue minerals include quartz, calcite, barite, and hydrocarbons, none of which are abundant. The distribution of the ore bodies was controlled by the distribution of the more permeable sedimentary strata and of fracture openings. The cinnabar deposits are younger than the Tertiary volcanic rocks.

Spain.—Production decreased to 39,100 flasks, a drop of 12 percent, continuing the decline from 1950. The new furnace under construction at the Almaden mine by the Pacific Foundry Co., Ltd., of San Francisco, was nearing completion at the year end. Exports exceeded production, indicating a drawing on stocks for a quantity equivalent to the entire domestic consumption (always small) and part of exports. Stocks were believed to be relatively small at the end of 1952. According to monthly reports, which will be adjusted somewhat when final data are available, exports in 1952 were as follows:

Destination:	*Flasks*
United States	27,200
United Kingdom	4,600
Switzerland	3,900
France	3,800
Germany	1,800
Netherlands	1,300
Portugal	800
Other	800
	44,200

[27] Yates, Robt. G., Kent, Dean F., and Concha, Jaime Fernandez, Geology of the Huancavelica Quicksilver District, Peru: Geol. Survey Bull. 975–A, 1951, 45 pp

United Kingdom.—Imports of mercury into the United Kingdom, the second largest consumer of mercury in the world, dropped precipitously after the receipt of unprecedented quantities after war broke out in Korea in June 1950. In 1950, 54,200 flasks were imported, in 1951, 18,800 (revised) flasks; and in 1952, 9,200 flasks. Reexports in the 3 years were 14,300, 6,100, and 3,600 flasks, so the new metal made available for use in these years was 39,000, 12,700, and 5,600 flasks.

Trade reports indicated that industrial stocks of mercury in the United Kingdom were stringent late in 1952 but that the Government was believed to hold "useful" quantities.[28] Evidently the British Government, as well as that of the United States, was purchasing mercury late in 1952.[29]

Changes in prices for mercury in London are shown in the section on Prices.

Yugoslavia.—Control since the end of World War II of the Idria mine, near Trieste in the Julian Alps, Province of Gorizia, along the Idria River, made Yugoslavia a significant producer of mercury. During 1952 production was continuing at the high annual rate of nearly 15,000 flasks established in 1951.

The Idria mine has been worked almost continuously since early in the 15th century, and it was reported that it stood second in the world to the Almaden mine, Spain, in total production to the end of World War II. In more recent years the Abbadia San Salvatore and Solforate del Siele mines in the Monte Amiata district, Italy, have been larger producers.

The Idria mine was discovered in 1497 and between 1500 and 1813 passed through various hands as a result of wars or by succession. From 1813 until World War I it remained in Austrian hands but was transferred to Italy as a result of that war. It was under Italian control until the end of the second world conflict.

In 1944 the deepest shaft in the Idria mine was the Jozefor, reported to be 387 meters (1,270 feet) deep; there were 15 levels. Although at that time the output had decreased in quantity and grade, the mine was said to contain larger and richer reserves than any American mine. Production advanced after the latest change of control and in 1951 and 1952 appeared close to the reported annual maximum for all time.[30]

Another report indicated that the grade of ore produced at the Idria mine averaged 0.808 percent mercury in 1940, fell to 0.587 percent in 1947 and 0.45 percent in 1951. Production was expected to advance to 600 metric tons (17,000 flasks) within 3 or 4 years. In addition to the Idria, which supplied most of the production, there are small mines at Sveta Ana, Knapovze, Litija, and Marija Reka, in Slovenia; at Maraska and Cemernca in Bosnia-Heržegovina; at Avala and Donja Tresnjica in Serbia; and at Sutomor in Montenegro.[31]

[28] American Metal Market, vol. 59, No. 218, Nov. 13, 1952, p. 5.
[29] American Metal Market, vol. 59, No. 231, Dec. 3, 1952, p. 5.
[30] Abst. in large part from Eckel, Edwin B., Mercury Industry in Italy; Am. Inst. Min. and Met. Eng., Tech. Pub. 2292, January 1948, 21 pp.; Winslow, Rollin R. (American consul), The Mercury Mine At Idria, Venezia Giulia, Trieste, Italy, Oct. 19, 1932, 11 pp.
[31] Metal Bulletin (London), No. 3716, Aug. 12, 1952, p. 20.

Mica

By Waldemar F. Dietrich,[1] Robert D. Thomson,[2] and Gertrude E. Tucker[3]

PRODUCTION of mica in the United States reached a record high in 1952, a 5-percent increase above that in 1951, mainly as a consequence of the Government purchasing program for block, film, and hand-cobbed mica. Sheet-mica output in 1952 was the largest for the industry since 1946. The 1952 tonnage for scrap and flake mica was the largest in the history of the industry. Consumption continued at a high level, despite a 31-percent decrease in mica imports.

TABLE 1.—Salient statistics of the mica industry in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Domestic mica sold or used by producers:						
Total sheet mica:[1]						
Pounds	1,552,911	270,042	513,994	578,818	594,884	697,989
Value	$1,512,572	$45,940	$132,097	$125,928	$160,322	$908,135
Average per pound	$0.97	$0.17	$0.26	$0.22	$0.27	$1.30
Scrap and flake mica:						
Short tons	48,465	52,157	32,856	69,360	71,871	75,236
Value	$955,284	$1,091,698	$795,782	$1,742,616	$1,884,087	$1,954,286
Average per ton	$19.71	$20.93	$24.22	$25.12	$26.21	$25.97
Total sheet, scrap, and flake mica:						
Short tons	49,241	52,292	33,113	69,650	72,168	75,585
Value	$2,467,856	$1,137,638	$927,879	$1,868,544	$2,044,409	$2,862,421
Ground mica:						
Short tons	56,551	64,642	56,393	72,250	70,122	74,806
Value	$2,276,911	$3,232,632	$2,860,956	$3,935,697	$3,842,628	$4,278,103
Consumption of splittings:						
Pounds	8,450,740	7,917,365	8,114,804	10,783,198	13,379,295	10,220,671
Value	$4,506,496	$6,300,581	$7,096,365	$8,631,421	$11,760,617	$9,729,099
Imports for consumption short tons	11,215	17,896	12,738	[2] 18,510	[2] 18,917	13,048
Exports do	1,066	1,402	1,108	1,547	[2] 1,894	2,472

[1] Includes small quantities of splittings in certain years.
[2] Revised figures.

GOVERNMENT PROGRAMS UNDER DEFENSE PRODUCTION ACT OF 1950

In 1950, under provisions of the Defense Production Act, the Defense Minerals Administration was established to encourage the exploration, development, and mining of critical and strategic metals and minerals, including strategic mica. With dissolution of DMA in early 1952, the exploration functions were delegated to Defense Minerals Exploration Administration (DMEA), and the programing,

[1] Chief, Ceramic and Fertilizer Materials Branch.
[2] Commodity-industry analyst.
[3] Statistical assistant.

development loans, facilities loans, and tax-amortization functions were transferred to Defense Minerals Procurement Administration (DMPA).

Defense Minerals Exploration Administration.—The encouragement of exploration of unknown or undeveloped sources of strategic or critical metals and minerals through financial assistance, established as a DMA program in 1951, became the function of DMEA. Under the program the Government contributed 90 percent of the approved costs of mica-exploration projects, repayable from the net returns from any mineral produced as a result of the project within 10 years after certification of discovery or development. As of December 31, 1952, 62 projects were in force or executed, with Government participation totaling $314,903. Of these projects, only six certificates of discovery or development were issued. Information regarding the mica contracts is shown in table 2.

TABLE 2.—DMEA mica contracts in force or terminated, as of December 1952, by States, counties, and mines

State, county, and mine	Applicant	Government [1] participation	Disposition
Georgia: Upson, Carter	Anderson, A. T	$4,959	In force.
Idaho: Latah, Muscovite	Idaho Beryllium & Mica Corp	25,830	Do.
New Hampshire:			
Cheshire, Lyman-Fitzgibbon	Alstead Mica Miners, Inc	5,040	Do.
Grafton, Atwood	Berry, R. N	11,700	Do.
North Carolina:			
Avery:			
Elk	Vance, S. K., and Guy, R. B	6,210	Do.
Cow Camp	Trammell Mining Corp	3,060	Terminated.
Powder Hill	Powder Mill Mining Co	2,808	Do.
Winters Prospect	Burleson, C. C	2,390	Do.
Buncombe:			
Big Cove	Hipps, W. H	2,610	In force
Swannanoa	Robinson & West	6,930	Do.
Cleveland:			
Cliff Blanton Mica	Boone, R. L	3,600	Terminated.
Bumgardner	Hendricks, F. B	3,780	Do.
Carpenter	do	1,440	Do.
Hubert Cook No. 1	do	3,150	Do.
Hubert Cook No. 2	do	2,250	Do.
Covington, W. H., Prospect	Covington, W. H	1,341	In force.
Martin, W. W	Schmitt, Lawrence	3,240	Terminated.
Mead, A. P	Hendricks, F. B	2,160	In force.
Mead, Glen	do	1,350	Do.
Gaston:			
Big Bess	Phillips, F. O	6,210	Do.
Huskins	Gaston Strategic Minerals Co., Inc.	5,040	Certified.
Self, E. R	Piedmont Minerals Co., Inc	11,160	In force.
Haywood:			
Grassy Knob	Conway, Revis	2,970	Do.
Little East Fork	Arrowood, Fred	5,760	Do.
Poston Prospect	Poston, E. L. and R. W	9,180	Do.
Jackson:			
Shell Ridge	Dixie Minerals, Inc	4,140	Do.
Stephens, D. H	do	3,600	Do.
Macon:			
"A"	Wilson, Fred	3,600	Do.
Baird Cove	Bauer Mining Co	8,190	Do.
Burke, John	Burke, John, Mica Miners	6,120	Do.
Cabe No. 1	Cabe, Fred D	4,397	Certified.
Campbell	Franklin Developers, Inc	3,240	Do.
Chalk Hill	Mica Development Corp	5,400	Terminated.
Enloe No. 1	Enloe, H. E	1,800	Do.
Garden Branch	do	450	Do.
Iotla-Bowers	Phillips, S. L	4,050	In force.
Judson	Judson, F. A	1,575	Terminated.
Kasson	Angel, Zeb	6,210	In force.
Kelly (Pine Knob)	Toe River Mining Co	4,050	Do.

For footnotes, see end of table.

TABLE 2.—DMEA mica contracts in force or terminated, as of December 1952, by States, counties, and mines—Continued

State, county, and mine	Applicant	Government[1] participation	Disposition
North Carolina—Continued			
Macon—Continued			
Meadows	Meadows, H. C	$2,750	Terminated.
Miller	Ward, A	3,420	In force.
Penland, L. S	Penland, L. S	450	Terminated.
Reid	Reid & Hooker	1,170	In force.
Do	Keller, C. J	5,850	Terminated.
Reid-Mary	Pitt Mica Corp	2,372	Certified.
Roper-Ray	Roper, W. H	3,600	In force.
Talley, Harry	Enloe, H. E	2,934	Terminated.
Zachery	Zachery, E. H	2,435	Do.
Mitchell:			
Chalk Mountain	Ernest Mica Co., Inc	1,170	Do.
Sinkhole	Sinkhole Miners	31,680	In force.
Stevenson, Joe	Buchanan, Otis and Ira	3,420	Do.
Zinniman	Baker, Robert	6,633	Do.
Watauga, Mica Ridge	Tamarack Mining Co	2,043	Terminated.
Wilkes, Robinson, Henry L. and, Buchanan, Herbert.	Robinson, H. L	3,353	Do.
Yancey:			
Autrey, Jess W	Yancey Mica Mines, Inc	8,280	In force.
Cattail	do	14,543	Certified.
Grassy Knob Prospects	Grigg & West Co	8,685	In force.
Huskins Mica	Anglin & Elkins	6,750	Do.
Presnell	Yancey Mica Mines, Inc	3,690	Do.
Westall	Chrissawn, W. B., and Gibbs, Harris.	2,880	Do.
South Dakota:			
Custer:			
Dyke No. 2[2]	Collingwood, Lewis W	4,725	Do.
Glenwood	Mineral Mills, Inc	1,080	Certified.

[1] 90 percent of approved project estimated costs. Total actual expenditures by Government on terminated and certified contracts often were less than obligated funds.
[2] Classified as a mica-beryl project.

Defense Materials Procurement Administration.—In March 1952 the General Services Administration, under authority from DMPA, announced a long-range purchasing program for domestic mica to stimulate production of this mineral critical for national defense. The program was to continue until June 20, 1955, or until the total domestic block, film, and hand-cobbed mica delivered to and accepted by the Government reached the equivalent of 25,000 short tons of hand-cobbed mica (90 pounds of full-trimmed block or film mica is equivalent to 1 ton of hand-cobbed mica). Depots for the inspection and purchase of hand-cobbed muscovite ruby mica and processed muscovite ruby block and film mica were established at Franklin, N. H.; Spruce Pine, N. C.; and Custer, S. Dak. Purchases began at Custer on July 15, 1952, at Spruce Pine on July 21, and at Franklin on August 20. By December 31, 1952, purchases at these depots totaled $144,411, $571,638, and $47,599, respectively.

DOMESTIC PRODUCTION

Sheet Mica.—Production of crude sheet mica in 1952 increased 17 percent in quantity and 466 percent in value over 1951 (table 3). The 1952 production was the largest for the industry since 1946. Of the 10 States reporting, North Carolina ranked first, with 85 percent of the total domestic output.

TABLE 3.—Mica sold or used by producers in the United States, 1943–47 (average) and 1948–52

Year	Sheet mica: Uncut punch and circle mica		Sheet mica: Uncut mica larger than punch and circle		Sheet mica: Total sheet mica [1]		Scrap [2] and flake mica [3]		Total	
	Pounds	Value	Pounds	Value	Pounds	Value	Short tons	Value	Short tons	Value
1943–47 (average)	1,204,813	$192,169	348,098	$1,320,403	1,552,911	$1,512,572	48,465	$955,284	49,241	$2,467,856
1948	216,794	23,928	53,248	22,012	270,042	45,940	52,157	1,091,698	52,292	1,137,638
1949	450,835	72,576	63,159	59,521	513,994	132,097	32,856	795,782	33,113	927,879
1950	546,433	86,675	32,385	39,253	578,818	125,928	69,360	1,742,616	69,650	1,868,544
1951:										
Arizona	----------	----------	----------	----------	----------	----------	1,763	50,030	1,763	50,030
Colorado	----------	----------	----------	----------	----------	----------	1,882	32,901	1,882	32,901
New Hampshire	([4])	([4])	([4])	([4])	([4])	([4])	([4])	([4])	196	14,035
North Carolina	419,524	84,056	45,425	43,148	464,949	127,204	52,550	1,441,886	52,782	1,569,090
South Dakota	----------	----------	----------	----------	----------	----------	2,292	42,714	2,292	42,714
Undistributed [5]	124,522	24,373	5,413	8,745	129,935	33,118	13,384	316,556	13,253	335,639
Total	544,046	108,429	50,838	51,893	594,884	160,322	71,871	1,884,087	72,168	2,044,409
1952:										
Alabama	([4])	([4])	([4])	([4])	([4])	([4])	([4])	([4])	378	17,298
Georgia	11,800	2,463	1,210	16,389	13,010	18,852	([4])	([4])	([4])	([4])
Idaho	7,491	2,745	12,529	112,827	20,020	115,572	170	5,100	180	120,672
New Hampshire	([4])	([4])	([4])	([4])	([4])	([4])	([4])	([4])	187	47,882
North Carolina	548,723	102,928	46,608	561,147	595,331	664,075	58,576	1,551,071	58,874	2,215,146
South Dakota	----------	----------	4,308	32,034	4,308	32,034	915	24,148	917	56,182
Undistributed [5]	57,286	9,732	8,034	67,870	65,320	77,602	15,575	373,967	15,049	405,241
Total	625,300	117,868	72,689	790,267	697,989	908,135	75,236	1,954,286	75,585	2,862,421

[1] Includes small quantities of splittings in certain years.
[2] Includes the mica, except sheet mica, obtained from pegmatite mining as a sole product or as a byproduct, from the preparation of sheet mica, and from factory waste.
[3] Includes finely divided mica recovered from mica and sericite schist, and as a byproduct of feldspar and kaolin beneficiation.
[4] Included under "Undistributed" to avoid disclosure of individual company operations.
[5] Figures include Arizona (1952), California (1952), Colorado (1952), Connecticut, Georgia (1951), Maine, Pennsylvania, Virginia, and States indicated by footnote 4.

As of December 31, 1952, a total of 55,500 pounds of domestic full-trimmed mica (rifted mica trimmed on all sides, eliminating all cracks, reeves, and crossgrains) was obtained from purchases by the General Services Administration's mica-purchasing depots. Sheet mica usually is sold to industry by domestic producers as rough-trimmed or half-trimmed mica (rifted mica knife-trimmed on two sides). Processing of the hand-cobbed mica and half-trimmed mica purchased at the depots into full-trimmed mica was done under contract by private companies. The full-trimmed mica recovered from hand-cobbed mica was about 5,000 pounds. About 48 percent of the quantity of full-trimmed block and film mica was Good Stained and better quality; 43 percent, Stained; and 9 percent, Heavy Stained.

TABLE 4.—Yield of full-trimmed muscovite mica and byproducts from domestic purchases by GSA, July–December 1952, by quality, grade, and depot, in pounds

Grade and depot	Full-trimmed					Byproducts		
	Total	Good Stained and better	Stained "A"	Stained "B"	Heavy Stained	Other	Punch	Scrap
Spruce Pine, N. C.:								
2 and larger	200.26	149.41	22.94	11.88	16.03			
3	437.91	295.90	79.36	32.78	29.87			
4	1,565.40	958.61	361.78	131.04	113.97			
5	6,500.17	4,045.18	1,556.30	514.43	384.26			
5½	5,326.85	3,180.51	1,363.93	465.60	316.81			
6	22,800.14	13,840.95	5,850.27	1,859.70	1,249.22			
Total	36,830.73	22,470.56	9,234.58	3,015.43	2,110.16	196.26	296.05	43.19
Franklin, N. H.:								
2 and larger	36.72	6.44	9.77	12.31	8.20			
3	110.17	27.08	46.56	26.17	10.36			
4	286.54	81.96	121.01	62.23	21.34			
5	959.55	326.40	383.85	191.98	57.32			
5½	757.39	255.47	310.06	156.86	35.00			
6	2,138.39	782.81	880.67	373.99	100.92			
Total	4,288.76	1,480.16	1,751.92	823.54	233.14	1,765.01	933.23	1,581.14
Custer, S. Dak.:								
2 and larger	121.38	24.88	84.31		12.19			
3	312.05	50.06	227.87		34.12			
4	1,044.00	225.12	708.88		110.00			
5	4,008.19	816.38	2,599.94		591.87			
5½	2,347.50	385.19	1,481.06		481.25			
6	6,562.25	1,210.37	3,931.50		1,420.38			
Total	14,395.37	2,712.00	9,033.56		2,649.81		30,353.50	50,905.88
Grand total	55,514.86	26,662.72	23,859.03		4,993.11	1,961.27	31,582.78	52,530.21

A report on United States mica production, consumption, and imports, with general data on foreign mica-producing countries, was published in 1952 by the United States Tariff Commission.[4] The economics of the mica industry was summarized in two separate publications.[5] The President's Materials Policy Commission emphasized the strategic significance of mica and stated that, in view of the promising developments for mica substitutes and reconstituted mica,

[4] U. S. Tariff Commission, Unmanufactured Sheet Mica (Blocks, Films, and Splittings): Industrial Materials Series, Rept. M-4, April 1952, 50 pp.

[5] Arundale, J. C., Mica: chap. in Atlas of the World's Resources: The Mineral Resources of the World, by William Van Royen and Oliver Bowles: Prentice-Hall, Inc., New York, vol. II, 1952, pp. 178-181.
Tyler, P. M., Mica: Encyclopedia of Chemical Technology, vol. 9, 1952, pp. 68-75.

it seemed reasonable that a major portion of United States mica supply will be furnished domestically by 1975.[6]

The Federal Geological Survey released a report on the pegmatite bodies in the southeastern Piedmont province. Special attention was given to the distribution, geology, and economic possibilities of the pegmatite dikes.[7]

Investigations of mica-bearing pegmatites in the Amelia district, Virginia, were summarized, and the geology of the district, structural and mineralogical features of the pegmatite dikes, mining, and individual deposits were described.[8] The pegmatites of the Coshiers and Zirconia districts, North Carolina, were discussed in a report.[9]

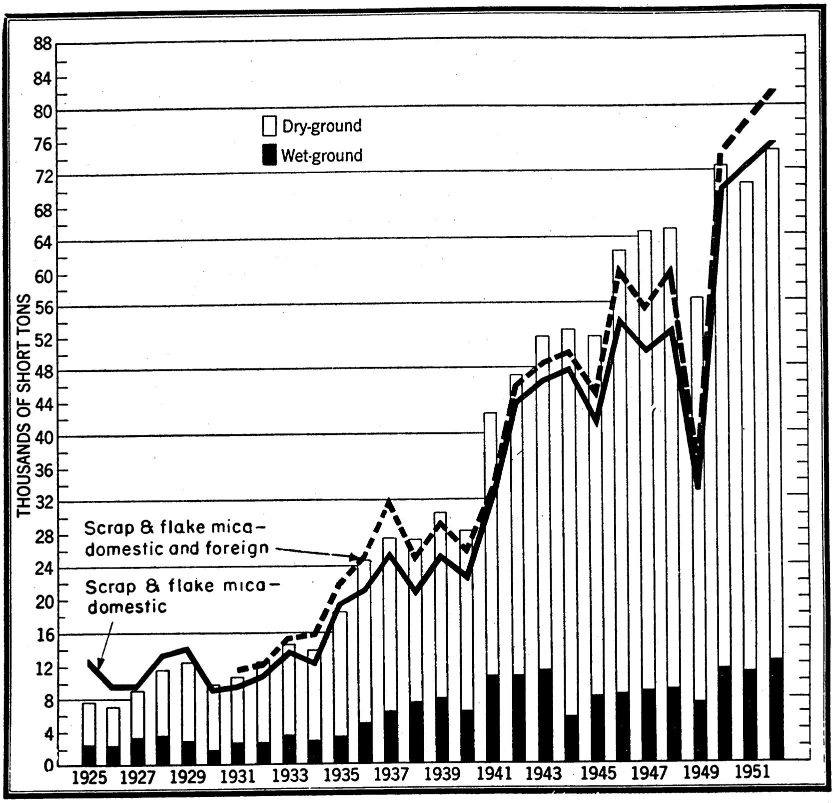

FIGURE 1.—Scrap, flake, and ground mica sold in the United States, 1925–52.

[6] President's Materials Policy Commission, Special Strategic Materials—Mica; Resources for Freedom: Vol. II, The Outlook for Key Commodities, June 1952, pp. 94–95.

[7] Jahns, R. H., Griffitts, W. R., and Heinrich, E. W., Mica Deposits of the Southeastern Piedmont. I. General Features: Geol. Survey Prof. Paper 248–A, 1952, 102 pp.

[8] Lemke, R. W., Jahns, R. H., and Griffitts, W. R., Mica Deposits of the Southeastern Piedmont II. Amelia District: Geol. Survey Prof. Paper 248–B, 1952, 138 pp.

[9] Olson, J. C., Pegmatites of the Coshiers and Zirconia Districts, N. C.: North Carolina Div. of Mineral Resources, Bull. 64, 1952, 32 pp.

Scrap and Flake Mica.—Sales of domestic scrap and flake mica in 1952 increased 5 percent above 1951 sales (table 5). Scrap is defined as the mica, except sheet mica, obtained from pegmatite mining as a sole product or as a byproduct, from the preparation of sheet mica, and from factory waste. Flake mica, previously called reclaimed, includes finely divided mica recovered from mica and sericite schists and as a byproduct of feldspar and kaolin beneficiation. The 1952 tonnage was the largest in the history of the industry.

Ground Mica.—Sales of ground mica in 1952 were the largest on record (table 6). Dry-ground mica was 84 percent and wet-ground mica 16 percent of the total. Mica for grinding was derived from scrap and flake mica.

TABLE 5.—Scrap and flake mica sold or used by producers in the United States, 1943–47 (average) and 1948–52

Year	Scrap [1]		Flake mica [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	30,253	$595,023	18,212	$360,261	48,465	$955,284
1948	(3)	(3)	(3)	(3)	52,157	1,091,698
1949	24,942	526,268	7,914	269,514	32,856	795,782
1950	58,250	1,401,411	11,110	341,205	69,360	1,742,616
1951	59,514	1,475,059	12,357	409,028	71,871	1,884,087
1952	57,201	1,452,174	18,035	502,112	75,236	1,954,286

[1] Includes the mica, except sheet mica, obtained from pegmatite mining as a sole product or as a byproduct, from the preparation of sheet mica, and from factory waste.
[2] Includes finely divided mica recovered from mica and sericite schist and as a byproduct of feldspar and kaolin beneficiation.
[3] Figure withheld to avoid disclosure of individual company operations.

TABLE 6.—Ground mica sold by producers in the United States, 1943–47 (average) and 1948–52, by methods of grinding

Year	Dry-ground		Wet-ground		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	48,121	$1,417,749	8,430	$859,162	56,551	$2,276,911
1948	55,494	2,035,618	9,148	1,197,014	64,642	3,232,632
1949	49,133	1,850,400	7,260	1,010,556	56,393	2,860,956
1950	61,139	2,374,089	11,111	1,561,608	72,250	3,935,697
1951	59,200	2,294,620	10,922	1,548,008	70,122	3,842,628
1952	62,465	2,526,407	12,341	1,751,696	74,806	4,278,103

CONSUMPTION

Sheet Mica.—Consumption of sheet mica (block, film, and splittings) in 1952 increased slightly over 1951. Before the third quarter of 1952, accurate statistics on sheet-mica consumption were not available; therefore the Bureau of Mines, in cooperation with the National Production Authority, conducted a quarterly canvass on mica consumption. Data on the consumption of muscovite ruby and nonruby block and film and phlogopite block during the last 6 months of 1952 are given in tables 8, 9, 10, and 11. A total of 26 companies in 11 States reported consumption of muscovite block and film mica during the 6-month period (table 12). About 45 percent of the consumption was by 5 companies in North Carolina, Pennsylvania, and Virginia.

Consumption of splittings decreased 24 percent in 1952 compared with 1951 (table 13). Consumption of splittings was reported by 16 companies in 9 States, as shown in table 14. Splittings were not purchased by the Government during the year.

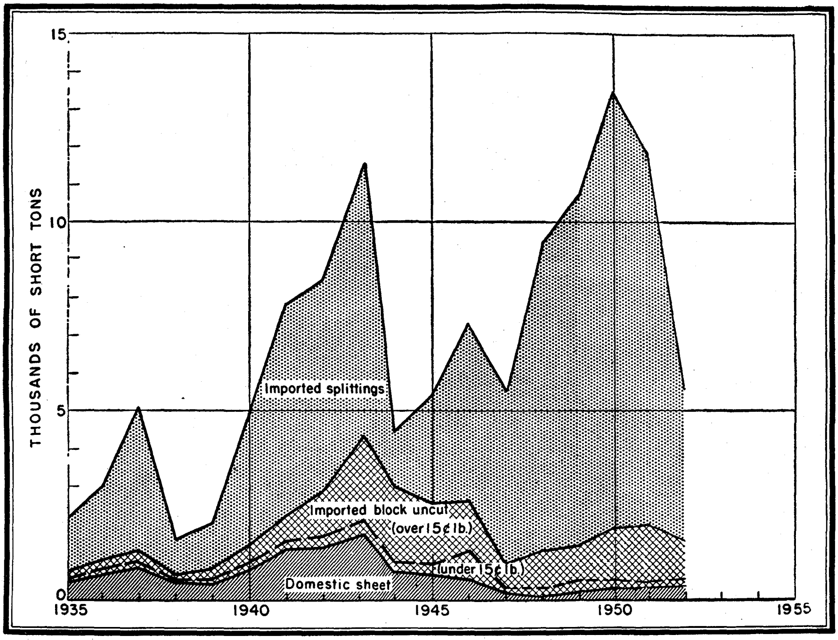

FIGURE 2.—Block mica and splittings imported for consumption in the United States and sales of domestic sheet mica, 1935–52.

TABLE 7.—Production and apparent consumption [1] of sheet mica in the United States, 1941–52, in pounds

Year	Production	Apparent consumption [2]	Year	Production	Apparent consumption [2]
1941	2,666,453	15,999,540	1947	415,589	11,216,257
1942	2,761,844	19,500,839	1948	270,042	19,297,842
1943	3,448,199	25,604,974	1949	513,994	21,646,158
1944	1,523 313	10,247,381	1950	578,818	27,709,386
1945	1,298,587	12,127,690	1951	594,884	25,225,267
1946	1,078,867	14,963,842	1952	697,989	12,478,048

[1] The sum of domestic sheet-mica production and imports of unmanufactured and manufactured sheet mica minus the exports of sheet mica.

[2] Revised figures, 1941–51.

TABLE 8.—Fabrication of muscovite ruby and nonruby block and film mica in the United States, July–December 1952, by quality and grade, in pounds

Quality	Grade					
	No. 4 and larger	No. 5	No. 5½	No. 6	Other [1]	Total
Block, ruby:						
Good Stained and better	7,988	9,030	7,744	39,291		64,053
Stained	69,376	86,605	52,140	1,000,816		1,208,937
Lower than Stained	75,041	102,846	14,644	111,469	146,866	450,866
Total	152,405	198,481	74,528	1,151,576	146,866	1,723,856
Block, nonruby:						
Good Stained and better	491	2,097	25	238		2,851
Stained	5,621	11,766	2,071	17,262		36,720
Lower than Stained	19,538	14,943	1,055	6,130	5,790	47,456
Total	25,650	28,806	3,151	23,630	5,790	87,027
Film, ruby:						
First quality	3,880	14,235	11,234	5,052		34,401
Second quality	13,795	24,518	20,699	14,009		73,021
Other quality					11,440	11,440
Total	17,675	38,753	31,933	19,061	11,440	118,862
Film, nonruby:						
First quality	307	61	55	50		473
Second quality	436	264	89	233		1,022
Other quality					2,494	2,494
Total	743	325	144	283	2,494	3,989

[1] Figures for block mica include "all smaller than No. 6" grade and "punch" mica.

TABLE 9.—Fabrication of muscovite ruby and nonruby block and film and phlogopite block by end-product use in the United States, July–December 1952, in pounds

Form, quality, and grade	Electronic uses					Nonelectronic uses			
	Capacitors	Tubes: Radio and TV: Receiving	Tubes: Radio and TV: Transmitting and radar	Tubes: Other tubes (including subminiatures)	Other electronic	Magnetos	Gage glass, compass cards, and diaphragms	Other	Total
Muscovite block ruby and nonruby:									
Good Stained and better	287	49,730	475	12,190	975		2,694	553	66,904
Stained	1,169	1,140,085	14,859	6,704	9,232	200	1,918	71,490	1,245,657
Lower than Stained	185	122,963	2,405	1,480	4,063			[1] 367,226	498,322
Total	1,641	1,312,778	17,739	20,374	14,270	200	4,612	[1] 439,269	1,810,883
Muscovite film, ruby and nonruby:									
First quality	34,395				20	140		319	34,874
Second quality	73,131				240	12		660	74,043
Other	13,820							114	13,934
Total	121,346				260	152		1,093	122,851
Phlogopite block, all grades: Total					220			4,112	4,332

[1] Includes punch mica.

TABLE 10.—Consumption of muscovite block and film in the United States July–December 1952, by end use

Block and film	Quantity (pounds)	Percent of grand total	Percent of quality
Good Stained and better:[1]			
Electronic:			
Capacitors	107,813	5.6	31.3
Tubes	62,395	3.2	35.5
Other	1,235	.1	.7
Total	171,443	8.9	97.5
Nonelectronic	4,378	.2	2.5
Total	175,821	9.1	100.0
Stained:[2]			
Electronic:			
Capacitors	14,989	.8	1.2
Tubes	1,161,648	60.0	92.2
Other	9,232	.5	.7
Total	1,185,869	61.3	94.1
Nonelectronic	73,722	3.8	5.9
Total	1,259,591	65.1	100.0
Lower than Stained:			
Electronic:			
Capacitors	185	(3)	(3)
Tubes	126,848	6.6	25.5
Other	4,063	.2	.8
Total	131,096	6.8	26.3
Nonelectronic	367,226	19.0	73.7
Total	498,322	25.8	100.0
Grand total	1,933,734	100.0	

[1] Includes first- and second-quality film.
[2] Includes other-quality film.
[3] Less than 0.1 percent.

TABLE 11.—Cost and value of muscovite ruby and nonruby block and film and phlogopite block receipts, fabrication and deliveries in the United States, July–December 1952

Form	Estimated cost of material received	Market value of material fabricated	Market value of material delivered without fabrication
Total muscovite block—ruby	[1] $2,807,257	[2] $5,415,031	$141,638
Total muscovite block—nonruby	[1] 161,236	[2] 278,532	4,620
Total muscovite film—ruby	834,590	1,151,583	378,687
Total muscovite film—nonruby	8,925	15,307	3,615
Total phlogopite block	21,992	13,435	

[1] Includes estimated cost of punch mica received.
[2] Includes market value for punch mica fabricated.

TABLE 12.—Consumption of muscovite block and film mica in the United States, July–December 1952, by States

State	Number of consumers	Quantity (pounds)
Connecticut, Massachusetts, and Rhode Island	5	414,062
Illinois, Indiana, and Ohio	5	36,755
New Jersey	3	140,230
New York	8	472,397
North Carolina, Pennsylvania, and Virginia	5	870,290
Total	26	1,933,734

TABLE 13.—Consumption and stocks of mica splittings in the United States, 1943–47 (average) and 1948–52, by sources

	1943–47 (average)		1948		1949	
	Pounds	Value	Pounds	Value	Pounds	Value
Consumption:						
Domestic	53, 719	$29, 914	[1] 75, 395	[1] $33, 106		
Canadian	[2] 362, 838	[2] 190, 687	237, 350	150, 487	81, 001	$45, 767
Indian	7, 622, 325	4, 008, 216	7, 228, 660	5, 866, 441	7, 462, 101	6, 624, 447
Madagascan	360, 037	241, 014	375, 960	250, 547	571, 702	426, 151
Mexican	[2] 51, 821	[2] 36, 665	(1)	(1)	---	---
Total	8, 450, 740	4, 506, 496	7, 917, 365	6, 300, 581	8, 114, 804	7, 096, 365
Stocks (Dec. 31):						
Domestic	13, 627	6, 202				
Canadian	[2] 161, 788	[2] 100, 841	147, 297	78, 992	[3] 85, 934	[3] 34, 141
Indian	4, 373, 992	2, 422, 472	3, 168, 801	2, 723, 175	3, 858, 495	4, 003, 621
Madagascan	293, 755	198, 911	402, 217	283, 170	413, 434	365, 098
Mexican	[2] 59, 348	[2] 41, 356	---	---	(3)	(3)
Total	4, 902, 510	2, 769, 782	3, 718, 315	3, 085, 337	4, 357, 863	4, 402, 860

	1950		1951		1952	
	Pounds	Value	Pounds	Value	Pounds	Value
Consumption:						
Domestic					---	---
Canadian	[3] 200, 728	[3] $105, 717	[3] 164, 213	[3] $104, 868	184, 541	$74, 197
Indian	9, 847, 591	8, 032, 918	12, 306, 853	10, 995, 620	9, 356, 561	9, 091, 784
Madagascan	734, 879	492, 786	908, 229	660, 129	679, 569	563, 118
Mexican	(3)	(3)	(3)	(3)	---	---
Total	10, 783, 198	8, 631, 421	13, 379, 295	11, 760, 617	10, 220, 671	9, 729, 099
Stocks (Dec. 31):						
Domestic			---	---	---	---
Canadian	[3] 235, 537	[3] 182, 999	50, 784	24, 486	63, 588	23, 352
Indian	5, 464, 294	5, 552, 016	9, 756, 536	9, 379, 176	8, 218, 683	8, 356, 888
Madagascan	450, 581	432, 872	522, 110	497, 658	512, 158	460, 015
Mexican	(3)	(3)	---	---	---	---
Total	6, 150, 412	6, 167, 887	10, 329, 430	9, 901, 320	8, 794, 429	8, 840, 255

[1] Mexican included with domestic.
[2] Mexican included with Canadian in 1947.
[3] Mexican included with domestic and Canadian.

TABLE 14.—Consumption of mica splittings in the United States, 1952, by States

State	Number of consumers	Quantity (pounds)
Indiana, Michigan, and Wisconsin	4	1, 428, 181
Massachusetts	4	2, 828, 899
New York, North Carolina, and Virginia	4	3, 848, 155
Ohio and Pennsylvania	4	2, 115, 436
Total	16	10, 220, 671

Built-up Mica.—Built-up mica consists of alternate layers of splittings and an insulating binder. Sales of built-up mica decreased 24 percent in 1952. Various forms of built-up mica were produced, as shown in table 15, and were used for electrical insulation in such equipment as generators, motors, transformers, electric irons, and toasters.

Ground Mica.—Sales of ground mica increased 7 percent above the 1951 total. The most extensive use of ground mica was in the manufacture of roofing materials (table 16). The next important use was as an ingredient in paint. Smaller quantities of ground mica were used for many purposes, including rubber, pipeline enamel, and plastics filler and in well drilling.

TABLE 15.—Built-up mica[1] sold or used in the United States, 1950–52, by kinds of product

Product	1950		1951		1952	
	Pounds	Value	Pounds	Value	Pounds	Value
Molding plate	2, 114, 502	$3, 860, 049	2, 184, 654	$3, 898, 117	1, 682, 742	$3, 137, 011
Segment plate	2, 548, 442	4, 928, 870	2, 778, 482	5, 488, 492	2, 094, 397	3, 972, 515
Heater plate	898, 333	2, 416, 478	1, 140, 404	2, 901, 670	511, 120	1, 419, 575
Flexible (cold)	711, 412	1, 914, 911	917, 326	2, 596, 787	721, 037	2, 002, 263
All other (tape, etc.)	1, 773, 912	7, 120, 539	2, 439, 289	11, 457, 814	2, 139, 670	10, 916, 674
Total	8, 046, 601	20, 240, 847	9, 460, 155	26, 342, 880	7, 148, 966	21, 448, 038

[1] Consists of a composite of alternate layers of a binder and irregularly arranged and partly overlapped splittings.

TABLE 16.—Ground mica sold by producers in the United States, 1951–52, by use

Use	1951			1952		
	Short tons	Percent of total	Value	Short tons	Percent of total	Value
Roofing	27, 919	40	$846, 801	30, 922	41	$887, 700
Wallpaper	865	1	121, 065	583	1	79, 673
Rubber	6, 551	9	507, 602	5, 126	7	457, 194
Paint	11, 760	17	1, 028, 490	16, 566	22	1, 549, 671
Plastics	1, 186	2	138, 778	1, 959	3	181, 889
Pipeline enamel	6, 378	9	202, 741	2, 668	4	85, 537
Welding rods	1, 203	2	78, 916	1, 749	2	102, 934
Well drilling	(1)	(1)	(1)	4, 847	6	245, 504
Miscellaneous [2]	14, 260	20	918, 235	10, 386	14	688, 001
Total	70, 122	100	3, 842, 628	74, 806	100	4, 278, 103

[1] Included with "Miscellaneous" to avoid disclosure of individual company operations.
[2] Includes mica used for molded electric insulation, house insulation, Christmas-tree snow, manufacture of axle greases and oil, annealing, well drilling (1951 only), and other purposes.

PRICES

Prices offered by fabricators for domestic sheet mica were identical to those in 1951, but subsidized prices paid by the Government at the mica-purchasing depots were about 4 to 6 times the market price (tables 17 and 18).

TABLE 17.—Prices for various grades of clear sheet mica in North Carolina district, December 31, 1952, in dollars per pound[1]

[E&MJ Metal and Mineral Markets]

Grade	December 1952
Punch	$0.12 to $0.22
1½- x 2-inch	.80 to .85
2- x 2-inch	1.10 to 1.20
2- x 3-inch	1.50 to 1.60
3- x 3-inch	1.80 to 1.90
3- x 4-inch	2.20 to 2.30
3- x 5-inch	2.40 to 2.50
4- x 6-inch	3.15 to 3.25
6- x 8-inch	4.00 to 4.50

[1] Stained or electric sheet mica was sold at approximately the same prices as clear sheet.

North Carolina scrap mica was quoted at $32 to $35, depending on the quality.

Dry- and wet-ground mica prices are quoted in table 19.

TABLE 18.—Price per pound for full-trimmed and half-trimmed block and film muscovite ruby mica purchased by the Government, 1952, by grade and quality

Quality	Grade		
	No. 3 and larger	No. 4 and No. 5	No. 5½ and No. 6
Full-trimmed:			
Good Stained and better	$70.00	$40.00	$15.00
Stained	18.00	8.00	5.00
Heavy Stained	13.00	6.00	3.00
Half-trimmed:			
Stained	12.00	5.00	3.00
Heavy Stained	8.00	4.00	2.00

TABLE 19.—Price of dry- and wet-ground mica in the United States, December 1952, in cents per pound [1]

[Oil, Paint and Drug Reporter]

	Price
Dry-ground:	
Paint, 100-mesh	4⅛
Plastic, 100-mesh	4⅛
Roofing, 20- to 80-mesh	3⅝
Wet-ground: [2]	
Biotite	6½
Extra fine	5¾
Extra fine, less than carlots [3]	6½
Paint or lacquer	7¼
Paint or lacquer, less than carlots [3]	8
Rubber	7
Rubber, less than carlots [3]	7¾
Wallpaper	7¼
Wallpaper, less than carlots [3]	8
White, extra fine	7¼
White, extra fine, less than carlots [3]	8

[1] In bags at works, carlots, unless otherwise noted.
[2] Freight allowed east of Mississippi River.
[3] Ex warehouse or freight allowed east of Mississippi River.

FOREIGN TRADE [10]

Imports.—In 1952 imports of mica of all varieties totaled 13,048 short tons, a decline of 31 percent compared to 1951. The biggest factor in the decline was the large decrease in imports of mica splittings.

Data on imports of muscovite block, film, and splittings and phlogopite splittings, compiled by the United States Tariff Commission from official documents of the United States Bureau of Customs by quality and principal source, for 1952, are given in tables 22, 23, and 24. Before 1952 such information was not tabulated.

In 1951 a method for estimating sheet-mica imports was determined from figures compiled by the United States Department of Commerce. Muscovite-block imports were assumed to comprise imports of unmanufactured mica valued above 15 cents per pound,

[10] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 20.—Mica imported into and exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Imports for consumption								Exports	
	Uncut sheet and punch		Scrap		Manufactured		Total		All classes	
	Pounds	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948	2,829,335	$2,477,598	7,124	$107,540	9,357	$12,960,918	17,896	$15,546,056	[1] 1,402	$720,359
1949	2,466,546	2,111,095	1,758	21,740	9,747	17,212,419	12,738	19,345,254	1,108	676,752
1950	[1] 3,334,652	3,094,616	4,402	59,014	12,441	20,506,774	18,510	23,660,404	1,547	859,796
1951	[1] 3,563,242	[1] 3,855,063	[1] 5,885	93,357	11,250	18,568,148	[1] 18,917	[1] 22,516,568	[1] 1,894	1,101,917
1952	2,479,483	3,518,592	6,531	106,475	5,277	11,054,206	13,048	14,679,273	2,472	911,076

[1] Revised figure.

TABLE 21.—Mica imported for consumption in the United States, 1948–51 [1] (totals) and 1952, by kinds and by countries of origin

[U. S. Department of Commerce]

Country	Unmanufactured									
	Waste and scrap, valued at not more than 5 cents per pound				Untrimmed phlogopite mica from which no rectangular piece exceeding 1 by 2 inches in size may be cut		Other			
	Phlogopite		Other				Valued not above 15 cents per pound n. e. s.		Valued above 15 cents per pound	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1948	4,834,354	$38,046	9,414,366	$69,494	434,429	$77,167	330,455	$35,354	2,064,451	$2,365,077
1949	981,156	5,658	2,534,919	16,082	28,304	4,238	635,313	94,182	1,802,929	2,012,675
1950	896,400	6,988	7,908,526	52,026	129,400	21,755	429,269	41,384	2,775,983	3,031,477
1951	494,740	4,284	[1] 11,275,723	89,073	169,586	28,827	364,494	33,371	[1] 3,029,162	[1] 3,792,865
1952:										
Angola			240,211	1,321					24,198	91,703
Argentina							150,490	7,230	12,072	8,816
Austria									1,400	935
Brazil							127,847	11,131	1,312,925	1,883,178
British East Africa			199,450	1,787					15,032	48,632
Canada	579,008	3,831	232,840	2,442	116,142	20,187	74,250	9,210	89,744	128,117
Ceylon							200	29		
Colombia							745	112	1,625	706
French Morocco							2,271	313	992	826
India			9,268,271	72,267					524,174	1,275,860
Italy									1,000	688
Madagascar									5,729	10,882
Mexico			100,563	859					2,083	4,170
Mozambique			89,600	822					3,087	2,274
Other Portuguese West Africa			110,230	509						
Southern Rhodesia									13,477	13,593
Union of South Africa			2,240,995	22,637						
Total	579,008	3,831	12,482,160	102,644	116,142	20,187	355,803	28,025	2,007,538	3,470,380

For footnote, see end of table.

TABLE 21.—Mica imported for consumption in the United States, 1948–51 [1] (totals) and 1952, by kinds and by countries of origin—Continued

Country	Manufactured—films and splittings							
	Not cut or stamped to dimensions				Cut or stamped to dimensions		Total films and splittings	
	Not above 12/10,000 inch in thickness		Over 12/10,000 inch in thickness					
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1948	16,148,048	$12,231,738	367,052	$417,931	28,905	$63,220	16,544,005	$12,712,889
1949	18,402,145	16,208,432	447,884	701,346	18,722	154,641	18,868,751	17,064,419
1950	23,086,329	18,387,967	1,090,082	1,505,827	27,799	363,097	24,204,210	20,256,891
1951	19,665,057	13,533,318	1,823,938	3,848,677	43,405	729,059	21,532,400	18,111,054
1952:								
Angola	-	-	150	470	-	-	150	470
Brazil	4,901	3,874	1,119,350	1,335,756	1,570	9,621	1,125,821	1,349,251
Canada	350	350	400	400	140	1,050	890	1,800
France	-	-	-	-	10	218	10	218
Germany, West	-	-	-	-	9,202	195,060	9,202	195,060
India	7,245,780	6,040,975	789,134	1,878,844	12,407	87,315	8,047,321	8,007,134
Japan	-	-	66	1,824	7,534	158,812	7,600	160,636
Madagascar	697,712	361,857	-	-	-	-	697,712	361,857
Mexico	5,263	5,451	-	-	18,540	255,201	23,803	260,652
Union of South Africa	32,286	12,980	-	-	-	-	32,286	12,980
United Kingdom	300	1,129	35	3,838	10,157	264,479	10,492	269,446
Total	7,986,592	6,426,616	1,909,135	3,221,132	59,560	971,756	9,955,287	10,619,504

Country	Manufactured—cut or stamped to dimensions, shape, or form		Manufactured—other					
			Mica plates and built-up mica		All mica manufactures of which mica is the component material of chief value		Ground or pulverized	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1948	162,540	$161,917	3,053	$2,139	25,698	$33,204	1,978,960	$50,769
1949	81,551	102,083	4,002	11,989	5,247	16,935	533,833	16,993
1950	82,353	112,136	9,779	25,619	25,590	86,314	560,000	25,814
1951	106,176	119,008	25,840	79,568	55,566	217,281	779,910	41,237
1952:								
Brazil	20,072	25,375	10,876	58,675	25,875	145,348	-	-
Canada	65	765	12	72	-	-	477,300	26,655
Denmark	36	128	-	-	-	-	-	-
France	-	-	7,160	12,211	-	-	-	-
Germany, West	220	309	1,838	2,330	1,606	2,909	-	-
India	29,887	56,963	700	1,613	-	-	-	-
Italy	-	-	80	1,680	-	-	-	-
Mexico	3,305	4,121	6,513	27,879	9,091	25,925	-	-
Mozambique	-	-	-	-	-	-	2,198	1,000
Sweden	27	274	-	-	-	-	-	-
Switzerland	-	-	62	149	-	-	-	-
United Kingdom	-	-	933	36,735	314	3,586	-	-
Total	53,612	87,935	28,174	141,344	36,886	177,768	479,498	27,655

[1] Changes in Minerals Yearbook, 1951, should read as follows: Unmanufactured (other), valued above 15 cents per pound—Canada, 337,272 pounds ($295,805); waste and scrap (other)—India, 9,625,701 pounds.

minus phlogopite valued above 15 cents per pound, plus the imports from Brazil of manufactured films and splittings, not cut or stamped to dimensions, over 12/10,000 inch thick. Imports from India of manufactured films and splittings over 12/10,000 inch thick were assumed to comprise muscovite-film imports. Muscovite-splittings imports largely consisted of imports from India of manufactured films and splittings not above 12/10,000 inch thick, and phlogopite-splittings imports were essentially the imports from Madagascar of manufactured films and splittings not above 12/10,000 inch thick. The Tariff and Commerce data are compared, using the above procedure in table 25.

TABLE 22.—Muscovite block and film mica, United States general imports, 1952, by quality and principal sources,[1] [2] in pounds

Quality	Countries			Total
	India	Brazil	Other [3]	
Block:				
Good Stained and better	117,589	197,459	37,189	352,237
Stained	599,870	1,389,055	30,618	2,019,543
Heavy Stained	37,933	524,757	10,537	573,227
Lower	118,291	510,006	37,304	665,601
Total	873,683	2,621,277	115,648	3,610,608
Film:				
First quality	101,363	----------	31	101,394
Second quality	196,360	330	119	196,809
Other	3,932	235	----------	4,167
Total	301,655	565	150	302,370
Block and film:				
Good Stained and better [4]	415,312	197,789	37,339	650,440
Stained [5]	603,802	1,389,290	30,618	2,023,710
Heavy Stained	37,933	524,757	10,537	573,227
Lower	118,291	510,006	37,304	665,601
Total	1,175,338	2,621,842	115,798	3,912,978

[1] Compiled by U. S. Tariff Commission from official documents of U. S. Bureau of Customs.
[2] Does not include imports from Angola, Austria, Port of East Africa, and Northern Rhodesia because detailed breakdowns from these sources are not available. Imports from these sources totaled 48,350 pounds.
[3] Includes imports from Angola, Argentina, Canada, Colombia, Southern Rhodesia, Tanganyika, and United Kingdom.
[4] Includes first- and second-quality film.
[5] Includes other-quality film.

TABLE 23.—Muscovite splittings, United States general imports, 1952, by form and principal sources,[1] in pounds

Country	Form			Total
	Book	Loose	Loose dusted	
India	894,916	4,843,051	1,021,234	6,759,201
Other [2]	5,691	10,756	153	16,600
Total	900,607	4,853,807	1,021,387	6,775,801

[1] Compiled by U. S. Tariff Commission from official documents of U. S. Bureau of Customs.
[2] Includes imports from Brazil and Mexico.

TABLE 24.—Phlogopite splittings, United States general imports, 1952, by principal sources [1]

Country	Pounds
Madagascar	677,688
Other [2]	1,084
Total	678,772

[1] Compiled by U. S. Tariff Commission from official documents of U. S. Bureau of Customs.
[2] Includes imports from Canada and Mexico.

TABLE 25.—Mica block, film, and splittings imported into the United States, 1952, by variety and principal sources, in pounds

	U. S. Tariff Commission data	U. S. Department of Commerce data
Muscovite block:		
India	873,683	524,174
Brazil	2,621,277	2,432,275
Other	[1] 115,648	152,210
Total	3,610,608	[2] 3,108,659
Muscovite film:		
India	301,655	[3] 789,134
Brazil	565	
Other	150	
Total	302,370	789,134
Muscovite splittings:		
India	6,759,201	[4] 7,245,780
Other	[5] 16,600	
Total	6,775,801	7,245,780
Phlogopite splittings:		
Madagascar	677,688	[6] 697,712
Other	[7] 1,084	
Total	678,772	697,712

[1] Includes imports from Angola, Argentina, Canada, Colombia, Southern Rhodesia, Tanganyika, and United Kingdom.
[2] Includes imports of unmanufactured mica valued above 15 cents per pound, minus phlogopite valued above 15 cents per pound, plus imports from Brazil of manufactured films and splittings, not cut or stamped to dimension, over 12/10,000 inch in thickness.
[3] Manufactured films and splittings, not cut or stamped to dimensions, over 12/10,000 inch in thickness, from India.
[4] Manufactured films and splittings, not cut or stamped to dimensions, not above 12/10,000 inch in thickness, from India.
[5] Includes imports from Brazil and Mexico.
[6] Manufactured films and splittings, not cut or stamped to dimensions, not above 12/10,000 inch in thickness, from Madagascar.
[7] Includes imports from Canada and Mexico.

Exports.—Total exports of mica and mica products in 1952 increased about 31 percent in quantity above 1951. Canada received about 47 percent of all mica exports; Venezuela, 19 percent; and West Germany and Belgium-Luxembourg, 8 percent each.

TABLE 26.—Mica and manufactures of mica exported from the United States, 1948–51 (totals) and 1952, by countries of destination

[U. S. Department of Commerce]

Country	Unmanufactured		Manufactured			
			Ground or pulverized		Other	
	Pounds	Value	Pounds	Value	Pounds	Value
1948	338,768	$68,632	2,268,403	$124,926	198,063	$526,801
1949	113,776	43,140	1,922,179	102,147	180,157	531,465
1950	335,941	98,614	2,567,807	158,947	190,075	602,235
1951	398,662	93,572	3,136,548	189,836	254,179	818,509
1952:						
North America:						
Barbados	---	---	20,000	1,080	---	---
Canada	556,488	17,465	1,669,290	81,173	118,480	431,609
Cuba	60	144	28,490	2,453	3,628	9,320
Mexico	17,670	8,037	86,000	4,803	9,942	34,260
Other North America	---	---	---	---	526	1,856
South America:						
Argentina	---	---	125,500	5,575	6,663	19,056
Brazil	10,232	1,474	57,000	2,289	1,053	3,480
Chile	349	1,305	---	---	4,642	16,000
Colombia	10	122	2,500	125	4,046	15,597
Peru	---	---	5,896	478	6,114	17,763
Venezuela	---	---	930,475	39,732	2,195	7,076
Other South America	---	---	---	---	616	1,449
Europe:						
Austria	---	---	---	---	1,110	10,472
Belgium-Luxembourg	64	170	380,800	30,948	1,087	4,360
France	---	---	182,350	14,865	13,389	9,697
Germany, West	---	---	407,550	33,395	---	---
Italy	2,205	750	65,000	5,250	1,191	21,953
Netherlands	---	---	11,000	990	567	1,725
Switzerland	---	---	28,000	1,947	413	5,390
United Kingdom	4,875	8,293	---	---	62	330
Other Europe	---	---	14,800	1,005	925	2,262
Asia:						
India	746	1,566	47,100	3,175	173	1,257
Indonesia	---	---	2,600	212	193	1,012
Japan	---	---	---	---	360	5,874
Philippines	80	1,196	10,000	656	579	1,821
Other Asia	122	178	---	---	201	1,625
Africa:						
Angola	---	---	4,000	278	---	---
Belgian Congo	---	---	500	150	784	3,018
Union of South Africa	---	---	94,100	3,503	757	2,453
Other Africa	---	---	---	---	152	495
Oceania:						
Australia	---	---	---	---	437	4,855
Other Oceania	---	---	---	---	197	229
Total	592,901	40,700	4,172,951	234,082	180,482	636,294

TECHNOLOGY

The Bureau of Mines Electrotechnical Laboratory, Norris, Tenn., made further progress in synthetic mica research. The investigations resulted in development of methods for making a machinable mica-ceramic dielectric by hot pressing, dry pressing, or fusion casting. The dielectric properties of hot-pressed synthetic mica were shown to be comparable to those of the best commercial ceramic dielectrics. An electric resistance melting process for growing synthetic mica crystals from a fluor-phlogopite melt was developed in which the mica batch acted as a container, a seal for fluorine vapor, and an insulator during cooling. The mica crystals were small, but evaluation tests by industry indicated that synthetic mica equaled natural mica in quality for vacuum-tube spacers under ordinary operating conditions and was superior in insulating quality and outgassing characteristics at higher temperatures. Synthetic mica flakes were reconstituted to form a sheet of controllable thickness and uniformity.[11]

A synthetic fluor-phlogopite mica, in which the hydroxyl ion of normal micas can be replaced completely by fluorine, was synthesized from a melt. Data on the physical, electrical, thermal, and chemical properties of the mica were published.[12]

Results of investigations under contract to the Office of Naval Research, Department of the Navy, were released during the year. The first described history of synthetic mica research. The synthesis of mica, descriptive mineralogy of mica, properties of synthetic mica, and synthetic mica products were discussed.[13] The second was an investigation of the growth of cadmium iodide by Horizons, Inc., in an attempt to relate the data to the mechanism of crystallization and growth of synthetic fluorine mica. The best crystals, in which layers in each component extend the length and breadth of the crystal, were obtained by the Bridgman method.[14] In this method, a crucible containing the melt batch is lowered through a thermal gradient from above to below the melting-point temperature. Crystallization begins at the cooler, lower end of the crucible and proceeds upward through the melt.

The absorption coefficients of several mica compositions were determined to facilitate selection of mica suitable for windows in X-ray tubes and ionization chambers. Muscovite and paragonite micas were found to have the lowest absorption coefficients, while biotite had the highest.[15] Details of the procedure and application of the German and hydride processes of metal-to-ceramic and mica-to-metal seals for vacuum tubes were given in a report.[16] A book was published on materials technology for electronic tubes, in which the electrical properties of ceramics and mica were discussed in detail.[17]

Developments by General Electric Co. and Samica Corp. made it possible to use domestic scrap mica to produce a new micaceous insulating material, known as reconstituted mica.[18] Processes of both companies formed sheets by conventional papermaking techniques, but the methods for preparing the raw mica differed. Mica for General Electric's product, known as Mica Mat, was heated to remove a small percentage of the combined water and then ground under water in a hammer-mill type disintegrator.[19] Material for

[11] Hatch, R. A. and Comeforo, J. E., Synthetic Fluorine-Mica Research, First Quarterly Progress Rept., July 1 to Sept. 30, 1952: Bureau of Mines, Synthetic Minerals Branch, Electrotechnical Laboratory, Norris, Tenn., 1952, 30 pp.; and Synthetic Fluorine-Mica Research, Second Quarterly Progress Rept., Oct. 1 to Dec. 31, 1952: 1952, 44 pp. (ms. rept. in files of Bureau of Mines).

Comeforo, J. E., Hatch, R. A., Humphrey, R. A., and Eitel, Wilhelm, Synthetic Mica Investigations. VI. A Hot-Pressed Machinable Ceramic Dielectric: Bureau of Mines, Synthetic Minerals Branch, Electrotechnical Laboratory, Norris, Tenn., 1952, 27 pp. (ms. rept. in files of Bureau of Mines).

[12] Van Valkenburg, Alvin, and Pike, R. G., Synthesis of Mica: Nat. Bureau of Standards, Jour. Research, vol. 48, No. 5, May 1952, pp. 360–369.

[13] Roy, Rustum, Synthetic Mica—Critical Examination of the Literature: Owens-Corning Fiberglass Corp., Toledo, Ohio (Tech. Rept. to Office of Naval Research), 1952, 72 pp.

[14] Horizons, Inc., Growth of Oriented Crystals of Layer Minerals (Mica): Progress Rept. 2, Cleveland, Ohio (Tech. Rept. to Office of Naval Research), 1952, 13 pp.

[15] Deodhar, G. B., and Mande, Chintamani, X-ray Absorption Coefficients of Mica: Jour. Sci. Indian Research, vol. 11-B, No. 7, 1952, pp. 265–268.

[16] Taylor, Stanley, Metals, Ceramics, and Seals Used in Vacuum Tubes: Ohio State Univ. Eng. Exp. Sta. News, vol. 23, No. 5, 1951, pp. 52–53.

[17] Kohl, W. H., Materials Technology for Electronic Tubes: Reinhold Pub. Corp., New York, 1951, pp. 347–402.

[18] Tyler, P. M., Reconstituted Mica and Synthetic Mica: Nat. Acad. Sciences Rept. MMAB 31-C, Aug. 27, 1952, 63 pp. (ms. rept. in files of Bureau of Mines).

[19] Kern, E. A., Letteron, H. A., and Staats, P. L., Mica Mat—New Tool for the Electrical Designer: Gen. Elec. Rev., vol. 55, No. 3, May 1952, pp. 54–57, 60.

Wieseman, R. W., New Flexible Mica Makes Bid as Insulation for Armature Windings: Power, vol. 96, No. 7, July 1952, pp. 80–81.

"Samica" sheets was heated to cause partial dehydration of the mica. This hot mica first was immersed in a saturated solution of sodium carbonate or sodium bicarbonate and, after draining, in a strong solution of hydrochloric or sulfuric acid. Only washing and agitation were necessary to produce a pulp material from the chemically treated mica.[20] The Mica Mat or Samica sheet as it came from the paper machine was not strong enough for general insulation uses. Therefore, suitable bonding agents and bonding materials, such as cloth or paper, were used to improve the mechanical and electrical properties. General Electric had its own processing facilities for impregnation at Coshocton, Ohio. The thin, coherent sheets had a uniform thickness, more uniform bond content, and greater flexibility and could be machined, punched, molded, or tapped. Samica Corp. planned to begin commercial production of mica paper in early 1953 at its new plant under construction near Rutland, Vt., and proposed to offer unbonded sheets for sale to processors for impregnation.

A third firm, Integrated Mica Corp., split mica in distilled water by means of high-pressure water jets.[21] The split mica was floated into a water bath and allowed to settle upon a belt feeding into a drier. The material was treated with resins to decrease the porosity and increase the strength. The company, which was in semicommercial production, produced mica sheets from both mica waste and synthetic mica supplied by the Federal Bureau of Mines. Considerable time was devoted to development of a protective coating technique, and a patent for a mica-splitting machine was issued in 1952.[22]

Dow Corning Corp. announced development of a silicone resin for binding mica flake to glass. The resulting mica-glass fabric can be produced as either flexible or rigid sheets or tapes that can be used as slot liners in motors, as ground insulation, and as layer insulation in transformers. A second silicone resin, used as a solution in toluene and xylene, was developed as a suitable bonding resin for mica segments in commutators.[23]

The Wet Ground Mica Association, Inc., issued pamphlets on the effect of a wet-ground mica extender on the behavior of vinyl primer materials and a compilation of formulas containing mica for latex paints.[24]

The International Organization for Standardization, Technical Committee on Mica, convened at Columbia University for the 1952 triennial meeting. Documents on methods for grading processed muscovite mica, classification of processed muscovite ruby mica, and specifications for processed phlogopite mica were discussed. Many revisions were accepted by the delegates from Brazil, France, Germany, India, the United Kingdom, and the United States in an effort to clarify the

---

20 Griffeth, R. L., and Younglove, E. R., Mica Paper Developed for Electrical Insulation: Materials and Methods, vol. 35, No. 6, June 1952, pp. 174, 176, 178, 180, 182, 184.

21 Electrical World, vol. 137, No. 26, June 1952, p. 127.
Chemical Week, Three to Make Ready: Vol. 70, No. 25, June 21, 1952, pp. 59–61.

22 Heyman, Moses D., Mica-Splitting Apparatus: U. S. Patent 2,612,889, Oct. 7, 1952.

23 Materials and Methods, Silicones: Vol. 36, No. 4, October 1952, p. 134.

24 Wet Ground Mica Association, Inc., An Investigation of the Effect of a Platy Mica Extender on the Behavior of Vinyl Primer Materials—part I: Tech. Bull. 10, August 1952, 4 pp.; part II: Tech. Bull. 11, 1952, 4 pp.
Wet Ground Mica Association, Inc., Compilation of Formulations for Latex Paints Containing Mica: Tech. Bull. 12, November 1952, 6 pp.

terminology. Working groups were set up to examine samples with a view to preparing a set of master standards for block mica and mica splittings.[25]

During the year, specifications for classifying natural muscovite mica by visual qualities, and natural block and film mica by electrical testing, were accepted by the American Society for Testing Materials as tentative standards.[26] Also, specifications for mica used in the manufacture of asphalt roofing and a method of test for pasted mica in electrical insulation were accepted by the society.[27]

An investigation was made to determine whether nonruby mica, as well as ruby mica, should be considered for stockpiling. Results showed that satisfactory capacitors had been made from electrically tested nonruby mica. The data confirmed the fact that nonruby mica tends to be more variable than ruby mica in quality, yield, and performance and showed that technologic factors favor the use of ruby mica when available in plentiful supply at reasonable prices. If the electrical test is used in conjunction with visual qualification, quantities of nonruby that would otherwise be rejected could be selected for stockpiling or industry use. Electrical testing eliminates some human factors of visual inspection, but strong justification must be established to counterbalance cost factors before sizable lots are tested.[28]

A method was described for making crystal structure models from transparent, hollow, plastic balls.[29]

Patents were issued for converting mica into sheets by a conventional papermaking method and into a molded form,[30] for an insulating material comprised of mica flakes and a pine-tar bonding agent,[31] and for a method and apparatus for making high-temperature-resisting bonded-mica products.[32]

WORLD REVIEW

The estimated world production of mica in 1952 decreased 4 percent compared to 1951. Table 27 shows data for 1948–52.

Australia.—Production of mica in Australia was insufficient for domestic requirements. About 75 percent of the mica used in Australia was imported, principally from India. To compensate for a decline in production in the Northern Territory, exploration and development of mica at Yinnietharra was encouraged during the year. Allied Works Council recovered sizable quantities of high-quality mica during World War II from Yinnietharra, but most of the mica was small grade.[33]

---

[25] Standardization, Mica ISO/TC 56: Vol. 23, No. 9, September 1952, p. 292.

[26] ASTM, Natural Muscovite Mica Based on Visual Quality: D 351–52T, February 1952. Natural Block Mica and Mica Films Suitable for Use in Fixed Mica-Dielectric Capacitors: D 748–52T, February 1952.

[27] ASTM, Asphalt Roofing Surfaced With Powdered Talc or Mica: D 224–52, 1952. Testing Pasted Mica Used in Electrical Insulation: D 352–52, 1952.

[28] Tyler, P. M., Usability of Green Mica: Nat. Acad. Sciences Rept. MMAB–21–SC, Sept. 15, 1952, 21 pp. Q-Meter Testing as a Means of Augmenting Supplies of Capacitor Mica: Nat. Acad. Sciences Rept. MMAB–28–C, Sept. 25, 1952, 51 pp.

[29] Hatch, R. A., Comeforo, J. E., and Pace, N. A., Transparent, Plastic-Ball, Crystal-Structure Models, Illustrated by Phlogopite Mica: Am. Mineral., vol. 37, 1952, pp. 58–67.

[30] Gérand de Senarclens (assigned to Samica Corp.), Method of Treating Mica: U. S. Patent 2,614,055, Oct. 14, 1952.

[31] Schulman, E. L., and Reeder, G. S. (assigned to Westinghouse Electric Corp.), Flexible Mica Compositions: U. S. Patent 2,575,733, Nov. 21, 1951.

[32] Mansfield, W. R., and Hughes, F. C. (assigned to W. A. Baughton, C. L. Dawes, W. R. Mansfield, F. C. Hughes, and D. M. Hill), Method of and Apparatus for Making High-Temperature-Resisting Bonded-Mica Products: U. S. Patent 2,567,721, Sept. 11, 1951.

[33] Queensland Government Mining Journal, Australian Mica: Vol. 52, No. 596, June 1951, p. 407.

Belgian Congo.—Mica in large sheets is known to occur in pegmatites of the tin district of the eastern part of the Colony.[34] In Ruanda-Urundi, scrap mica has been recovered.

TABLE 27.—World production of mica, by countries,[1] 1948–52, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
North America:					
Canada (sales)	3,584	1,583	1,760	2,250	903
Mexico (exports)	27	(3)	(3)	(3)	(3)
United States (sold or used by producers):					
Sheet	122	233	262	270	317
Scrap	47,316	29,806	62,922	65,200	68,253
South America:					
Argentina:					
Sheet [4]	300	300	300	300	300
Scrap [4]	1,100	1,100	1,100	1,100	1,100
Brazil	2,141	1,363	1,813	1,658	(3)
Uruguay	2	2	1	1	1
Europe:					
Austria	90	253	368	307	(3)
Italy	23	(3)	(3)	(3)	(3)
Norway, including scrap	153	331	553	986	[4] 1,000
Spain	11	9	14	11	18
Sweden:					
Block	14	11	2	42	} (3)
Ground	50	50	165	173	
Asia:					
Ceylon	-------	-------	-------	(5)	9
India (exports):					
Block	685	418	773	1,637	[4] 1,500
Splittings	10,309	9,161	12,070	13,939	[4] 5,000
Scrap	7,390	4,164	3,736	9,351	[4] 8,000
Korea, Republic of	-------	-------	(3)	(3)	6
Taiwan (Formosa):					
Sheet	-------	-------	-------	15	1
Scrap	-------	-------	-------	470	13
Africa:					
Angola:					
Sheet	10	12	15	15	29
Scrap and splittings	98	45	154	121	200
Eritrea	1	(5)	1	-------	(3)
French Morocco:					
Sheet	} 144	{ -------	1	12	-------
Scrap		198	74	25	6
Kenya	(3)	4	6	1	2
Madagascar:					
Block (phlogopite)	67	126	57	958	41
Splittings	440	833	762	-------	1,028
Mozambique, including scrap	1	103	41	11	1
Northern Rhodesia, sheet	-------	3	2	6	16
Southern Rhodesia:					
Block	275	87	76	94	95
Scrap	18	216	331	254	664
South-West Africa, scrap	-------	-------	59	114	-------
Tanganyika (exports):					
Block and sheet	67	60	50	70	108
Ground	3	36	60	-------	15
Scrap	-------	-------	25	-------	1
Uganda	2	2	(5)	(5)	(5)
Union of South Africa:					
Sheet	1	1	14	5	5
Scrap	1,361	1,065	1,357	1,774	2,663
Australia [6]	427	736	738	536	501
Total (estimate) [1]	90,000	70,000	105,000	125,000	120,000

[1] In addition to countries listed, mica is also produced in China, Rumania, and U. S. S. R., but data on production are not available; estimates for these countries by senior author of chapter are included in total.
[2] This table incorporates a number of revisions of data published in previous mica chapters.
[3] Data not available; estimate by senior author of chapter included in total.
[4] Estimate.
[5] Less than 0.5 ton.
[6] These figures include the following tonnages of damourite produced in South Australia: 1948: 368 tons; 1949: 703 tons; 1950: 707 tons; 1951: 513 tons; 1952: 468 tons.

[34] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 5, November 1952, p. 50.

Brazil.—The majority of the mica mines and prospects in Brazil are scattered through the eastern part of Minas Gerais, where Governador Valadares and Espera Feliz are the principal producing regions. The mica belt trends north-northeastward through mountainous terrain for over 600 kilometers. In 1952 it was reported that four mines were opened in Pernambuco and Paraiba and a small quantity of mica was recovered from waste piles of earlier beryl-tantalite mining.[35] Employment and revenue from mica mining in the northeastern States were economic benefits to the region during the long drought, which greatly reduced income from agriculture and livestock.

Canada.—Exports of crude mica, block mica, and mica splittings were shipped to the United States and Japan. The United States received 99 percent of the crude, 43 percent of the block, and about 12 percent of the splittings. All of Canada's exports of scrap and ground mica went to the United States.[36] Micha Mica Mines, Ltd., was formed to acquire a muscovite mica prospect in Cardiff Township, Haliburton County, eastern Ontario. A high content of mica was indicated by sampling of the principal outcrop on the 4,000-acre group.[37]

French Cameroons.—A pegmatite dike containing books of muscovite mica 10 to 15 cm. in diameter was found near the village of Efok.[38] Similar undeveloped deposits occur 50 kilometers northwest of Efok and 40 kilometers southwest of Bafia.

India.—The Indian States of Bihar, Rajasthan, and Madras continued to be the principal mica-producing areas in the world. The most important district was Hazaribagh, Bihar. All mica produced in Rajasthan was shipped to Bihar for processing and export since no dealers' licenses were issued at Rajasthan. The Nellore and Nilgiris districts were the principal mica areas in the State of Madras.

A decline in the demand for Indian mica was discussed by the Mica Advisory Committee in September at Calcutta.[39] The committee recognized the fact that the lack of domestic markets resulted in complete dependence on foreign markets and was mainly responsible for the crisis in the mica trade. Because purchases of splittings by India's largest consumer—the United States—declined and since about 75 percent of India's mica production is splittings, many small producers, who had resumed production to satisfy the heavy demand from the United States Government for stockpiling, were forced to close, and the larger producers had to reduce their output. The committee blamed the large-scale export of scrap mica at low prices for a portion of the decreasing market, stating that reconstituted mica made from scrap and development of synthetic mica might eventually destroy the Indian mica industry, which depends on the sales of splittings and scrap to continue profitable operations. According to Rajasthan Industrial and Mining Association, the Government of India must ban the export of scrap mica and develop other markets for the sale of mica, as well as stimulate internal consumption.[40]

---

35 Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 3, March 1952, p. 37.
36 Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 1, July 1953, pp. 50–51.
37 Northern Miner, Micha Mica Formed by U. S. Interests: Vol. 37, No. 48, Feb. 21, 1952, p. 6.
38 Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 1, July 1952, p. 39.
39 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 1, January 1953, pp. 34–39.
40 Engineering and Mining Journal, vol. 153, No. 8, August 1952, p. 155. Mining Journal (London), Indian Mica: Vol. 238, No. 6093, May 1952, p. 557; vol. 239, No. 6104, August 1952, p. 174.

Madagascar.—Production of phlogopite totaled 40.5 metric tons of block and 1,028.4 tons of splittings in 1952. Exports of block mica totaled 73.3 metric tons and exports of splittings 654.7 tons.[41]

Phlogopite mica was produced principally from southern Madagascar near Isohy southward to Fort-Dauphin. The largest producing mica mine has been the Benato mica mine, 20 miles north of Betroka. The Union de Mica Mine about 62 miles south of Betroka at Ampandrandava produced 240 tons during 1952. Between 60 and 70 percent of the production is exported to the United States.

Norway.—It was reported in 1952 that research was begun on a method of recovery of mica found in the tailings of the Mofjellet sphalerite mine, operated by Bergverkselskapet Nord-Norge. The company estimated that at least 1,000 tons of ground biotite mica could be produced at the Mo-i-Rana flotation plant each year. Some consideration was given to reopening the State-owned Rendalsvik graphite mine if the ground mica could be sold at a favorable price as a byproduct. Almost the entire production of wet-ground, dry-ground, and "micronized" mica has been exported, principally to the United Kingdom and France. There was no production of sheet mica in Norway in 1952.[42]

Southern Rhodesia.—About 242,000 pounds of block mica was exported in 1952, with 218,000 pounds shipped to the United Kingdom and the remainder to Tanganyika and the Union of South Africa. The United States received about 184,000 pounds of the scrap-mica exports and the United Kingdom about 160,000 pounds.[43]

Tanganyika.—In 1952 the Netherlands firm of Van Eeghen & Maclaine, Ltd., built a mica-sorting plant in Marogoro. The work force totaled about 100. This company was the fourth largest exporter of sheet mica from Tanganyika.[44]

---

41 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 39.
42 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, pp. 39–40.
43 Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 1, July 1953, pp. 51–52.
44 American Embassy ,Dar es Salaam, Tanganyika, State Department Dispatch 282, June 16, 1952, 2 pp.

Molybdenum

By Robert W. Geehan [1]

DOMESTIC production of molybdenum concentrates in 1952 was higher than that of any prior years except 1942 and 1943. Production and shipments of concentrates were 11 and 13 percent more, respectively, in 1952 than in 1951. In spite of the increased production the metal remained in short supply and programs of industry and the Government designed to increase output in future years were initiated. Production of the primary products of molybdenum in 1952 was slightly less than in 1951, but shipments of these materials increased. Industry stocks of both concentrates and products increased and were 36 and 11 percent, respectively, higher at the year end than those available at the end of 1951.

During 1952 molybdenum concentrates were allocated by Defense Materials Procurement Agency, and most of the primary products were under the allocation and end use control orders of National Production Authority. Both concentrates and products were included in the distribution plans that the International Materials Conference submitted to member nations for approval. Allocations of pure molybdenum were discontinued by National Production Authority in September.

Government Regulations and Programs.—During 1952 the following regulations of the Government were important to producers and consumers of molybdenum-bearing materials:

MO–8—Defense Materials Procurement Agency. Allocations of molybdenum concentrates.

M–80—National Production Authority. Iron and steel alloying materials and alloy products; allocations, end use, and reporting procedures.

M–81—National Production Authority. Pure tungsten and pure molybdenum; allocations, end use, and reporting procedures. Amended September 12, 1952, to remove the requirements for allocations.

TABLE 1.—Salient statistics of molybdenum concentrates in the United States, 1943–47 (average) and 1948–52

	Molybdenum contained, thousands of pounds					
	1943–47 (average)	1948	1949	1950	1951	1952
Production	35,283	26,706	22,530	28,480	38,855	43,259
Shipments (including exports)	33,208	29,669	23,280	44,544	37,955	42,717
Exports [1]	4,495	4,132	5,320	6,235	3,729	6,172
Imports for consumption	826	-------	48	3	4	50
Consumption	29,864	25,156	19,960	26,029	33,691	32,715
Stocks (industry), Dec. 31 [2]	19,427	21,206	19,159	4,326	5,058	6,856

[1] Includes roasted concentrates.
[2] At mines and at plants making molybdenum products.

[1] Assistant chief, Ferrous Metals and Alloys Branch.

DOMESTIC PRODUCTION OF ORES AND CONCENTRATES

Domestic production of molybdenum in concentrates during 1952 was more than that of any years except 1942 and 1943. Production of concentrates in 1952 totaled, in thousands of pounds (metal content), 43,259 contrasted to 38,855 in 1951, 40,363 in 1941, 56,942 in 1942, and 61,667 in 1943. During 1952 the greatest production was obtained in the third quarter, when 13,042 thousand pounds was produced; in the following quarter production dropped to 11,065.

The most important molybdenum-bearing mineral is molybdenite (MoS_2), which was the source of virtually all the molybdenum mined in 1952. Wulfenite ($PbMoO_4$), once mined from several deposits in southwestern United States, has not been reported as produced since 1944. Powellite [$Ca(Mo,W)O_4$] contributed a relatively small quantity of molybdenum in 1952. Some molybdenum contained in tungsten concentrates is recovered at steel plants; this material is not included in the statistical tables.

Molybdenite is produced at mines operated chiefly for molybdenum and as a byproduct at mines operated mainly for copper or tungsten. The molybdenite content of raw ore mined at the former ranges from about 0.4 to 1.75 percent; at the latter the range is about 0.01 to 0.09 percent. In both cases a molybdenite concentrate is produced; the molybdenite content of the concentrate shipped ranges from about 54 to 92 percent, while 90 percent is considered a standard grade for price quotations. Output of mines operated solely or almost solely for molybdenum was 23,992 thousand pounds (metal content) in 1952, a 5-percent increase from 1951; byproduct concentrates from copper and tungsten operations totaled 19,267 thousand pounds, an increase of 20 percent.

Molybdenum was produced in six States in 1952. Colorado led, followed in order by Utah, Arizona, New Mexico, California, and Nevada. Shipments of molybdenum concentrates (metal content) comprised 37,427 thousand pounds to domestic consumers and 5,290 thousand pounds for export; total shipments increased 13 percent compared with 1951. Nearly all of the concentrates consumed are shipped to plants in Pennsylvania for conversion to primary products; however, the output of Miami Copper Co. is roasted before shipment.

Actions of the Government designed to stimulate production were important. In July 1952 Climax Molybdenum Co. signed a contract negotiated with Defense Materials Procurement Agency. This agreement provides for an investment of $9.5 million by the company to provide facilities for producing molybdenum concentrates from submarginal ores. The first output will be purchased by the Government at $1.24 a pound of contained molybdenum; prices are expected to range from $1 to $1.07 after large-scale production is obtained. Climax Molybdenum Co. also has contracts with the Government for production from the standard-grade portion of the ore body.[2]

An interim revision of the expansion goal for molybdenum ore and concentrates was established at 70,000,000 pounds of domestic production in 1954, measured in terms of molybdenum content.[3]

Molybdenum Mines.—Ores that contained molybdenum as the chief value were worked by two domestic mines in 1952; their combined

[2] E&MJ Metal and Mineral Markets, vol. 23, No. 28, July 10, 1952, p. 3.
[3] American Metal Market, vol. 59, No. 222, Nov. 19, 1952, p. 1.

output represented 55 percent of the molybdenum in concentrates produced in 1952. The Climax, Colorado, mine of Climax Molybdenum Co. was the world's leading producer of molybdenite concentrates. This firm was completing a construction and mine development program and began work to provide facilities for production and concentration of submarginal ores.[4]

The Molybdenum Corp. of America produced molybdenite concentrates at the Questa mine, Questa, N. Mex. This mine was opened in 1919 and since 1923 has been a regular producer. A portion of the 1952 output was from tailings produced in prior years; production of concentrates was 14 percent less than in 1951.

Byproduct Sources.—During 1952 molybdenite concentrates were produced as a byproduct at 6 domestic copper mines and 1 domestic tungsten plant. Output of this group represented 45 percent of the molybdenum contained in concentrates produced in 1952.

Bagdad Copper Corp., Bagdad, Ariz., began to recover molybdenite concentrates during 1951 and produced 320,128 pounds of molybdenite in 1952.

Kennecott Copper Corp. operated molybdenite recovery units at its Chino Mines Division (Hurley, N. Mex.), Nevada Mines Division (McGill, Nev.), and the Utah Copper Division (Arthur and Magna mills, near Salt Lake City, Utah). Production of molybdenite increased 22 percent at Hurley, 2 percent at McGill, and 16 percent at the Arthur-Magna plant. The increased output resulted from treatment of a larger tonnage of copper ore and from improved metallurgical practices in the molybdenum section of the mills.

Miami Copper Co. has been a regular producer of molybdenite concentrates since 1938 as a byproduct of its copper operations at Miami, Ariz. The concentrates are converted to molybdic oxide at the same location.

The Phelps Dodge Corp. produced 1,116 tons of molybdenite concentrates as a byproduct of milling copper ore at its Morenci, Ariz., operations during 1952.

United States Vanadium Corp. recovered molybdenum products as a byproduct of tungsten ores and concentrates at its Pine Creek mill and chemical treatment unit near Bishop, Calif. The plant treats tungsten ores produced at the Pine Creek mine and tungsten ores and concentrates produced by others.

TABLE 2.—Molybdenum in ore and concentrates produced and shipped from mines in the United States, 1943–47 (average) and 1948–52

[Thousands of pounds and dollars]

	1943–47 (average)	1948	1949	1950	1951	1952
Production	35, 283	26, 706	22, 530	28, 480	38, 855	43, 259
Shipped from mines [1]	33, 208	29, 669	23, 280	44, 544	37, 955	42, 717
Value [2]	23, 436	20, 418	19, 332	37, 729	36, 177	40, 845

[1] Figures for 1943–44 represent shipments from mines, plus concentrates converted to oxide by producer at Miami, Ariz.; those for 1945–52 represent shipments to domestic and foreign customers, plus concentrates converted to oxide at Miami, Ariz., and Langeloth, Pa.

[2] Largely estimated by Bureau of Mines.

[4] Mining World, vol. 14, No. 13, December 1952, pp. 34–35.

CONSUMPTION AND USES

Consumption, as measured by shipments to domestic consumers of molybdenum primary products, exceeded that of 1951 by 1 percent. About 90 percent of the molybdenum is used in ferrous alloys, to which it is added as molybdic oxide, calcium molybdate, or ferromolybdenum. A relatively small quantity of molybdenite is used by a few steel companies as an addition in the ladle when both sulfur and molybdenum are required in the product to improve machinability. Molybdenum is also used in the metallic form in the electrical industry, and alone or in nonferrous alloys for certain high-temperature applications; molybdenum disulfide (molybdenite) is used in special lubricants, and various molybdenum compounds are used as fertilizers, in pigments, for ceramics, and as catalysts. The following distribution of molybdenum products by use is indicated in reports of the National Production Authority: Steel 63.7 percent, gray iron and malleable castings 27.8 percent, molybdenum metal 1.9 percent, paint and pigments 1.8 percent, welding electrodes 1.4 percent, catalysts 0.8 percent, lubricants 0.3 percent, all other (includes chemicals and nonferrous alloys) 2.3 percent.

Molybdenum is so widely used in alloy steels that it is difficult to list the types and uses. Modern usage ordinarily calls for remarkably small quantities of this element per ton of steel; an exception is high-speed steel, where 6 percent molybdenum is a common composition. Additions in the range 0.1 to 0.5 percent molybdenum are common in many alloy steels that also contain chromium and nickel. Molybdenum is used in steels to promote uniform hardness and strength, to reduce softening when tempering, to reduce the tendency of certain steels to become brittle after tempering, to increase strength and creep resistance at elevated temperatures, to retard embrittlement in steels subjected to stress at temperatures ranging from 600° to 1,000° F., to aid corrosion resistance, to impart red hardness to high-speed steels, and, along with other alloying elements, for many special applications. In cast irons molybdenum increases the tensile strength, promotes uniform strength in castings with light and heavy sections, improves high-temperature strength, improves resistance to chipping, and improves hardenability of heat-treated castings. In both iron and steel the ability to use a very small quantity of molybdenum to yield the desired effect minimizes the cooling action at the time the alloying element is added to the melt.

TABLE 3.—Production and shipments of molybdenum products [1] in the United States, 1943–47 (average) and 1948–52, in pounds of contained molybdenum

Year	Production	Shipments		
		To domestic consumers	Exports [2]	Total
1943–47 (average)	29,333,500	26,672,300	1,757,000	28,429,300
1948	24,445,300	23,808,900	1,215,800	25,024,700
1949	19,624,200	15,019,000	1,314,100	16,333,100
1950	25,347,800	32,735,700	1,955,100	34,690,800
1951	32,775,000	29,845,000	1,387,700	31,232,700
1952	32,382,600	30,210,700	1,843,600	32,054,300

[1] Comprises ferromolybdenum, molybdic oxide, and molybdenum salts and metal.
[2] Reported by producers to the Bureau of Mines.

STOCKS

Industry stocks of both concentrates and products increased during the year; details are listed in table 4.

TABLE 4.—Industry stocks of molybdenum concentrates and products at producers' plants, Dec. 31, 1943–47 (average) and 1948–52, in thousands of pounds of contained molybdenum

Year	Concentrates [1]	Products [2]	Total
1943–47 (average)	19,427	8,952	28,379
1948	21,206	7,547	28,753
1949	19,159	10,838	29,997
1950	4,326	1,495	5,821
1951	5,058	3,037	8,095
1952	6,856	3,373	10,229

[1] At mines and at plants making molybdenum products.
[2] Comprises ferromolybdenum, molybdic oxide, and molybdenum salts and metal.

PRICES

There was no change in the prices quoted for molybdenum concentrates or primary products during 1952. The published price, f. o. b. mines, of molybdenite in concentrates containing 90 percent MoS_2 was 60 cents a pound (equivalent to $1 a pound of molybdenum contained). The prices of the principal molybdenum products are based on a pound of contained molybdenum, f. o. b. producer's plant. During 1952 the prices quoted were as follows: Molybdic oxide $1.14, calcium molybdate $1.15, ferromolybdenum $1.32, and molybdenum metal $3. These prices have remained unchanged since December 1, 1950.

FOREIGN TRADE [5]

Imports of molybdenum ores and concentrates into the United States are normally small; 49,600 pounds general import and import for consumption (contained molybdenum) were received in 1952, compared with 8,200 pounds general import and 4,200 pounds import for consumption in 1951. The entire quantity came from Canada.

Exports of molybdenum concentrates and products in 1952 were restricted by export quotas and by allocations from Defense Materials Procurement Agency or National Production Authority, which were required for concentrates and products, respectively, in addition to an export license from the Office of International Trade. However, the level of exports approved was only slightly below that of 1950, and shipments for export were well above those in 1951. Germany, France, United Kingdom, and Canada were the chief foreign markets in 1952.

Exports of ferromolybdenum totaled 1,090,100 pounds, gross weight [6] in 1952 compared with 1,483,800 pounds in 1951. Canada (439,500 pounds), Belgium and Luxemburg (160,000 pounds), Austria (81,200 pounds), Italy (65,600 pounds), and Australia (51,800 pounds)

[5] Figures on imports and exports (unless otherwise indicated) compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the United States Department of Commerce.
[6] Ferromolybdenum contains about 60–65 percent molybdenum.

were the most important markets for ferromolybdenum in 1952. Exports in 1952 also included the following molybdenum products:

	Pounds
Metals and alloys	172, 285
Wire	14, 605
Powder	4, 096
Primary forms, mainly rods, sheets, and tubes	8, 040

Exports of molybdenum ores and concentrates, including roasted concentrates, are listed on table 5. Roasted concentrates are classed as a molybdenum product in statistics of the Bureau of Mines. The following tabulation lists shipments for export reported to the Bureau of Mines from 1950 to 1952; because of the time lag between shipment from mine or plant and an actual export this information is not directly comparable to the data in table 5.

Shipments for export; molybdenum content, thousands of pounds:	*1950*	*1951*	*1952*
Concentrates (not roasted)	5, 386	3, 270	5, 290
Roasted concentrates (oxide)	790	751	1, 173
All other primary products	1, 165	637	671

The International Materials Conference issued press releases outlining plans of distribution for molybdenum concentrates and primary products that had been accepted by the member nations. These plans were based on estimated production and shipments; however, they serve as a means of indicating the approximate level of international trade. Concentrates include raw and roasted molybdenite concentrates; primary products include ferromolybdenum, molybdic acid, and molybdenum salts, including calcium molybdate and molybdic oxide. Quantities listed as concentrate include material for conversion to primary products for export. Table 6 lists the distribution for 1952.

Tariff.—The tariff on molybdenum concentrates and products remained unchanged in 1952. The duty on ore and concentrate was

TABLE 5.—Molybdenum ore and concentrates (including roasted concentrates) exported from the United States, 1950–52, by countries of destination

[U. S. Department of Commerce]

Country	1950		1951		1952	
	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value
Australia					59, 085	$67, 567
Austria	20, 918	$19, 515	9, 996	$11, 397	34, 965	39, 859
Belgium-Luxembourg					23, 154	27, 971
Canada	226, 297	194, 187	294, 687	313, 957	535, 800	609, 414
Canal Zone	465	458	700	712	450	352
Denmark					3, 000	3, 900
Finland			2, 957	7, 841	4, 400	5, 720
France	674, 296	591, 249	420, 161	397, 125	1, 735, 176	1, 958, 951
Germany	1, 105, 577	956, 329	761, 731	786, 750	1, 986, 670	2, 121, 494
Italy	43, 420	38, 638	135, 712	147, 408	192, 994	225, 967
Japan	40, 677	34, 197	62, 340	51, 476	199, 035	250, 192
Mexico	345	247			12, 622	13, 082
Netherlands	61, 200	65, 000	41, 524	50, 000		
New Zealand					10, 080	11, 491
Spain					9, 990	13, 447
Sweden	274, 406	211, 195	241, 349	257, 051	479, 680	546, 475
Switzerland					2, 476	3, 120
United Kingdom	3, 786, 920	3, 342, 637	1, 758, 108	1, 711, 739	882, 355	892, 693
Total	6, 234, 521	5, 453, 652	3, 729, 265	3, 735, 456	6, 171, 932	6, 791, 695

35 cents a pound on the metallic molybdenum contained and was 25 cents a pound of molybdenum contained plus 7.5 percent ad valorem on ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum.

TABLE 6.—Summary of International Materials Conference distribution of molybdenum in 1952

[Metric tons of metal content]

Country	Concentrates	Primary products [1]	Country	Concentrates	Primary products [1]
Argentina		0.52	New Zealand		12.37
Australia		85.00	Norway		11.00
Austria	17.50	76.50	Portugal		8.00
Belgium		96.00	South Africa		22.50
Brazil		20.20	Spain		33.50
Canada		375.50	Sweden	468.00	12.00
Chile	1.00	3.00	Switzerland	4.00	49.00
Denmark		6.00	Turkey		9.50
Finland		10.00	United Kingdom	2,215.50	
Formosa		.50	United States	16,121.60	
France	1,217.00		Yugoslavia		10.50
Germany	972.95		Reserve	7.95	
India		4.00			
Italy	78.50	104.00	Total estimated production	21,346.00	
Japan	225.00				
Mexico		.85	Total distribution of products		966.94
Netherlands	17.00	16.50			

[1] Raw material to produce these products is included in the concentrate column.

TECHNOLOGY

Mining.—Molybdenum ores are mined in large, low-grade deposits and in relatively small quantities from small, high-grade ore bodies. In addition, significant quantities of molybdenite concentrate are produced as a byproduct of copper mining. Mining methods range from large-scale open-cut or underground caving to nonsystematic workings following small ore showings. Significant development in 1952 included the following: Climax Molybdenum Co. was completing an extensive development of the Storke level which will permit mining the portion of the ore body between this and the Philipson level, which is 300 feet higher; past production has been from ore above the latter.[7]

Milling and Production of Primary Products.—Molybdenum ores of all types require concentration before a useful product can be made. Flotation is standard practice at both molybdenum mines and mines where molybdenum is produced as a byproduct. Constant research designed to improve recovery and reduce costs is in progress. During 1952 recovery at byproduct mines improved. The Kennecott Copper Corp. modified its flow sheets at the Arthur and Magna mills in Utah to provide re-treatment of copper-plant tailings for recovery of molybdenum. The previous method provided for recovery of molybdenite from a concentrate produced in the copper section of the mills. Construction of the new plant facilities was still in progress at year end, but some of the new units were in use at the Arthur mill during the year. Flotation cells installed in the new sections are trough-type 62-inch Fagergren machines; each row contains 16 cells. More efficient equipment for recovering molybdenum at the McGill, Nev., mill of Kennecott Copper Corp. resulted in an increase in production of molybdenum. At Climax, Colo., the Climax Molybdenum Co. installed a gyratory crusher, said to be one of the world's largest, for

[7] Mining World, vol. 14, No. 13, December 1952, pp. 34–35.

primary crushing of ore from the newly developed Storke level.[8] The crushed ore will be moved by 4,700-foot conveyor system to the present mill, which has been expanded to a capacity of 20,000 tons per day.

Molybdenite concentrates are converted to oxide by roasting; this product is used as a raw material for production of nearly all other primary molybdenum products, and for direct charging to iron and steel furances.

Metal.—Molybdenum metal is produced by reduction of a purified oxide. In recent years there has been a tremendous interest in this metal because of its high melting point and good thermal conductivity. The metal has been produced by hydrogen reduction, followed by sintering of the resulting metal powder for such applications as components of vacuum tubes and X-ray equipment. Because many potential uses of this metal call for large sheets or sections and require the virtual elimination of impurities, such as oxygen, new techniques have been developed for producing large ingots in vacuum furnaces. During 1952 the results of many research projects on production and fabrication were published.

Methods of purifying commercial molybdenum metal by melting in a high vacuum and tests of the resulting metal were described;[9] the following is quoted from this paper:

> The as-cast molybdenum of high purity had considerably greater ductility than did the less pure commercial as-cast metal. Athough transverse-grain specimens of the commercial as-cast molybdenum fractured intergranulárly in a brittle manner at room temperature, similar specimens of the high purity molybdenum were ductile under the same test conditions. Therefore, a reduction in the amounts of the impurities at the grain boundaries of cast molybdenum eliminated intergranular brittleness and thereby had a marked influence on the bend ductility of the metal.
>
> Bend tests on longitudinal-grain specimens, in which case the normal stress on the grain boundaries was comparatively low, indicated that the ductility of the individual grains of molybdenum was improved with an increase in purity.

The fact that welding methods require complete shielding from oxygen and that traces of carbon are undesirable was the subject of one paper,[10] and a new material for very high temperature brazing of molybdenum was developed.[11] Methods of forming molybdenum by slip casting and hot pressing were described.[12]

Technical information on the thermal conductivity of molybdenum

---

[8] Mining Record, vol. 63, No. 47, Nov. 20, 1952, p. 8.

[9] Rengstorff, G. W. P., and Fischer, R. B., Cast Molybdenum of High Purity: Journ. Metals, vol. 4, No. 2, February 1952, pp. 157–160.

[10] Boam, Willard M.: Jet Engines Push Welded Molybdenum Study. Iron Age, vol. 170, No. 2, July 10, 1952, pp. 145, 148.

[11] Materials and Methods, vol. 36, No. 3, September 1952, p. 170.

[12] Miller, G. L., Iron Age, vol. 169, No. 16, Apr. 17, 1952, pp. 122, 124.

metal was published;[13] the following list of conductivity values is quoted from this publication:

Conductivity values

Temperature (° F.):	*Thermal conductivity (B. t. u./hr.—ft.²—° F./ft.)*
1,000	70.3
1,100	69.1
1,200	67.9
1,300	66.7
1,400	65.4
1,500	64.2
1,600	62.9
1,700	61.6
1,800	60.4
1,900	59.0
2,000	57.7
2,100	56.5

Alloys.—Research on both ferrous and nonferrous alloys containing molybdenum was conducted in 1952. The phase diagrams at 1,200° C. for iron-cobalt-molybdenum, iron-nickel-molybdenum, and nickel-cobalt-molybdenum were published.[14] The use of boron to improve heavy sections of molybdenum steel,[15] information regarding preparation and some properties of the molybdenum-borides [16] and the effects of tungsten or molybdenum in cobalt-chromium alloys [17] were the subjects of other reports.

WORLD REVIEW

Austria.—A small production of molybdenum is obtained as a byproduct of lead-zinc mining. The Bleiberg-Kreuth mine in Carinthia is the principal producer; others are the Dirstentritt in Tirol and Scheinitzen in Carinthia.[18]

Canada.—The La Corne mine in Quebec was in production during 1952.

Chile.—Molybdenite is produced as a byproduct of copper mining in Chile; this country is the only large producer in the Western Hemisphere except the United States.

[13] Mikol, Edward P., The Thermal Conductivity of Molybdenum over the Temperature Range, 1,000°–2,100° F.: Eng. Exp. Sta., Coll. of Engineering, Univ. of Alabama, Tech. Rept. 2, May 1952.

[14] Das, D. K., Rideout, S. P., and Beck, Paul A., Intermediate Phases in the Mo-Fe-Co, Mo-Fe-Ni, and Mo-Ni-Co Ternary Systems: Jour. Metals, vol. 4, No. 10, October 1952, pp. 1071–1075.

[15] Bardgett, W. E., English Use Boron in Normalized and Drawn Heavy Sections: Iron Age, vol. 169, No. 2, Jan. 10, 1952, pp. 81–84.

[16] Steinitz, R., Binder, I., and Moskowitz, David, System Molybdenum-Boron and Some Properties of the Molybdenum-Borides: Jour. Metals, vol. 4, No. 9, September 1952, pp. 983–987.

[17] Fletcher, E. E., and Elsea, A. R., Effects of Tungsten or Molybdenum Upon the Alpha-Beta Transformation and Gamma Precipitation in Cobalt-Chromium Alloys: Jour. Metals, vol. 4, No. 5, May 1952, pp. 524–526.

[18] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 5, May 1952, p. 20.

French Cameroons.—Deposits in the Mungo region were described.[19] No production was reported during 1952.

Japan.—Molybdenum has been produced from several small mines; during 1952 production was stimulated because of the worldwide shortages of the metal.

Norway.—The Knaben mine near Egersund on the southwestern coast of Norway has been the most important source of molybdenum production.

Union of Soviet Socialist Republics.—Important quantities of molybdenum are probably produced from the deposit east of Kounrad near Lake Balkhash; however, no reliable information is available regarding the output.

TABLE 7.—World production of molybdenum in ores and concentrates, by countries,[1] 1943–52, in metric tons [2]

[Compiled by Berenice B. Mitchell]

Country [1]	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952
Australia	15	9	(3)	4	2	2	3	3	1	(3)
Austria	5	7	1	20	1	(4)	9	18	19	12
Canada	178	509	228	184	207	83	------	28	104	135
Chile	680	1,051	841	560	402	532	558	992	1,725	1,644
China:										
Manchuria	[5] 516	[5] 516	[5] 30	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Other Provinces	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Finland	108	110	92	99	70	------	------	------	------	(4)
France	11	7	------	------	------	------	------	------	------	(4)
Indochina	2	(3)	------	------	------	------	------	------	------	
Italy	16	(3)	------	------	------	------	------	------	------	------
Japan	[6] 87	[6] 189	[6] 108	52	18	1	------	13	54	87
Korea, Republic of	291	394	54	------	5	2	11	------	(4)	(4)
Mexico	1,138	717	468	818	136	------	------	------	------	------
Morocco, French	7	------	------	39	32	------	------	------	------	------
Norway	227	248	76	10	98	79	71	67	125	122
Peru	85	62	29	4	3	2	2	1	3	(4)
Sweden	12	20	3	------	------	1	5	6	2	(4)
United States	27,972	17,545	13,972	8,264	12,268	12,114	10,219	12,918	17,625	19,622
Yugoslavia	(4)	(4)	215	72	------	------	243	174	308	(4)
Total (estimate)	31,400	21,400	16,200	10,800	14,000	13,600	11,500	14,600	20,500	22,200

1 Molybdenum is also produced in North Korea, Rumania, Spain, and U. S. S. R., but production data are not available. Estimates by author of chapter are included in total.
2 This table incorporates a number of revisions of data published in previous molybdenum chapters.
3 Less than 0.5 ton.
4 Data not yet available; estimate by author of chapter included in total.
5 Exports to Japan proper.
6 Year ended March 31 of year following that stated.

19 Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 1, July 1952, p. 19.

Natural and Manufactured Iron Oxide Pigments

(Mineral-Earth Pigments)

By Robert D. Thomson[1] and Frances P. Uswald[2]

THE MINERAL pigments discussed in this chapter are divided into two groups—natural mineral iron oxide pigments, commonly known as mineral-earth pigments, and chemically manufactured iron oxide pigments, referred to as pure or synthetic. The principal color classifications of commercial materials are black, brown, red, and yellow, each composed of numerous shades varying in masstone, undertone, and tinting strength. The vicinity of Cartersville, Bartow County, Ga., has been a prominent producer of natural iron oxide pigments, especially ocher. Another important district is in Berks, Lehigh, and Northampton Counties, Pa. Production is recorded also from California, Illinois, New Jersey, New York, Ohio, Vermont, and Virginia. Natural iron oxide pigments are prepared for market by washing, drying, grinding, blending, and calcining. Synthetic iron oxide pigments are produced by the calcination of copperas or the controlled oxidation of precipitated ferrous hydroxide. The principal uses of iron oxide pigments are in paints, wood and paper stains, linoleum, oilcloth, mortar, plaster, rubber, brick, and other pigmentable materials. Synthetic pigments have greater tinting strength and uniformity, but natural pigments are preferred in certain products and continue to be important in the industry.

PRODUCTION

Sales of natural and synthetic iron oxide pigments in 1952 were approximately 2 percent lower in quantity than in 1951 (tables 1 and 2). The trend toward greater use of synthetic pigments continued in 1952. Synthetic iron oxide pigments made up 45 percent of the total tonnage and 77 percent of the value. The remainder were natural iron oxide pigments.

In 1952 sales of natural and manufactured iron oxide pigments were reported from 11 States, as shown in table 3. Over one-third of the tonnage sold was from six plants in Pennsylvania. Illinois, Ohio, and Wisconsin, as a group, ranked second.

---

[1] Commodity-industry analyst.
[2] Statistical clerk.

TABLE 1.—Natural and manufactured iron oxide pigments sold by processors in the United States, 1943–47 (average) and 1948–52

Year	Short tons	Value	Year	Short tons	Value
1943–47 (average)	105,742	$9,192,799	1950	129,256	$14,762,782
1948	111,317	10,957,422	1951	126,432	14,987,075
1949	[1] 104,322	[1] 10,573,338	1952	123,343	13,606,609

[1] Revised figure.

TABLE 2.—Natural and manufactured iron oxide pigments sold by processors in the United States, 1951–52, by kinds

Pigment	1951		1952	
	Short tons	Value	Short tons	Value
Mineral blacks	17,247	$342,013	18,101	$338,843
Precipitated magnetic blacks	2,010	479,930	2,319	545,258
Natural brown oxides (metallic browns)	7,710	494,317	7,335	551,446
Vandyke brown (finished pigment)	150	29,102	128	24,528
Pure browns (96 percent or better iron oxides)	1,072	273,661	1,156	299,256
Natural red oxides	23,497	1,168,420	27,140	1,097,470
Pure red oxides (98 percent or better Fe_2O_3)	21,560	5,248,167	21,841	4,996,461
Venetian reds	4,910	490,295	4,625	454,370
Pyrite cinder	1,419	113,773	1,238	100,231
Other red iron oxides	17,096	2,230,449	12,255	1,539,182
Natural yellow oxides (high Fe_2O_3)	6,178	142,321	4,319	116,638
Pure yellows (85 percent or better Fe_2O_3)	13,798	2,747,668	13,001	2,610,861
Ocher (low Fe_2O_3)	2,188	105,628	2,573	83,640
Siennas:				
Burnt	1,108	195,848	866	149,915
Not burnt	1,458	234,867	1,014	159,738
Umbers:				
Burnt	3,473	424,760	2,587	316,573
Not burnt	817	86,954	661	75,625
Other	741	178,902	2,184	146,574
Total	126,432	14,987,075	123,343	13,606,609

TABLE 3.—Sales of natural and manufactured iron oxide pigments in the United States, 1952, by States

State	Number of producers	Quantity (short tons)
Georgia	1	3,047
Pennsylvania	6	46,992
Illinois, Ohio, Wisconsin	7	41,918
Maryland, New Jersey, New York, Virginia	7	16,486
Other States [1]	4	14,900
Total	25	123,343

[1] Includes California, North Dakota, and a quantity unspecified by State.

PRICES

According to the Oil, Paint and Drug Reporter, prices were quoted as follows during December 1952 (in cents per pound, bags, works, carlots, unless otherwise noted):

Mineral black, 1.6–6.75
Metallic brown oxide, 3.75
Sap brown, crystals, 12
Sap brown, powdered, 13
Sienna, burnt, 4.25–15.25
Sienna, raw, 4.5–13
Umber, burnt, American, 6
Umber, burnt, Turkey, 6.25
Umber, raw, American, 6.25–6.50
Umber, raw, Turkey, 6.50–6.75
Vandyke brown (bbl.), 11
Metallic red (bbl.), 2.50
Natural red iron oxide, 5.75–9.25
Persian Gulf oxide, 6.75–7.00
Spanish oxide (bbl.), 5.75
Venetian red, 3.50–5.25
Natural yellow iron oxide, 1.41–2.50
Natural yellow iron oxide, French type, 4.50.
Natural yellow iron oxide, Peruvian type, 1.85–2.10
Golden American yellow ocher, 1.25–2.75
Synthetic (pure) black iron oxide, 11.75
Synthetic (pure) brown iron oxide, 12.75–13.00
Synthetic (pure) red iron oxide, 12.25–12.50
Synthetic (pure) yellow iron oxide, 10
Special, high color, red iron oxide, 6

FOREIGN TRADE[3]

Imports of mineral pigments were quantitatively less for every category in 1952 compared with 1951, with an overall decrease of 37 percent (table 4). Natural iron oxide pigments were imported principally from Spain and the United Kingdom. West Germany supplied 56 percent of the United States imports of synthetic iron oxides and Canada 35 percent. Ocher, crude and washed, was

TABLE 4.—Selected mineral pigments imported for consumption in the United States, 1949–52

[U. S. Department of Commerce]

Pigments	1949		1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Iron oxide pigments:								
Natural	1,194	$94,343	2,803	$143,894	3,476	$160,015	2,388	$118,914
Synthetic	767	120,281	2,220	294,017	5,303	643,918	3,317	432,451
Ocher, crude and refined	89	5,058	157	6,759	815	37,494	798	46,777
Siennas, crude and refined	211	16,567	474	33,433	779	62,421	566	49,702
Umber, crude and refined	1,758	47,730	3,259	88,168	3,457	93,761	1,603	44,435
Vandyke brown	118	11,757	261	18,562	174	10,765	119	6,685
Total	4,137	295,736	9,174	584,833	14,004	1,008,374	8,791	698,964

[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

imported from three foreign countries, of which French Morocco represented about 79 percent of the imports and the Union of South Africa 21 percent. All crude umber imports came from Malta, while washed umber was imported from Malta, Italy, and the United Kingdom, in order of importance. Siennas, crude and washed, were imported principally from the countries that exported washed umbers.

Various deposits of red and yellow ochers exist in Belgian Congo, but these have been used only in small quantities by natives.[4]

The mineral-pigment industry of the Netherlands has recovered remarkably from heavy damage that occurred during World War II and is becoming increasingly important in the country's exports.[5] White and colored pigments are manufactured in 18 plants located mostly in the mining area in the southern section of the country.

Exports, as shown in table 5, declined 17 percent in 1952 and represent the lowest annual exports of mineral pigments since 1943.

TABLE 5.—Mineral-earth pigments exported from the United States, 1949–52,[1] by countries

[U. S. Department of Commerce]

Country	1949		1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Argentina	9	$2,549	(2)	$1,082	(2)	$600	46	$20,250
Austria	37	9,354	41	10,274	6	1,548	------	------
Belgian Congo	------	------	6	856	9	1,839	2	460
Belgium-Luxembourg	201	39,467	85	15,035	39	9,859	8	2,912
Bolivia	21	7,555	2	900	25	8,819	1	187
Brazil	155	43,575	27	16,056	93	18,185	41	11,786
Canada	3,076	248,780	2,945	274,311	2,528	282,136	2,545	288,382
Chile	80	14,801	------	------	37	8,322	18	4,950
China	21	5,081	13	7,970	------	------	------	------
Colombia	110	38,891	114	39,986	120	46,179	93	31,728
Cuba	298	41,395	284	54,724	294	61,885	297	59,502
Dominican Republic	19	5,159	18	4,566	29	8,302	33	9,693
France	24	8,132	17	8,646	17	10,874	9	12,179
Greece	75	18,158	14	2,657	7	2,279	2	652
Guatemala	35	14,294	53	13,955	49	13,180	23	5,877
Haiti	42	4,242	63	6,133	52	12,761	45	5,049
Honduras	4	1,288	4	1,468	5	1,512	20	4,559
Hong Kong	77	20,210	5	1,295	2	702	(2)	136
Indonesia	44	10,314	27	10,099	11	4,016	31	9,284
Israel and Palestine	4	1,049	3	773	17	4,783	4	895
Italy	118	33,614	51	12,754	37	5,197	6	14,942
Japan	1	1,064	18	4,450	17	4,186	24	8,108
Mexico	124	30,191	85	25,323	106	48,629	90	31,787
Netherlands	452	44,026	227	9,029	341	13,766	135	5,292
Netherlands Antilles	17	5,097	11	2,266	21	6,354	10	3,657
Panama	8	2,103	61	5,965	17	3,456	11	2,900
Peru	21	4,827	12	3,760	29	9,694	10	2,954
Philippines	132	23,169	85	17,729	93	24,362	47	10,321
Portugal	38	9,118	7	1,587	2	1,126	5	1,356
Sweden	7	2,058	5	1,341	24	5,276	6	1,578
Switzerland	34	3,733	3	801	27	7,496	14	3,934
Union of South Africa	121	32,746	82	20,776	127	36,635	87	23,690
United Kingdom	807	31,312	809	30,926	275	14,867	3	720
Uruguay	------	------	39	9,066	7	2,078	6	1,602
Venezuela	141	41,571	257	70,111	104	29,785	133	33,842
Other countries	90	27,951	90	25,020	85	27,478	65	18,603
Total	6,443	826,874	5,563	711,690	4,652	738,166	3,870	633,767

[1] Minerals Yearbook, 1951—India, 1950, revised to none.
[2] Less than 1 ton.

[4] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, p. 50.
[5] Foreign Commerce Weekly, Netherlands Has Important Pigment Industry: Vol. 47, No. 7, May 19, 1952, p. 22.

342070—55——49

TECHNOLOGY

Stabilized Pigments, Inc. of Piscataway, N. J., increased its output of pure red iron oxide from 80 to 200 tons per month through the addition of new production facilities and new processing methods. The plant operation is highly efficient in that it is continuous and automatic from the stockpile of raw iron sulfate byproduct to the finished red iron oxide.[6]

Two pilot plants for wet chemical production of synthetic red, brown, black, and yellow oxides from iron-containing solutions, such as waste pickle liquors, were described in an article.[7] Continuous operation in these plants has shown cost and operating advantages over the batch processes. Recently, patents were issued for the production without roasting of powdered iron oxide pigments of controlled hues varying from orange to red,[8] for iron oxide pigments in the form of dry powder free from agglomeration,[9] and for the manufacture of brown iron oxide.[10]

During the year, specifications for Venetian red were adopted by the American Society for Testing Materials as a tentative standard.[11] A method of test for determining the mass color and tinting strength of dry colors was also accepted by the society.[12] All ASTM Specifications, methods of testing, and definitions of terms pertaining to paint, varnish, lacquer, and related products were assembled and published as one volume in 1952.[13]

---

[6] Paint Industry Magazine, vol. 67, No. 2, February 1952, p. 34.

[7] DeWitt, C. C., Livingood, M. D., and Miller, K. G., Pigment Grade Iron Oxides; Recovery From Iron-Containing Waste Liquors: Ind. Eng. Chem., vol. 44, No. 3, March 1952, pp. 673–678.

[8] Toxby, Thomas (assigned to C. K. Williams & Co.), Method of Making Iron Oxide Pigment: British Patent 656,265, Aug. 15, 1951.

[9] Marcot, G. C., Cauwenberg, W. J., and Lamanna, S. A (assigned to American Cyanamid Co.), Preparation of Iron Oxide Pigment: U. S. Patent 2,558,302, June 26, 1951.

[10] Bennetch, L. M. (assigned to Reichard-Coulston, Inc.), Brown Oxide of Iron: U. S. Patent 2,574,459, Nov. 13, 1951.

[11] American Society for Testing Materials, Venetian Red: D767–52T, April 1952.

[12] American Society for Testing Materials, Mass Color and Tinting Strength of Color Pigments: D387–52T, May 1952.

[13] American Society for Testing Materials, ASTM Standards on Paint, Varnish, Lacquer and Related Products: 1952, 784 pp.

Nickel

By Hubert W. Davis [1]

THE SUPPLY of nickel outside the U. S. S. R. was furnished chiefly by Canada, Cuba, and New Caledonia in 1952. The United States and Finland supplied small quantities of nickel sulfate, which is recovered as a byproduct of copper refining; the Union of South Africa contributed a small quantity of nickel in the form of matte, which is produced from the complex ores in the Rustenburg district; and a little nickel was contained in the cobalt ore produced in French Morocco. Total world production outside the U. S. S. R. was about 16,000 short tons greater in 1952 than in 1951. All countries except the United States showed an increase over 1951. Canada produced 86 percent of the total (excluding the U. S. S. R.) in 1952.

Notwithstanding the increase in world production of nickel in 1952, there was a scarcity of this metal, although supplies were adequate for defense needs. Insufficient nickel was available for many civilian uses, and manufacturers were forced to employ substitute materials. Conservation of nickel in the more critical items was achieved by substitution of steels lower in nickel or by steels containing no nickel, depending upon the application and the conditions under which the steels were employed. Substitutions for nickel have involved the use of boron, manganese, and chromium.

TABLE 1.—Salient statistics for nickel, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
United States:						
Production:						
Primary ______ short tons	757	883	790	913	756	633
Secondary ______ do	7,102	8,850	5,680	8,795	8,602	7,479
Imports (gross weight) [1] ______ do	[2] 118,255	105,650	95,711	96,640	101,620	117,713
Exports (gross weight) [3] ______ do	8,257	8,184	4,471	3,645	4,622	6,941
Consumption ______ do	[4] 85,705	93,558	68,326	98,904	86,416	101,048
Price per pound [5] ______ cents	31½–35	33¾–40	40	40–50½	50½–56½	56½
Canada:						
Production ______ short tons	123,711	131,740	128,690	123,659	[6] 137,903	140,007
Exports ______ do	121,169	131,840	127,141	119,984	130,239	142,022
World production ______ do	[6] 160,000	[6] 165,000	161,000	[6] 159,000	[6] 175,000	191,000

[1] Comprises refined metal, matte, and oxide.
[2] Includes scrap.
[3] Excludes "Manufactures," weight of which is not recorded.
[4] 1945–47 average.
[5] Price quoted to United States buyers by International Nickel Co., Inc., for electrolytic nickel in carlots f. o. b. Port Colborne, Ontario; price includes duty of 2½ cents a pound, 1943–47, and 1¼ cents, 1948–52.
[6] Revised figure.

[1] Commodity-industry analyst.

Throughout the world the search for new deposits of nickel was pressed with unprecedented intensity in 1952. This exploration was being carried on by the established producers as well as by some new to the industry. Expansion of existing production facilities was underway, and facilities were being installed to serve newly developed deposits. As a result of these expansions, it is estimated that equipped mines will have capacity to produce over 200,000 tons of nickel in 1956.

Imports of new nickel into the United States in 1952 were 16 percent greater than in 1951 and the largest since 1944. Canada continued to be the chief source.

Consumption of nickel in the United States was 17 percent more than in 1951 and the largest since 1944. The steel industry continued to be the chief consumer; 45 percent of all nickel used in 1952 was in stainless and engineering alloy steels. Consumption in stainless steel was 25 percent larger but that for engineering alloy steels only 9 percent greater. More nickel was also utilized in high-temperature and electrical-resistance alloys, nonferrous alloys, anodes, and catalysts, but less was used in cast irons, ceramics, and magnets.

Prices of electrolytic nickel and nickel oxide sinter remained unchanged throughout 1952.

Copper, nickel, and cobalt mineralization has been noted during recent years in the gabbros at and near granite in the Superior National Forest along the South Kawishiwi River, Lake County, Minn. All the surface rights and all the mineral rights, except 1 parcel of 327 acres, in the Superior National Forest are held by the Government. Inspections and samplings by the Bureau of Mines and the Minnesota Geological Survey in the summer of 1951 indicated that the possibility of developing a large tonnage of low-grade copper-nickel ore was good. In the areas inspected, based on an average of the outcrop samples and samples from a diamond-drill hole 75 feet deep, it was estimated that there is an inferred 28,125,000 tons of ore that will average about 0.52 percent copper, 0.16 percent nickel, and 0.02 percent cobalt, all occurring as sulfides, with small values in gold, silver, and platinum. At least 66 applications for permits to prospect for copper-nickel ore in the Superior National Forest had been received by the Bureau of Land Management by the end of 1952. The International Nickel Co. has entered into arrangements giving it the right to prospect for copper-nickel ores in the area.

A comprehensive report on nickel, prepared for the National Security Resources Board by the Bureau of Mines, with the cooperation of the Geological Survey, was made available in 1952.[2]

Allocation of primary nickel (excluding nickel salts) to the Free World countries by the International Materials Conference was continued. The United States was allocated 67.6 percent of the total in 1952.

---

[2] Bureau of Mines, Materials Survey—Nickel: 1952, 284 pp.

TABLE 2.—Nickel allocations to the free-world countries by the International Materials Conference in 1952

Country	Metric tons	Country	Metric tons
Argentina	44.5	Mexico	16.0
Australia	581.3	Netherlands	294.5
Austria	724.7	New Zealand	7.1
Belgium-Luxembourg	415.7	Norway	269.4
Bolivia	.8	Pakistan	2.7
Brazil	87.6	Philippines	.8
Canada	3,855.3	Portugal	9.1
Chile	45.0	Southern Rhodesia	2.4
Colombia	6.0	Spain	77.6
Cuba	4.0	Sweden	2,685.6
Denmark	74.8	Switzerland	542.7
Egypt	3.8	Trieste	1.4
Finland	65.1	Turkey	16.8
Formosa	7.0	Union of South Africa	81.4
France	6,801.8	United Kingdom	21,396.6
Germany, West	5,315.4	United States	96,302.6
Greece	5.2	Uruguay	5.2
India	385.1	Yugoslavia	73.7
Ireland	1.3		
Italy	1,049.9	Total	142,397.8
Japan	1,137.9		

PRODUCTION

Domestic production of nickel (other than from imported matte and oxide) is small and comprises metal recovered from scrap (nickel anodes and nickel-silver and copper-nickel alloys, including Monel metal) and primary nickel recovered in copper refining. There has been no output of nickel from ore or as a byproduct of talc production since 1945.

Substantial quantities of nickel-bearing ferrous scrap are recovered and used chiefly in the production of engineering alloys and stainless steels. No figures are available on the quantity of low-alloy nickel-bearing scrap used, but 102,000 short tons of chromium-nickel stainless steel scrap was consumed in 1952.

A total of 1,266,000 pounds of nickel, in the form of both crude and refined nickel sulfate, was recovered in 1952 as a byproduct of copper refining at Baltimore, Md.; Carteret and Perth Amboy, N. J.; Laurel Hill, N. Y.; and Tacoma, Wash. Shipments were 1,237,000 pounds, the bulk of which was crude nickel sulfate sold to refiners for use as an intermediate in the manufacture of refined nickel salts. Although all the nickel recovered as a byproduct of copper refining is credited to domestic production, some is actually recovered from imported blister copper.

In addition to the nickel recovered as a byproduct of copper refining in 1952, 2,935,000 pounds (nickel content) of refined nickel salts (chiefly sulfate) was produced in the United States from crude nickel sulfate and from nickel shot and nickel scrap.

The total production of refined nickel salts in the United States was 3,336,000 pounds (nickel content) in 1952; shipments to consumers for electroplating, catalysts, and ceramics totaled 3,263,000 pounds.

TABLE 3.—Nickel produced in the United States, 1943–47 (average) and 1948–52

Year	Primary (short tons) [1]	Secondary	
		Short tons	Value
1943–47 (average)	[2] 757	7,102	$5,078,898
1948	883	8,850	6,966,720
1949	790	5,680	4,877,984
1950	913	8,795	8,408,020
1951	756	8,602	[3] 9,759,829
1952	633	7,479	8,799,791

[1] Byproduct of copper refining. Value withheld to avoid disclosing individual company operations.
[2] Includes some production from ore.
[3] Revised figure.

CONSUMPTION AND CONSUMERS' STOCKS

Tables 4, 5, and 6 give data on the consumption of nickel, as determined by a Bureau of Mines survey. The data cover all known consumers of nickel in the form of new metal, oxide, and matte. The figures for nickel salts, however, fall short of the total and probably represent only 54 and 49 percent, respectively, of the totals for 1952 and 1951.

Total consumption of nickel in 1952 was 17 percent more than in 1951 and the largest since 1944. Of the 1952 total consumption, about 45 percent was utilized in stainless and engineering alloy steels. Usage of nickel in stainless steel was 25 percent more than in 1951, but that for engineering alloy steels was only 9 percent greater. Substitution of straight chromium stainless steel was made in the architectural, utensil, appliance, and other fields. In engineering alloy steels conservation was achieved by substituting steels lower in nickel, by using steels containing no nickel, and by substituting boron, manganese, and chromium. Consumption of nickel in high-temperature and electrical-resistance alloys, nonferrous alloys, anodes, and catalysts was larger by 8, 18, 15, and 5 percent, respectively; but usage for cast irons, ceramics, and magnets declined 2, 21, and 8 percent, respectively.

As a result of restrictions, consumption of nickel by the electroplating industry in 1952 was substantially less than before the Korean conflict. The quantity allowed to be used was inadequate to permit coatings thick enough to provide satisfactory performance of plated items. Efforts were made to substitute other coatings, such as bright electroplated zinc, improved deposition of copper plus chromium, and new tin-nickel alloys, but the results were reported to be not as satisfactory for protection or in appearance as those obtained with nickel plating of conventional thickness.

The quantity of nickel allowed in nickel-silver alloys for civilian flatware and other applications was less than in 1951 but this reduction was more than offset by enlarged demand for cupronickel tubing for defense purposes.

As heretofore, most of the nickel consumed in 1952 was in the form of metal, but the proportion of oxide and oxide sinter was appreciably larger in 1952 than in 1951.

TABLE 4.—Nickel (exclusive of scrap) consumed and in stock in the United States, 1951–52, by forms, in pounds of nickel

Form	1951			1952		
	Consumption	Stocks at consumers' plants Dec. 31	In transit to consumers' plants Dec. 31	Consumption	Stocks at consumers' plants Dec. 31	In transit to consumers' plants Dec. 31
Metal [1]	135,919,818	[2] 8,184,924	379,777	149,831,963	10,334,742	182,560
Oxide and oxide sinter	17,492,609	1,365,801	1,083	30,776,740	3,613,557	1,344
Matte	17,481,384	1,197,296		19,531,663	1,584,575	
Salts [3]	1,938,621	[2] 668,531	30,542	1,955,436	699,987	919
Total	172,832,432	[2] 11,416,552	411,402	202,095,802	16,232,861	184,823

[1] Includes a relatively small but undetermined quantity of secondary nickel (ingot or shot remelted from scrap nickel and scrap-nickel alloys).
[2] Revised figure.
[3] Figures for 1951 and 1952 represent 49 and 54 percent, respectively, of total.

TABLE 5.—Nickel (exclusive of scrap) consumed in the United States, 1948–52, by forms, in pounds of nickel

Form	1948	1949	1950	1951	1952
Metal	130,911,216	99,377,479	148,508,734	135,919,818	149,831,963
Oxide and oxide sinter	33,052,564	19,514,759	28,840,556	17,492,609	30,776,740
Matte	21,238,604	15,654,621	17,843,880	17,481,384	19,531,663
Salts [1]	1,914,134	2,105,369	2,614,529	1,938,621	1,955,436
Total	187,116,518	136,652,228	197,807,699	172,832,432	202,095,802

[1] Figures for 1948, 1949, 1950, 1951, and 1952 represent 43, 39, 62, 49, and 54 percent, respectively, of total.

TABLE 6.—Nickel (exclusive of scrap) consumed in the United States, 1948–52, by uses, in pounds of nickel

Use	1948	1949	1950	1951	1952
Ferrous:					
Stainless steels	32,487,815	23,817,187	41,822,486	43,584,274	54,685,711
Other steels	43,564,600	26,948,418	35,554,167	32,850,461	35,956,787
Cast iron	8,431,667	6,792,472	9,761,622	7,430,972	7,276,976
Nonferrous [1]	56,067,736	37,942,549	56,277,952	52,675,585	62,332,365
High-temperature and electrical-resistance alloys	12,336,123	8,107,918	11,407,174	14,815,616	16,040,189
Electroplating:					
Anodes	28,425,717	27,620,766	34,847,601	11,967,184	13,798,835
Solutions [2]	1,327,396	1,448,584	1,481,215	562,033	620,571
Catalysts [3]	1,190,851	994,206	2,015,234	2,768,905	2,920,062
Ceramics [4]	370,708	299,246	604,766	495,355	389,156
Magnets Other	2,913,905	2,680,882	1,946,971 2,088,511	1,291,856 4,390,191	1,190,624 6,884,526
Total	187,116,518	136,652,228	197,807,699	172,832,432	202,095,802

[1] Comprises copper-nickel alloys, nickel-silver, brass, bronze, beryllium alloys, magnesium and aluminum alloys, Monel, Inconel, and malleable nickel.
[2] Figures [illegible] olutions for 1948, 1949, 1950, 1951, and 1952 represent about 34, 34, 38, 19, and 28 percent, respectively, [illegible] tal.
[3] Figures for catalysts for 1948, 1949, and 1950 represent about 37, 42, and 84 percent, respectively, of total.
[4] Figures for ceramics for 1948–50 represent about 50 percent of total.

SUBSTITUTES AND ALTERNATES

In view of the urgent need for conservation of nickel, cobalt, tungsten, manganese, and molybdenum because of acute world shortages, a Joint Subcommittee on Utilization was formed by the International

Materials Conference to study the possibilities of saving these elements. Concerning nickel, the Subcommittee reported as follows:[3]

Many opportunities for adding to the availability of nickel for essential purposes by tightening up on scrap salvage and by substitution have been noted by the Subcommittee. Nickel could be saved in relatively large amounts by the increased use of economy steels, such as triple alloy (nickel-chromium-molybdenum), boron-containing steels, or other substitute steels. The greatest proportionate savings could probably be made in case-hardening steels where relatively high nickel content continues to be used in some countries. There are also important opportunities for the down-grading of high nickel alloy compositions, where lower grade non-ferrous alloys and stainless steels may often be substituted. In the case of nickel-containing electrical resistance alloys, down-grading would require technical consideration of the individual cases. In this field, more extended use might also be made of the iron-base, iron-chromium-aluminum alloys, once the technical problems of manufacture and use are fully mastered. Much of the nickel-containing stainless and heat-resisting steel production could similarly be down-graded, even going as far, in many instances, as substitution of nickel-free ferritic for nickel-containing austenitic steels. Such substitutions, however, would not of course be achieved without some sacrifice of properties. The 70:30 cupro-nickel composition, which is long established as a material for condenser tubes, is giving way in Canada and the United States to a copper alloy with 10 percent nickel and 1 percent iron (except where brazing is employed) and in Europe to aluminum-brass. As should be clear from what was said earlier, nickel may be saved in non-vital uses of both soft and hard magnetic materials. Nickel could also be saved (but to a limited extent) by reducing its employment in aluminum-base piston alloys. The recent development of spheroidal-graphite cast-iron (known in the United States as "ductile iron") foreshadows savings in nickel, since it can often be used alternatively with alloy cast irons and steels.

Finally there are numerous applications of nickel and its alloys where the property requirements, especially corrosion-resistance, concern only the surface of the product. Here, there is room for extension of the use of nickel and nickel alloy-clad products. Specifically, heavy-gauge nickel and stainless clad steel could find wider use in the chemical industry and finer gauges to be used in electronic applications, while nickel-coated steel is being used to replace pure nickel in coinage. In Appendix I of this report, reference is made to the wide applicability of a new type of electroplated finish in which a deposit of a nickel-tin compound is laid down. Composite materials have much to recommend them where metal economy is concerned. The Subcommittee, however, is of the opinion that any proposals for extension of the use in these ways of nickel and the other elements under consideration should be given very careful scrutiny from the point of view of the alloy value, if any, of the material as scrap when its serviceability comes to an end, before being accepted as economy measures.

Chromium-manganese alloys, some containing no nickel and some with only minor additions of the element, have been introduced as suitable alternates for specific applications previously filled by the 18–8 (18 percent chromium—8 percent nickel) stainless steels. Although these chromium-manganese alloys have been known for many years, it was not until 1951 that processing and fabricating techniques were developed that permit their production in substantial quantities.

A new permanent-magnet alloy—bismanol—was being developed by the Naval Ordnance Research Laboratory.[4] In the new material, bismuth, manganese, and powdered iron are substituted for nickel and cobalt.

The application of ceramic coatings to J47 jet engine parts through a method that allows substitution of Type 321 stainless steel containing 8 percent nickel, instead of an alloy with a 76 percent nickel

[3] International Materials Conference, Utilization of Manganese, Nickel, Cobalt, Tungsten, Molybdenum: First Report of the Joint Subcommittee, Washington, December 1951, pp. 55–56.

[4] American Metal Market, Bismuth-Manganese Alloy May Conserve Nickel-Cobalt in Magnets: Vol. 59, No. 164, Aug. 23, 1952, p. 1.

content, was expected to result in substantial saving of nickel by the Solar Aircraft Co.[5]

The substitution of boron for nickel and chromium has been discussed.[6] According to Wray:

For the majority of applications for the constructional alloy steels, boron can probably replace a sizeable quantity of nickel, chromium, molybdenum and other critical alloys where their presence is necessary only for adequate hardenability.

PRICES

Throughout 1952 the contract price to United States buyers for electrolytic nickel in carlots f. o. b. Port Colborne, Ont., was 56½ cents a pound, including duty of 1¼ cents. For nickel oxide sinter (no duty), the price was 52¾ cents a pound (nickel content) f. o. b. Copper Cliff, Ont. These prices have been in effect since June 1, 1951. Cuban nickel oxide was priced at 50¾ cents a pound (nickel content) in bags and 51¾ cents a pound in cans, f. a. s. Nicaro, Cuba.

FOREIGN TRADE[7]

The quantity of new nickel imported into the United States in 1952 was 16 percent more than in 1951 and the fourth highest of record. Imports were comprised chiefly of metal, oxide, and matte. As heretofore, Canada was the chief source of the imports. The roasted and sintered matte was refined to Monel metal and other products at the plant of International Nickel Co., Inc., at Huntington, W. Va.

TABLE 7.—Nickel products imported for consumption in the United States, 1952, by countries, gross weight in pounds[1]

[U. S. Department of Commerce]

Country	Metal[2]	Ore and matte	Oxide and oxide sinter	Nickel scrap[2]	Nickel residues[3]
Canada	146, 582, 675	28, 835, 464	29, 129, 416	273, 735	1, 348, 011
Canal Zone				983	
Cuba			18, 781, 304		
French Pacific Islands		24, 229			
Germany, West	1, 120				
Norway	11, 750, 231				
Switzerland				220	
United Kingdom	321, 953			818, 517	
Total	158, 655, 979	28, 859, 693	47, 910, 720	1, 093, 455	1, 348, 011

[1] In corresponding table in Minerals Yearbook, 1951, imports of metal from Canada should read 143,266,543 pounds, Norway 9,745,420 pounds, United Kingdom 154,610 pounds and total metal 153,609,114 pounds (revised figures).
[2] Separation of metal from scrap is on basis of unpublished tabulations.
[3] Reported to Bureau of Mines by importers.

The nickel content of refined nickel, oxide, matte, and residues imported into the United States is estimated at 216,440,000 pounds in 1952 compared with 186,231,000 pounds in 1951.

[5] Steel, vol. 131, No. 11, Sept. 15, 1952, p. 91.
[6] American Metal Market, P. R. Wray Discusses Boron as Substitute for Nickel and Chromium: Vol. 59, No. 88, May 7, 1952, pp. 1, 3.
Cheney, Richard, Boron Saves the Day: Steelways, vol. 8, No. 3, May 1952, pp. 4-7.
[7] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

Since January 1, 1948, the rate of duty on refined nickel imported into the United States has been 1¼ cents a pound. Nickel ore, oxide, and matte enter the United States duty free.

Exports of nickel comprise largely products manufactured from imported raw materials. Exports of alloys and scrap, which comprise the bulk of the foreign shipments, were 46 percent more in 1952 than in 1951; those of metal in ingots, bars, sheets, etc., were 5 times greater but those of nickel-chrome electric-resistance wire were 32 percent smaller. Canada (5,673,413 pounds), United Kingdom (5,401,979 pounds), Japan (1,221,750 pounds), and West Germany (918,054 pounds) were the chief foreign markets for nickel, Monel metal, alloys, and scrap in 1952.

TABLE 8.—Nickel products (excluding residues) imported for consumption in the United States, 1950–52, by classes

[U. S. Department of Commerce]

Class	1950		1951		1952	
	Pounds	Value	Pounds	Value	Pounds	Value
Nickel ore and matte	22,270,886	$7,610,011	25,657,660	$5,561,034	28,859,693	$4,994,511
Nickel pigs, ingots, shot, cathodes, etc.[1]	138,397,272	58,685,369	[2] 153,609,114	[2] 81,521,060	158,655,979	89,212,383
Nickel scrap [1]	1,250,663	274,981	1,581,742	150,898	1,093,455	126,800
Nickel oxide	32,612,122	10,477,405	23,972,578	8,793,383	47,910,720	18,558,457
Total		77,047,766		[2] 96,026,375		112,892,151

[1] Separation of metal from scrap is on basis of unpublished tabulations.
[2] Revised figure.

TABLE 9.—Nickel products exported from the United States, 1950–52, by classes

[U. S. Department of Commerce]

Class	1950		1951		1952	
	Pounds	Value	Pounds	Value	Pounds	Value
Ore, concentrates, and matte	12,826	$2,110	35,578	$2,000		
Alloys and scrap containing nickel (including Monel metal)	5,675,191	2,805,872	7,984,503	4,783,015	11,648,169	$6,162,695
Metal in ingots, bars, sheets, etc	676,169	413,541	386,310	376,946	1,966,621	364,301
Manufactures	(1)	876,872	(1)	1,044,485	(1)	503,110
Nickel-chrome electric resistance wire	428,885	606,189	393,599	712,186	267,473	482,530
Nickel-silver or German silver, crude, scrap, or bars, rods, etc	496,598	236,193	443,175	185,089	(2)	(2)
Total		4,940,777		7,103,721		7,512,636

[1] Quantity not recorded.
[2] Beginning Jan. 1, 1952 not separately classified.

TECHNOLOGY

Bureau of Mines.—The Bureau of Mines did important research on nickel in 1952. It conducted pyrometallurgical tests at Albany, Oreg., on the silicate ore from Riddle, Oreg., to develop a low-cost electrosmelting process to yield ferronickel. Three grades of ferronickel, averaging 10, 25, and 45 percent nickel, were produced from

140 tons of dried ore in 2 lots averaging 1.7 and 1.5 percent nickel. The Albany Station also ran smelting tests on Cle Elum, Wash., iron-nickel-chrome ore.

The Ferrous Pyrometallurgy Section (Pittsburgh, Pa.) conducted tests on upgrading iron-nickel alloys to ferronickel by selective oxidation of iron in a basic converter. The raw materials for the converter operations were products of electric-furnace smelting of Riddle (Oreg.) ore at the Albany Station. About 2,000 pounds of alloy product of nonselective reduction, containing 78 percent iron, 9.4 percent nickel, 3.1 percent chromium, 7.9 percent silicon, 1.73 percent carbon, 0.027 percent sulfur, and 0.018 percent phosphorus, and 1,000 pounds of refined ferronickel, containing 66.8 percent iron, 33.6 percent nickel, 0.04 percent chromium, 0.2 percent silicon, 0.03 percent carbon, 0.03 percent sulfur, and 0.04 percent phosphorus, were supplied for the work. The tests demonstrated that a low-grade impure nickel alloy can be upgraded easily to 20 to 25 percent ferronickel, free of silicon, chromium, and carbon, by blowing in a basic converter with virtually no loss of nickel in the oxidation slag. Furthermore, the 25-percent ferronickel may be upgraded further to almost any nickel content by oxidizing enough iron from the molten metal. However, nickel losses in the iron oxide slag become greater as the nickel content of the alloy increases. The nickel loss in the slag was less than 2.5 percent for ferronickel alloys up to about 40 percent nickel. The production of alloys with 50 to 75 percent nickel results in high losses of nickel in the slag. However, by the cyclic oxidation operation, developed for the recovery of manganese, high-nickel-content alloys may be produced without excessive nickel loss.

Several selective reduction tests were made at the Pittsburgh Station on Cuban lateritic ore in the electric-arc furnace as the initial step in separating and recovering nickel and chromium from this type of raw material.

At the Minneapolis Station, laboratory flotation tests on a sample of copper-nickel-bearing material from Lake County, Minn., upgraded the copper from 1.16 to 19.70 percent and the nickel from 0.28 to 2.27 percent. Although 96 percent of the copper was recovered in the rougher concentrate, only 58 percent of the nickel was concentrated in this product. A microscopic study of a flotation tailing indicated that a finer grind was required for complete liberation of the nickel mineral. On the basis of this study, a series of flotation tests was made in which the grind was varied from minus-100-mesh to minus-325-mesh. However, the results showed that the fineness of the grind had little effect on the nickel recoveries, which averaged 58 percent in the flotation concentrates.

At the Mississippi Valley Experiment Station (Rolla, Mo.), sulfide-ore concentrates containing nickel, cobalt, copper, lead, and iron from the operations of the National Lead Co. at Fredericktown, Mo., were treated successfully on a laboratory scale to recover more than 90 percent of the nickel, cobalt, and copper. A cobalt-nickel bearing lead-copper matte, produced by the St. Joseph Lead Co. at Herculaneum, Mo., was treated to produce a lead-zinc fume, a copper sulfide concentrate, and a cobalt-nickel-iron product, netting a recovery of over 75 percent of the cobalt and about 90 percent of the nickel and copper.

Industry.—International Nickel Co. of Canada, Ltd., continued research activity on development of an economic process for recovering nickel and iron ore from nickel-bearing pyrrhotite. The process has been tested by pilot-plant procedures, and the necessary steps were being taken for designing a first production unit.[8]

Important progress was made at both Port Colborne, Ont., and Clydach, Wales, leading to improvements in the electrolytic and carbonyl refining processes.[9] Treatment of refinery residues by the Orford process at Clydach was replaced by new plant utilizing a more efficient hydrometallurgical refining process developed by the research staff.

At its refinery at Kristiansand, Norway, Falconbridge Nickel Mines, Ltd., changed from a sulfate process to a process involving both sulfates and chlorides. One outgrowth of the new process was a cobalt-separation unit, which was producing refined cobalt in moderate but increasing quantities in the latter half of 1952.

The efficiency of electric smelting and blast-furnace practice in the smelting of nickel ores has been compared.[10]

A patent was issued for recovering nickel values from nickeliferous oxide concentrates.[11]

A process using hydrochloric acid as a leaching agent for oxidized nickel ores has been described.[12]

A new process for extracting nickel, cobalt, copper, and other important metals from ores by chemical rather than the usual smelting and refining methods has been announced by the Chemical Construction Corp. The process consists of pressure leaching of unroasted sulfide ore concentrates, an almost simultaneous oxidation step, and then direct reduction of nickel, copper, and cobalt as pure metallic powders. Leaching can be done with either ammonia or acid, depending on the ore concentrate being treated. The process will be employed by Sherritt Gordon Mines, Ltd., at its refinery at Fort Saskatchewan, Alberta, which will use ammonia leaching, and by Cobalt-Nickel Reduction Co. at its refinery at Fredericktown, Mo., which will leach with sulfuric acid. The process has been described in some detail in a trade magazine.[13]

A method of recovering nickel, cobalt, and copper from the drosses and residues resulting from the production of Alnico permanent magnets has been described.[14] The cleaned, dried, and crushed waste material is magnetically sorted, then reblended to correct proportions. Aluminum is added as a deoxidizer. Silica and sodium silicate are added to produce a marketable slag. The mix is melted. Just before pouring, iron oxide is added to remove excess carbon and silicon.

---

[8] Thompson, J. F., The International Nickel Co. of Canada, Ltd., Address to Shareholders: Apr. 29, 1953, p. 16.
[9] International Nickel Co. of Canada, Ltd., Annual Report: 1952, p. 13.
[10] Downie, C. C., Practical Notes on Smelting Nickel Ores: Mining Jour. (London), vol. 239, No. 6123, Dec. 26, 1952, pp. 737, 739.
[11] Forward, F. A. (assigned to Sherritt Gordon Mines, Ltd.), Treatment of Nickeliferous Oxide Concentrates for Recovery of Nickel Values Therefrom: U. S. Patent 2,616,781, Nov. 4, 1952.
[12] Pawel, G. W., Acid-Leaching Oxidized Ores Offers New Source of Nickel: Eng. and Min. Jour., vol. 153, No. 10, October 1952, pp. 94-95.
[13] O'Connor, Joe, Chemical Refining of Metals: Chem. Eng., vol. 59, No. 6, June 1952, pp. 164-168, 368, 370, 372-374, 376.
[14] Sherman, A. H., and Pesses, Marvin, Alnico Recovery Process Salvages Valuable Nickel, Cobalt: Iron Age, vol. 170, No. 1, July 3, 1952, pp. 115-119.

Because of the shortage of strategic materials, more attention has been turned toward alloys that could use high-temperature scrap. Haynes Alloy 99 is one development. Approximate composition is 17–19 percent nickel, 11–13 percent cobalt, 20–22 percent chromium, 2–3 percent tungsten, 3–4 percent molybdenum, 0.03–0.08 percent boron, about 1 percent each of silicon and manganese, and the remainder iron.[15] This alloy is looked upon by metallurgists as a modified N–155, which contains 20 percent each of nickel, chromium, and cobalt, 3 percent molybdenum, 2 percent tungsten, 1 percent columbium, 0.32 percent iron, and 0.3 percent carbon.

A brief account of practical engineering details necessary for operating furnaces for a specific smelting capacity has been published.[16]

Researches on nickel matte have been discussed.[17]

The caving method of mining is being used on the upper levels at the Creighton mine in the Sudbury district of Ontario for recovering ore that had long been considered too low grade to be mined profitably. However, studies and research, followed by production on a small scale by International Nickel Co. of Canada, Ltd., showed that, by using the induced caving method of mining and concentrating the ore at the mine to reduce transportation costs, recovery of the low-grade ore was possible. Consequently, when the need arose for quick expansion of underground ore production, planning and development of the large-scale caving project, now producing 10,000 tons daily, was immediately undertaken. This low-cost bulk mining method is an adaptation of a mining technique by which great masses of ore are induced to cave and disintegrate by their own weight. At the Frood section of the Frood-Stobie mine, another low-cost bulk mining technique called the "blasthole" method has now become the principal method of mining. This differs from "induced caving" only insofar as explosives are used to break the ore. These and other methods of mining have been described in much detail.[18]

On January 18, 1952, International Nickel announced completion of a 7½-mile pipeline through which the bulk concentrate from 3,650,000 tons of nickel-copper ore will be pumped annually from its newly built Creighton concentrator to its reduction plants at Copper Cliff, Ont. The pipeline reduces the time required to transform nickel ore into refined nickel.

WORLD REVIEW

Table 10 shows world production of nickel by countries, 1943–47 (average) and 1948–52, insofar as statistics are available. Despite the fact that nickel is produced in several countries, one country—Canada—has supplied about 93 percent of the world output outside the U. S. S. R. since 1948.

---

[15] Steel, vol. 132, No. 1, Jan. 5, 1953, p. 282.
[16] Downie, C. C., Engineering Features of a Nickel Smeltery: Mining Jour. (London), vol. 239, No. 6110, Sept. 26, 1952, pp. 342–343.
[17] Downie, C. C., Researches on Nickel Matte: Mining Jour. (London), vol. 238, No. 6072, Jan. 4, 1952, pp. 12–13. Researches on Nickel Converter Practice: Mining Jour. (London), vol. 239, No. 6098, July 4, 1952, pp. 13–14.
[18] Mutz, H. J., and others, Underground Mining Methods at International Nickel Co.: Mining Eng., vol. 5, No. 1, January 1953, pp. 57–82.

TABLE 10.—World mine production of nickel, by countries, 1943–47 (average) and 1948–52, in metric tons of contained metal[1]

[Compiled by Berenice B. Mitchell and Lee S. Petersen]

Country	1943–47 (average)	1948	1949	1950	1951	1952
Brazil	13		7	(2)	(2)	(2)
Canada	112,229	119,512	116,745	112,181	125,103	127,012
Cuba (content of oxide)	6,253					8,127
Finland	2,269				85	405
French Morocco	18					182
Germany	190					
Greece	99					
Indonesia	[3] 720					
Italy	[3] 14					
Japan	797					
New Caledonia (content of ore)	4,335	3,450	2,475	4,250	6,700	10,500
Norway	335					
Sweden	358					
Union of South Africa	470	458	567	843	1,138	1,310
U. S. S. R.[3]	16,512	25,000	25,000	25,000	25,000	25,000
United States[4]	[5] 686	801	717	828	686	574
Total (estimate)	145,000	150,000	146,000	144,000	159,000	173,000

1 This table incorporates a number of revisions of data published in previous nickel chapters.
2 Data not available; estimate by author of chapter included in total.
3 Estimate.
4 Byproduct in electrolytic refining of copper.
5 Includes some production from ore.

Canada.—Virtually all the Canadian output is derived from copper-nickel ores of the Sudbury district, Ontario. Some nickel is also recovered as a byproduct from silver-cobalt ores of Cobalt, Ontario. Two companies—International Nickel Co. of Canada, Ltd., and Falconbridge Nickel Mines, Ltd.—are the principal producers. Nickel production in Canada was 140,007 short tons in 1952, a gain of 2 percent over 1951 and the fourth highest of record. Exports of nickel from Canada were 142,022 short tons in 1952 compared with 130,239 tons in 1951.

Sales of nickel in all forms by the International Nickel Co. of Canada, Ltd., were 249,017,358 pounds in 1952 compared with 243,865,030 pounds in 1951.[19]

During 1952 expansion of underground mining was pushed rapidly; ore mined was 10,196,068 short tons compared with 7,780,143 tons in 1951 and 5,733,269 tons in 1950. Open-pit ore mined was 3,052,525 tons compared with 4,019,177 tons in 1951 and 4,115,755 tons in 1950. A total of 13,248,593 tons—the highest in any year—was mined in 1952 compared with 11,799,320 tons in 1951 and 9,849,024 tons in 1950. According to the company, proved ore reserves at the end of 1952 were 256,356,000 tons containing 7,795,000 tons of nickel-copper compared with 253,705,000 tons containing 7,693,000 tons of nickel-copper at the end of 1951. Underground development in the producing mines advanced 132,435 feet (25 miles) in 1952, bringing the total footage to 1,717,981 or over 325 miles.

International Nickel again expanded its exploration in search for new sources of nickel. The number of feet of exploration drilling in Canada was 499,906 compared with 289,677 in 1951. The program has involved continuous geological work on its known deposits and

19 International Nickel Co. of Canada, Ltd., Annual Report: 1952, p. 6.

geological studies of other parts of the Sudbury Basin, including further exploration in the Crean Hill mine. Important parts of the exploration program were operation of exploration camps in Manitoba and in the Northwest Territories and property examinations and prospecting elsewhere in Canada and in other parts of the world. The cost of the program was $4,967,450 compared with $2,593,908 in 1951.

In advancing its program of expansion of underground mining the company reported as follows: [20]

One new shaft was completed at Stobie, two other shaft sinkings at Levack reached their working depths, deepening of a fourth shaft at Garson was continued and shaft stations were excavated in a fifth shaft at Murray, deepened in 1951. Production of ores from the lower-grade portion of the Creighton Mine was further increased in preparing to supply the full capacity of the Creighton Concentrator, which is being increased from 10,000 to 12,000 tons of ore daily. The caving project for the mining of these lower-grade ores completed its first full year of operation and fully demonstrated the economic practicability of the project.

Production of ore and matte by Falconbridge Nickel Mines, Ltd., established new records in 1952, despite the fact that both underground development and plant construction programs were being carried on intensively. Ore treated was 1,129,489 short tons—1,118,854 tons from company mines and 10,635 tons from the East Rim and Milnet mines—in 1952 compared with 1,083,670 tons in 1951. Production of metals in matte was 5 percent greater than in 1951. Ore hoisted at the Falconbridge mine was 888,082 tons in 1952 (930,164 tons in 1951), and output at the McKim mine was 224,774 tons (155,961 tons in 1951).

The following information concerning developments, exploration, expansions, and reserves is given in the 24th Annual Report of Falconbridge Nickel Mines, Ltd., for 1952.

At the Falconbridge mine an exploratory drive west from the No. 1 shaft on the 2,625-foot level was extended 1,214 feet without encountering any ore. The more important ore development work included drives along the main ore zone for lengths of 924 feet on the 2,975 level, 1,845 feet on the 3,325 level, 2,362 feet on the 3,850 level, and 891 feet on the 4,025 level. Average ore conditions were shown by these drives. The shaft begun at the East Falconbridge mine in 1951 was sunk an additional 2,001 feet to a depth of 2,251 feet below the collar, and stations were cut. The 802 drift was extended 1,565 feet to the eastern boundary of the property and disclosed ore of slightly better grade and in substantially greater quantities than had been indicated by previous surface drilling. A crosscut was driven on the 2,800 level near the eastern boundary and used as a station for deep drilling. One hole was completed by the year end which intersected ore of better than average grade at the 3,150 level. An easterly drive on the 650 level of the McKim mine disclosed and opened a new ore shoot of average mine grade. On the 1,175 level drifting was completed to the western boundary and to the present easterly ore limit. A northerly crosscut, 1,139 feet in length, was driven on the 1,350 level to provide diamond drill stations for testing the ore zone at depth. This drilling did not show any depth extension

[20] Work cited in footnote 18, pp. 3–4.

of the orebody within the area tested. In May 1952 the shaft at the Hardy mine was completed to its planned depth of 1,427 feet, with all stations cut. A permanent steel headframe was erected and an 8-foot hoist installed. Development was begun on all levels from the 250 to 1,000.

In the Sudbury district over 50,000 feet of diamond drilling was completed. The drilling program was concentrated in the Fecunis Lake-Strathcona section of the Levack area, with the purpose of outlining ore zones indicated by previous exploration. In addition, further work was done on the low-grade Blezard ore zone and elsewhere in the district. An active exploration program was continued in the concession area in Newfoundland throughout 1952. A number of interesting discoveries were made which will require further work to determine their worth.

The expansion program in the mill was virtually completed in 1952. A new rod mill substantially increased the capacity of the crushing and grinding circuits. With installation of larger flotation units and accessory equipment the concentrator is now capable of handling 2,500 to 2,600 tons of mill ore a day. A fourth converter was installed in the smelter and foundations were prepared for a third blast furnace and settler.

Ore reserves totaled 32,987,000 short tons on December 31, 1952, and comprised 10,091,500 tons of developed ore averaging 1.64 percent nickel and 0.87 percent copper in the Falconbridge and McKim mines and 22,895,500 tons of indicated ore averaging 1.63 percent nickel and 0.95 percent copper in Sudbury district holdings. Indicated ore increased 13,881,500 tons over 1951, resulting from additional ore disclosed by drilling at the Fecunis Lake, East Falconbridge and Strathcona West properties. At Fecunis Lake the large tonnage of high-grade ore is accompanied by a substantial quantity of low grade.

The Defense Materials Procurement Agency completed negotiations with East Rim Nickel Mines, Ltd., for purchasing 65,000 short tons of ore and with Milnet Mines, Ltd., for 4,104,000 tons. Production from these mines, which are in the Sudbury district, was begun in 1952. The ore will be processed by Falconbridge Nickel Mines, Ltd.

A concentrator with a capacity of 300 tons daily was contemplated for the nickel-copper property of Nickel Offsets in the Sudbury district.[21]

The status of the construction program of Sherritt Gordon Mines, Ltd., designed to get its Lynn Lake, Manitoba, mines into production by the end of 1953, has been summarized as follows: [22]

> The power development on the Laurie River was completed in October, 1952, and since then has been supplying power to Lynn Lake.
>
> The development of the "A" and "EL" mines and the construction of the production plant at Lynn Lake made very good progress and should be completed on schedule during the fourth quarter of this year.
>
> The progress made in the construction of the Lynn Lake railroad reflects great credit upon the contractor and the Canadian National Railways. By year end track had been laid from Sherridon to mile 54.7 on the north bank of the Churchill River and grading was well advanced up to mile 84. In January daily trains

[21] Northern Miner, vol. 38, No. 15, July 3, 1952, pp. 1, 5.
[22] Sherritt Gordon Mines, Ltd., Annual Report: 1952, pp. 2–3.

were in operation between Sherridon and a supply depot north of the Churchill, hauling in construction supplies for the balance of the line. By relocating certain sections of the line the engineers have reduced the overall length of the line to 144 miles. There is now little doubt that this railway will be completed on schedule.

The construction of our chemical metallurgical plant at Fort Saskatchewan, Alberta, made good progress during the latter half of the year. At the end of the year foundation work was ahead of schedule but structural steel work was considerably behind schedule. Fabrication of process equipment appears to be generally satisfactory. In this connection the Steel Division of the Department of Defence Production has given us invaluable assistance in obtaining the special steels required for this equipment.

A program of expansion and improvement in our pilot plant facilities at Ottawa is now nearing completion. A new circuit has been set up duplicating as closely as possible the flow sheet of the Fort Saskatchewan plant.

* * * * * *

As reported in the interim progress report dated November 26, 1952, the Company has taken a small participation in Western Nickel Limited, the company formed by Newmont Mining Corporation and Pacific Nickel Mines Limited to take over the latter company's nickel property at Choate, British Columbia.

Two nickel discoveries were reported near Kluane Lake, Yukon Territory, in 1952. The Hudson Bay Mining & Smelting Co., Ltd., and Prospectors Airways Co., Ltd., have staked ground in the area.

According to the Hudson Bay Mining & Smelting Co., Ltd.,[23] it has staked and holds under option to purchase the Wellgreen property, which is favorably located close to good highways leading to tidewater. It covers an area roughly 12 miles long and 3 miles wide, comprising 538 mineral claims; it is generally mineralized and in particular contains a nickel-copper deposit with precious metals. Work during 1952 consisted of building a 10-mile rough road into the property, erecting camp buildings, starting geological mapping, and carrying on limited diamond drilling. What drilling was done was to a shallow depth only and extended about 500 feet along the strike of the lode. The outcrop of the lode has been traced up to a mile. The drilling developed 67,000 tons of ore averaging 1.96 percent nickel, 1.33 percent copper, 0.056 percent cobalt, 0.004 ounce of gold, 0.078 ounce of platinum, and 0.053 ounce of palladium.

Prospectors Airways Co., Ltd., was reported [24] to have staked 28 claims in the area.

Cuba.—Rehabilitation of the nickel-producing facilities at Nicaro, Cuba, was completed in 1952. Four of the 12 furnaces were put into operation January 31—60 days ahead of schedule. The last two furnaces were put into operation July 7. The Cuban Nickel Company, a United States Government corporation, owns the plant and townsite; the operation is managed on a fee basis by the Nickel Processing Corp., a private concern.

Production of nickel oxide was 11,604 short tons containing 8,958 tons of nickel in 1952. During the first half of 1952, production of ore was 298,854 short tons averaging 1.35 percent nickel.

Under an agreement with Defense Materials Procurement Agency, the Bureau of Mines began drilling in the Levisa Bay district on September 15, 1952. By the end of the year, 254 holes had been drilled to explore an area of 700 hectares (1,730 acres) on the Zoilita Denounce-

[23] Hudson Bay Mining & Smelting Co., Ltd., Annual Report: 1952, pp. 1, 8.
[24] Northern Miner (Toronto), Nickel-Copper Yukon Find Looks Very Impressive: Vol. 38, No. 18, Sec. 1, July 24, 1952, pp. 1, 4.

ment. A preliminary estimate of the ore developed by this drilling was 3,100,000 metric tons of plus-1 percent combined nickel and cobalt.

Law Decree 509 of November 4, 1952, authorized the Ministry of Agriculture to issue a permit to the Cuban Nickel Company to explore for mineral ores in the El Cristal National Park area. A permit dated November 13, 1952, was issued to the company.

Finland.—Small quantities of nickel are found in the ores of the Outokumpu copper mine and the Nivala nickel-copper mine. Production of ore at the Nivala mine was 76,247 metric tons containing 0.73 percent nickel and 0.44 percent copper in 1952 compared with 15,868 tons containing 0.71 percent nickel, 0.45 percent copper, 6.1 percent sulfur, and 15.3 percent iron in 1951. Production of concentrates was 7,574 tons containing 5.32 percent nickel and 3.44 percent copper in 1952 compared with 1,413 tons containing 5.87 percent nickel, 3.87 percent copper, 0.41 percent cobalt, 24.4 percent sulfur, and 25.3 percent iron in 1951. The quantity of nickel is too small for conversion to primary metal and is used for manufacturing nickel sulfate by Outokumpu Oy. Nickel sulfate production was 281 tons in 1952; all was exported. Also exported in 1952 was 467 tons of low-grade nickel ore from the Nivala mine to West Germany.

New Caledonia.—Production of nickel ore (containing about 25 percent moisture) in New Caledonia was 392,050 metric tons in 1952 compared with 252,335 tons in 1951. The nickel content (dried) of the ore averaged 3.60 and 3.53 percent, respectively, in 1952 and 1951. Exports of ore comprised 97,935 tons (wet) averaging 3.41 percent nickel (dried) to Japan and 11,905 tons averaging 5.6 percent nickel to France in 1952 compared with 7,010 tons averaging 3.9 percent nickel (all to Japan) in 1951.

Production of nickel matte, fonte, and ferronickel by Société le Nickel was 57 percent more in 1952 than in 1951.

TABLE 11.—Production of nickel matte, fonte, and ferronickel by Société le Nickel in 1951 and 1952, in metric tons

Product	1951		1952	
	Gross weight	Nickel content	Gross weight	Nickel content
Matte	3,614	2,796	4,054	3,132
Fonte	1,777	} 1,234	{ 9,488	3,140
Ferronickel	1,856		201	74
	7,247	4,030	13,743	6,346

Norway.—Operating conditions at the refinery of Falconbridge Nickel Mines, Ltd., at Kristiansand, Norway, were complicated by the changeover to the chloride process, which was attended by increased metal losses and corrosion problems.[25] Nevertheless, production of refined nickel and copper established new records in 1952. By the end of 1952, the difficulties were being progressively overcome.

Output of nickel was 12,159 metric tons in 1952 compared with 11,080 tons in 1951.

[25] Falconbridge Nickel Mines, Ltd., 24th Annual Report: 1952, p. 8.

According to Norwegian press reports, quoted by Agefi, two deposits of nickel ore have been discovered in the Province of Nordland in northern Norway.[26] One is in the region of Misvaer about 25 miles from Bodö, and the other in the Einan district. Both deposits are situated near the sea.

Union of South Africa.—A small quantity (1,444 short tons in 1952) of nickel in the form of matte is produced annually in the Rustenburg district, Union of South Africa, by Rustenburg Platinum Mines, Ltd. The matte is exported to England for refining.

United Kingdom.—The operating efficiency of the nickel refinery of Mond Nickel Co. at Clydach, Wales, was greatly improved as a result of major alterations completed in 1952.[27] In addition, encouraging results obtained on a pilot plant scale have warranted the installation of a full-scale unit which is expected to effect savings in the cost of producing nickel at this refinery.

[26] Metal Bulletin (London) No. 3718, Aug. 19, 1952, p. 23.
[27] Thompson, J. F., The International Nickel Co. of Canada, Ltd., address to Shareholders: Apr. 29, 1953, pp. 16–17.

Nitrogen Compounds

By E. Robert Ruhlman [1]

DURING 1952 the nitrogen industry was characterized by shortages of nitrogen materials and continued industry expansions. The Defense Production Administration set a goal of 2.9 million short tons of nitrogen by 1955, an expansion of 1.3 million tons above the 1950 capacity.

All fertilizer nitrogen materials for export required licenses from the Office of International Trade during 1952.

DOMESTIC PRODUCTION

Synthetic anhydrous ammonia production reached a new high in 1952, 15 percent above the previous record of 1951. Domestic production of ammonium sulfate in 1952 was 5 percent more than in 1951 but less than in 1950. Ammonium sulfate produced in byproduct coking plants was 11 percent below the 1951 figure as a result of a 2-month steel strike in June and July 1952. Ammonium nitrate production reached another alltime high in 1952, 9 percent above the 1951 figure. As in previous years, synthetic sodium nitrate was produced only by Allied Chemical & Dye Corp., Hopewell, Va., and Mathieson Chemical Corp., Lake Charles, La.

TABLE 1.—Principal nitrogen compounds produced in the United States, 1943–47 (average) and 1948–52, in short tons

Commodity	1943–47 (average)	1948	1949	1950	1951	1952
Ammonia (NH_3):						
Synthetic plants: Anhydrous ammonia [1]	695, 129	1, 089, 786	1, 294, 057	1, 565, 569	[2]1,777,074	2, 052, 114
Byproduct coking plants (NH_3 content):						
Aqua ammonia	28, 817	24, 753	22, 750	23, 387	24, 878	22, 060
Ammonium sulfate	189, 850	207, 671	189, 202	207, 754	224, 566	200, 603
Subtotal	218, 667	232, 424	211, 952	231, 141	249, 444	222, 663
Grand total	913, 796	1, 322, 210	1, 506, 009	1, 796, 710	[2]2,026,518	2, 274, 777
Principal ammonium compounds:						
Ammonium sulfate:						
Synthetic plants [1] [3]	118, 873	264, 476	846, 195	1, 137, 721	[2] 605, 651	770, 610
Byproduct coking plants	759, 400	830, 683	756, 807	831, 016	898, 263	802, 412
Total	878, 273	1, 095, 159	1, 603, 002	1, 968, 737	[2]1,503,914	1, 573, 022
Ammonium nitrate, basis solution, 100 percent NH_4NO_3 [1]	[4] 744, 418	988, 342	1, 018, 706	1, 213, 911	1, 346, 443	1, 467, 341

[1] Data from Bureau of Census Facts for Industry series.
[2] Revised figure.
[3] Includes ammonium sulfate produced at byproduct coking plants from purchased ammonia.
[4] Average of 1945–47 only.

[1] Commodity-industry analyst.

Allied Chemical & Dye Corp., on June 1, 1952, announced establishment of a Nitrogen Division to assume all manufacturing and associated activities previously handled by the nitrogen and organic sections of the Solvay Process Division. Allied Chemical & Dye Corp. announced beginning of construction of a new fertilizer plant at South Point, Ohio, to manufacture a high-analysis complete fertilizer. Other expansion reported by this company included enlargement of research and development facilities at Hopewell, Va., and plans for the construction of a large ammonia and urea plant near La Platte, Nebr.[2]

The American Cyanamid Co. published a booklet listing its available products and services.[3]

W. R. Grace & Co. formed a wholly owned subsidiary—Grace Chemical Co.—to operate an ammonia-urea plant to be constructed near Memphis, Tenn., to supply Naco Fertilizer Co., also a subsidiary of W. R. Grace & Co., with nitrogen requirements for its plants in the Carolinas, Florida, Ohio, and California.[4]

The new anhydrous ammonia plant of the Hooker Electrochemical Co. at Tacoma, Wash., began to operate in May 1952, using nitrogen obtained from liquefied air and hydrogen from salt brine. It was announced that plans for expansion were under consideration.[5]

The Lion Oil Co. announced plans for constructing a plant at Luling, La., to manufacture anhydrous ammonia and prilled ammonium nitrate. Natural gas will be used as a raw material and fuel.[6]

The Mathieson Chemical Corp. began to operate the Army's Morgantown Ordnance Works, Morgantown, W. Va., under a 5-year lease for the production of ammonia and methanol. Products will be sold to industry and the Government, and used in Mathieson's own fertilizer plants.[7]

The Union Oil Co. of California formed a byproduct chemical division and planned construction of an ammonium sulfate plant at its Wilmington, Calif., refinery.[8]

Other companies which announced expansion programs or construction of new plants included: Ammonium Chemical Corp., Calif.; Gulf Improvement Co., Pascagoula, Miss.; Houston Oxygen Co., Houston, Tex.; Pacific Chemical Co., Pasco, Wash.; Phillips Chemical Co., Pasadena, Tex.; and the Rocky Mountain Chemical Co., Billings, Mont.

---

[2] Chemical and Engineering News, vol. 30, No. 21, May 26, 1952, p. 2212; No. 31, June 9, 1952, p. 2371; No. 39, Sept. 29, 1952, p. 4062; No. 42, Oct. 20, 1952, p. 4382.
Chemical Engineering, vol. 59, No. 6, June 1952, p. 112.
Oil, Paint, and Drug Reporter, vol. 161, No. 22, June 2, 1952, p. 5.

[3] American Cyanamid Co., Products and Services for Industry and Agriculture: 3d ed., 1952, 36 pp.

[4] Chemical and Engineering News, vol. 30, No. 14, Apr. 7, 1952, p. 1355.
Chemical Engineering, vol. 59, No. 6, June 1952, p. 110.
Chemical Engineering Progress, vol. 48, No. 6, June 1952, p. 40.
Oil, Paint and Drug Reporter, vol. 162, No. 15, Oct. 13, 1952, p. 4.

[5] Chemical Engineering, vol. 59, No. 6, June 1952, p. 252.
Mining and Contracting Review, vol. 54, No. 6, June 24, 1952, p. 15.
Oil, Paint and Drug Reporter, vol. 161, No. 19, May 12, 1952, p. 6.

[6] Chemical and Engineering News, vol. 30, No. 18, May 5, 1952, p. 1832.
Chemical Engineering, vol. 59, No. 6, June 1952, p. 106; No. 8, August 1952, p. 306; No. 9, September 1952, pp. 259–260.

[7] Chemical and Engineering News, vol. 30, No. 14, Apr. 7, 1952, p. 1398.
Chemical Engineering, vol. 59, No. 3, March 1952, p. 256; No. 5, May 1952, p. 344.
Commercial Fertilizer, vol. 84, No. 1, January 1952, p. 27.

[8] Chemical and Engineering News, vol. 30, No. 14, Apr. 7, 1952, p. 1402.

CONSUMPTION AND USES

The major part of the nitrogen supply continued to be consumed by agriculture, with smaller quantities used by industry. A small quantity of elemental nitrogen was consumed for industrial purposes, but most nitrogen entered both agriculture and industry in a variety of chemical compounds. Over 1.4 million tons of nitrogen was consumed by agriculture during the fiscal year ended June 30, 1952, a 17-percent increase above the previous fiscal year. The principal chemical nitrogen materials, in order of importance, were (1) ammonium nitrate and ammonium nitrate-limestone mixtures, (2) sodium nitrate, (3) ammonium sulfate, (4) anhydrous and aqua ammonia, (5) calcium nitrate, and (6) calcium cyanamide.

According to the United States Department of Agriculture, consumption of anhydrous ammonia, ammonium nitrate-limestone mixtures, and ammonium nitrate in 1951–52 increased 42, 34, and 25 percent, respectively, whereas consumption of calcium cyanamide was 34 percent less than in 1950–51.

PRICES

Prices of nitrogen compounds remained under control of the Office of Price Stabilization throughout 1952. Supplementary regulations and amendments were issued during the year. The prices for various nitrogen compounds in effect at the opening, middle, and end of 1952, as quoted in the Oil, Paint and Drug Reporter, are shown in table 2.

TABLE 2.—Prices of major nitrogen compounds in 1952, per short ton [1]

Commodity	Jan. 14, 1952	June 30, 1952	Dec. 29, 1952
Chilean nitrate, port, warehouse, bulk	$53.50	$57.00	$57.00
Sodium nitrate, synthetic, domestic, c. l. works, crude, bulk	47.50	47.50	47.50
Ammonium sulfate, coke ovens, bulk	40.00-45.00	40.00-45.00	44.00-49.50
Cyanamide, fertilizer-mixing grade, 20.6% N, granular, Niagara Falls, Ont., bagged	65.45	62.50	62.50
Ammonium nitrate, fertilizer grade:			
Canadian, eastern, 33.5% N, c. l., shipping point, bags	69.50	[2] 72.50	72.50
Western, domestic, works, bags	64.00	64.00	64.00
Anhydrous ammonia, fertilizer, tanks, works	79.00-80.00	79.00-80.00	79.00-82.00
Ammonium-nitrate-dolomite compound, 20.5% N, Hopewell, Va., bags	51.00	51.00	51.00

[1] Quotations from Oil, Paint and Drug Reporter of the dates listed.
[2] Effective February 8.

FOREIGN TRADE [9]

Total imports of nitrogen compounds were 7 percent more in 1952 than in 1951. As in previous years, imports of natural Chilean nitrate greatly exceeded the imports of any other nitrogenous material. The tonnage of sodium nitrate imported from Chile decreased 8 percent, whereas the average value per ton increased from $36.65 in 1951 to $40.91 in 1952.

Chilean potassium-sodium nitrate imports in 1952 were nearly double those of 1951. The average price per ton increased $5.42 in 1952.

[9] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines from records of the U. S. Department of Commerce.

Total exports of nitrogen compounds decreased 14 percent in 1952. Ammonium sulfate remained the major export.

TABLE 3.—Major nitrogen compounds imported for consumption into and exported from the United States, 1949–52, in short tons

[U. S. Department of Commerce]

	1949	1950	1951	1952
Imports:				
Industrial chemicals:				
Ammonium nitrate	1	--------	4	--------
Fertilizer materials:				
Ammonium nitrate mixtures:				
Containing less than 20 percent nitrogen	2,290	1,523	361	624
Containing 20 percent or more nitrogen	136,405	221,299	342,757	459,705
Ammonium phosphates	126,274	107,695	134,962	133,316
Ammonium sulfate	105,498	144,732	216,106	238,063
Calcium cyanamide	115,885	97,725	68,231	96,195
Calcium nitrate	38,611	44,331	55,743	39,466
Nitrogenous materials, n. s. p. f	4,829	23,830	26,023	22,067
Potassium nitrate, crude	1	20	[1] 3,367	20,199
Potassium-sodium nitrate	6,802	20,409	[1] 8,655	16,460
Sodium nitrate	675,543	618,018	[1] 737,324	675,329
Exports:				
Industrial chemicals:				
Anhydrous ammonia	3,477	10,202	5,907	15,431
Ammonium nitrate	17,004	3,336	5,049	5,709
Fertilizer materials:				
Ammonium nitrate	470,443	94,169	1,255	18,956
Ammonium sulfate	660,733	819,285	134,100	121,587
Nitrogenous chemical materials, n. e. s	23,510	41,363	63,768	48,109
Sodium nitrate	3,714	32,862	43,669	9,441

[1] Revised figure.

TABLE 4.—Sodium nitrate and potassium-sodium nitrate imported for consumption in the United States, 1948–52, by countries

[U. S. Department of Commerce]

	1948		1949		1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Sodium nitrate:										
Canada	199	$11,057	8	$416	8	$1,137	84	$4,622	50	$4,138
Chile	709,374	23,031,245	675,535	26,005,637	617,999	22,387,123	[1] 737,188	27,015,854	675,279	27,626,811
France	------	---------	------	---------	------	---------	33	3,213	------	---------
Germany	------	---------	------	---------	11	1,330	5	576	------	---------
Poland	------	---------	------	---------	------	---------	14	968	------	---------
Total	709,573	23,042,302	675,543	26,006,053	618,018	22,389,590	[1] 737,324	27,025,233	675,329	27,630,949
Potassium-sodium nitrate, mixtures:[2]										
Canada	------	---------	------	---------	------	---------	3	148	------	---------
Chile	------	---------	6,802	310,343	20,409	882,582	[1] 8,652	[1] 389,749	16,460	830,693
Total	------	---------	6,802	310,343	20,409	882,582	[1] 8,655	[1] 389,897	16,460	830,693

[1] Revised figure

[2] 1951: Germany revised to none.

TECHNOLOGY

The early nitrate industry of the United States, which began about 1800, was described in an article published during 1952. Saltpeter was produced by leaching the potassium nitrate from the dirt floors of caves and percolating the liquor through wood ashes. From 3 to 5 pounds of nitrate of lime was produced from 1 bushel of dirt.[10]

Studies were in progress at the University of Wisconsin during 1952 to determine the process by which plants convert free nitrogen to fixed nitrogen compounds. This "fixation" by plants has long been one of the mysteries of agronomy. When the process is known, fertilizers might be produced capable of supplying nitrogen in more favorable forms.[11]

The Tennessee Valley Authority, in its fertilizer research, constructed a 525-ton-per-day continuous vacuum crystallizer plant to develop a safer and more economical process for the production of ammonium nitrate. The product from the crystallizers is rounded, minus-16-plus-35-mesh crystals containing not less than 33 percent nitrogen.[12]

The first commercial installation to produce ammonia by partial oxidation of natural gas with oxygen was under construction at Vicksburg, Miss., for the Spencer Chemical Co. It was reported that this new process will reduce the cost of ammonia by about 6 percent.[13]

A safe one-step method of producing ammonium nitrate was developed by the Commercial Solvents Corp. This process, called the Stengel Process (United States Pat. 2,568,901), combines ammonia and nitric acid at temperatures between 180° and 250° C. Following completion of pilot-plant studies, the company began to construct a commercial plant at Sterlington, La.[14]

The demand for urea as a nitrogenous fertilizer continued to increase throughout 1952. Combination of urea and formaldehyde yields nitrogen-bearing products, which apparently have desirable properties of both chemical and natural organic nitrogen fertilizer materials.[15]

The potential applications of nitric acid for acidulation of phosphate rock was the subject of an article. Four possibilities were listed for greater use of nitric acid in fertilizer technology:

1. Production of liquid and solid ammonium nitrate products.
2. Production of potassium nitrate.
3. Production of calcium nitrate.
4. Acidulation of phosphate rock.

Each of these was discussed and possible trends in their use in the United States were cited.[16]

Nitrogen tetroxide is being considered as rocket fuel. Its high oxygen content makes it desirable for rockets that must carry their own oxygen.[17]

---

[10] Jackson, G. F., Niter Caves: Compressed Air Mag., vol. 57, No. 6, June 1952, pp. 156–160.
[11] Science News Letter, vol. 63, No. 2, Jan. 10, 1953, p. 25.
[12] Seamen, W. C., McCamy, I. W., and Houston, E. C., Production of Ammonium Nitrate by Continuous Vacuum Crystallization: Ind. & Eng. Chem., vol. 44, No. 8, August 1952, pp. 1912–1914.
[13] Chemical and Engineering News, vol. 30, No. 10, May 5, 1952, p. 1862.
[14] Chemical Engineering, One-Step Ammonium Nitrate: Vol. 59, No. 8, August 1952, p. 215.
[15] Clark, K. G., Urea-Form—New Nitrogen Fertilizer: Crops and Soils, vol. 4, No. 8, June–July 1952, pp. 14–15.
[16] Critteden, E. D., What's Ahead for Nitric Acid: Chem. Eng., vol. 59, No. 6, June 1952, pp. 177–179, 286.
[17] Chemical Engineering, vol. 59, No. 4, April 1952, p. 162.

The origin and development of the nitriding process and recent improvements were discussed in an article published in 1952.[18]

The advantages of adding nitrogen to certain steel alloys and the improved properties of the resulting metal were discussed.[19]

WORLD REVIEW

According to the annual report of Aikman (London), Ltd., production and consumption of nitrogen increased in 1952–53, compared with 1951–52. As in previous years, Aikman's data show an apparent surplus, which from 1948–49 through 1952–53 totals over 900,000 metric tons of nitrogen for agriculture. Details of world production and consumption of nitrogen are shown in tables 5 and 6.

Chile.—The production of nitrates totaled 1,438,199 metric tons in 1952, a 22 percent decrease from 1951. Although the demand was high, the industry, largely because of labor difficulties, was not able to supply sufficient nitrates to fill orders. The consumption of nitrates in Chile has been increasing for several years and in 1951–52 totaled 74,809 metric tons. The exports of sodium nitrate and potassium nitrate in 1952 are shown in table 7.

TABLE 5.—World production and consumption of fertilizer nitrogen compounds, fiscal years ended June 30, 1951–53, by principal countries, in metric tons of contained nitrogen

[United Nations Food and Agriculture Organization]

Country	Production			Consumption		
	1950-51	1951-52 [1]	1952-53 [2]	1950-51	1951-52 [1]	1952-53 [2]
Austria	74,900	94,750	100,700	22,542	25,000	25,000
Belgium	173,357	214,269	215,000	78,000	77,500	78,000
Canada	149,208	149,208	161,208	32,659	32,659	34,500
Chile	242,583	234,660	234,660	8,369	9,000	9,000
Czechoslovakia	30,000	30,300	30,300	40,000	40,000	40,000
Denmark				70,000	73,000	75,000
Egypt		27,900	31,000	42,533	130,118	143,400
France	259,030	285,000	305,600	262,100	280,000	315,000
Germany						
Federal Republic	464,677	500,000	520,000	361,562	380,000	400,000
Soviet Zone	205,000	205,000	213,000	184,000	191,000	196,000
Greece				22,000	35,000	40,000
India	8,417	37,998	71,120	46,650	62,998	108,120
Italy	177,301	186,000	225,000	156,500	158,000	170,000
Japan	414,595	456,770	480,000	442,000	442,000	442,000
Korea, South		306	1,122	14,598	48,189	80,010
Netherlands	189,053	226,500	245,000	165,978	160,000	165,000
Norway	160,747	159,404	164,795	30,699	32,000	33,000
Peru	35,440	36,000	36,000	37,680	39,630	
Poland	65,000	65,000	65,000	75,000	75,000	75,000
Portugal [3]				31,870	33,000	34,000
Spain	6,600	7,000	7,000	56,600	60,000	60,000
Sweden	25,426	16,028	24,659	67,999	72,542	80,314
Taiwan (Formosa)	6,112	13,849	14,320	61,279	76,215	
United Kingdom	275,000	278,900	286,000	218,800	175,000	220,000
United States [3]	996,000	1,099,000	1,202,000	1,166,000	1,275,000	1,379,000
World total [4]	4,011,103	4,379,654	4,705,864	3,930,054	4,268,353	4,639,255

[1] Preliminary figures.
[2] Preliminary estimates.
[3] Figures for consumption include overseas territories.
[4] Exclusive of U. S. S. R.; includes quantities for minor producing and consuming countries not listed above.

[18] Chemical Age (London), The Theory and Practice of Nitriding: Vol. 67, No. 1730, Sept. 6, 1952, pp. 329–331.
[19] Metal Progress, How Nitrogen Refines Grain Size: Vol. 61, No. 4, April 1952, p. 105.

France.—Expansion of the nitrogen facilities provided a productive capacity of 375,000 metric tons per year at the close of 1952, compared to 280,000 tons capacity per year, previously.

TABLE 6.—Revised estimates of world production and consumption of nitrogen, in thousands of metric tons [1]

Year	Estimated production		Estimated consumption	
	For agriculture	For industry	In agriculture	In industry
1948-49	3,438	570	3,181	570
1949-50	3,891	670	3,525	670
1950-51	4,037	770	3,973	770
1951-52	4,376	840	4,179	840
1952-53	4,747	865	4,597	865

[1] Exclusive of U. S. S. R. Source: Aikman (London), Ltd., Amended Annual Report on the Nitrogen Industry.

TABLE 7.—Exports of sodium nitrate and potassium nitrate from Chile in 1952 [1]

Sodium nitrate		Potassium nitrate	
Country of destination	Metric tons	Country of destination	Metric tons
Argentina	23,500	Bolivia	20
Belgium	18,793	Brazil	4,026
Bolivia	100	Colombia	497
Brazil	34,319	Costa Rica	650
Colombia	832	Cuba	15,394
Costa Rica	350	Ecuador	450
Cuba	2,146	El Salvador	247
Denmark	15,240	Great Britain	3,861
Ecuador	1,420	Guatemala	395
Egypt	230,628	Honduras	1,000
El Salvador	3,211	Mauritius	1,004
France	62,065	Mexico	500
Germany	10,210	Netherlands	100
Great Britain	16,968	Nicaragua	495
Greece	2,932	Panama	10
Guatemala	396	Peru	1,640
India	16,166	United States	17,932
Italy	37,757	Venezuela	385
Jamaica	330		
Japan	10,954	Total	48,606
Mauritius	7,723		
Mexico	2,700		
Netherlands	10,971		
New Zealand	1,904		
Nicaragua	495		
Panama	10		
Peru	8,811		
Portugal	30,822		
Spain	77,839		
Sweden	26,577		
United States	615,160		
Venezuela	636		
Total	1,271,965		

[1] Source: Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 41.

Iceland.—The 18,000-ton-per-year ammonium nitrate fertilizer plant being constructed with Economic Cooperation Administration funds was scheduled for completion in 1953.[20]

[20] Foreign Commerce Weekly, vol. 43, No. 13, June 23, 1952, p. 16.

India.—The fertilizer factory at Sindri, Bihar, India was officially opened in March 1952. Initially built to produce 350,000 metric tons annually of ammonium sulfate, the plant was designed to provide for expansion to double the production of ammonium sulfate and also to produce ammonium nitrate, urea, and other chemicals. Coal, coke, and water are obtained nearby. The plant was designed to utilize gypsum deposits near the Pakistan-India border, but because the supply was not assured, the plant was redesigned to permit utilization of lower grade but more accessible gypsum deposits.[21]

[21] Chemical and Engineering News, vol. 30, No. 11, Mar. 17, 1952, p. 1118.
Chemical Engineering and Mining Review, vol. 44, No. 11, Aug. 11, 1952, p. 441.
Pit and Quarry, vol. 44, No. 10, April 1952, p. 73.
Rock Products, vol. 55, No. 10, October 1952, p. 87.

Perlite

By Oliver S. North[1] and Annie L. Marks[2]

THE OUTPUT in 1952 of 156,000 short tons of expanded perlite was a new record for the industry. Total sales reached 155,000 tons, or approximately 9,250,000 4-cubic-foot bags—an increase of 16 percent from the 1951 total—valued at $7,998,000.

The rate of the industry's growth gave indications of leveling, particularly in States and areas in which it has been established for some years. New geographic and use markets were being opened, and selling efforts in existing markets were intensified.

Developments of interest to members of the industry included the growing use of premixed perlite plaster, of perlite in concretes (especially in structural panels), of perlite in oil-well drilling, and of perlite fines as an emergency filtration additive.

DOMESTIC PRODUCTION

Crude Perlite.—Twenty-one firms and individuals in 7 States reported the output of crude perlite in 1952. Of these, 9 produced for sale to expanders only, 8 for use in their own expanding units only, and 4 produced both for their own furnaces and for sale to other expanders.

Of the 165,000 short tons of crude perlite used in the United States in 1952, 73 percent was produced in New Mexico and Nevada and 24 percent in California, Colorado, and Oregon. To avoid disclosing individual company operations, separate State totals are not published. Output of crude perlite in 1948–52 is shown in table 1.

TABLE 1.—Crude and expanded perlite produced and sold or used by producers in the United States, 1948–52

Year	Crude perlite					Expanded perlite		
	Produced (short tons)	Sold		Used at own plant to make expanded material		Produced (short tons)	Sold	
		Short tons	Value	Short tons	Value		Short tons	Value
1948	22,200	4,400	$29,000	17,700	$105,000	21,200	18,600	$742,000
1949	71,500	27,300	193,000	43,800	317,000	58,100	52,200	2,385,000
1950	110,694	59,802	411,205	41,734	237,957	88,892	86,962	4,741,383
1951	[1] 154,174	[1] 110,119	[1] 663,981	43,383	194,118	134,479	133,175	7,243,298
1952	190,442	135,070	873,054	29,775	129,866	155,955	154,563	7,997,731

[1] Revised figure.

[1] Commodity-industry analyst.
[2] Statistical clerk.

Expanded Perlite.—Production of expanded perlite in 1952 was reported from 72 plants located in 30 States. Of these plants, 13 were in California, 5 each in Illinois, Ohio, and Texas, and 4 in Pennsylvania. Production of this material was reported in 1952 for the first time from Florida, Massachusetts, and Nebraska. Output of expanded perlite in 1951–52 is shown in table 2.

TABLE 2.—Expanded perlite produced and sold by producers in the United States, 1951–52, by States

State	1951				1952			
	Produced (short tons)	Sold			Produced (short tons)	Sold		
		Short tons	Value	Average value per ton		Short tons	Value	Average value per ton
California	25, 850	25, 648	$1, 481, 428	$57. 76	28, 663	28, 419	$1, 202, 603	$42. 32
Illinois	11, 978	11, 967	692, 073	57. 83	15, 545	14, 562	776, 728	53. 34
Ohio	(1)	(1)	(1)	(1)	9, 975	9, 881	667, 561	67. 56
Pennsylvania	12, 446	12, 389	757, 060	61. 11	15, 690	15, 441	938, 690	60. 79
Texas	9, 044	8, 698	423, 730	48. 72	11, 780	11, 691	627, 917	53. 71
Other Western States [2]	32, 640	32, 584	1, 467, 831	45. 05	38, 488	38, 309	1, 714, 067	44. 74
Other Eastern States [3]	42, 521	41, 889	2, 421, 176	57. 80	35, 814	36, 260	2, 070, 165	57. 09
Total	134, 479	133, 175	7, 243, 298	54. 39	155, 955	154, 563	7, 997, 731	51. 74

1 Included under "Other Eastern States."
2 Includes Arizona, Arkansas, Colorado, Iowa, Kansas, Louisiana, Minnesota, Missouri, Nebraska (1952 only), Nevada, New Mexico, Oklahoma, Oregon, and Utah.
3 Includes Florida (1952 only), Indiana, Maryland, Massachusetts (1952 only), Michigan, New Jersey, New York, North Carolina, Ohio (1951 only), Tennessee, Virginia, and Wisconsin.

Perlite Mine and Plant Developments.—Dant & Russell, Inc., one of the earliest producers in the perlite industry, leased its mine and plant to Kaiser Gypsum Division of Henry J. Kaiser Co. The facilities are near Maupin, Oreg., 113 miles east of Portland, Oreg.[3]

The processing plant of Midwest Perlite Products, Inc., West Des Moines, Iowa, began making hardwall and finish-coat plaster aggregates, concrete aggregate, and acoustical plaster.[4]

An article described the mining methods of F. E. Schundler & Co., at its Taos County, N. Mex., mine, and milling practices at its Antonito, Colo., crushing plant.[5]

According to an item in the press, California Perlite Corp. began construction of a large perlite-crushing plant at Klondike, Calif.[6]

The perlite-processing facilities of the J. P. Loomis Coal & Supply Co., Akron, Ohio, were reported in the fall of 1952 to have been leased by Geotic Industries, Inc., Akron, Ohio.

The Perlite Division of Great Lakes Carbon Corp. permanently closed its expanding units at Torrance, Calif., and Linden, N. J., early in 1952. Its furnace unit at Socorro, N. Mex., operated throughout the year.

3 Rock Products, Kaiser Acquires Perlite Operation: Vol. 55, No. 6, June 1952, p. 90; Pit and Quarry, Kaiser Gypsum Acquires Dantore Quarry and Plant for Perlite Processing: Vol. 44, No. 12, June 1952, p. 74.
4 Rock Products, Perlite Aggregate Plant: Vol. 55, No. 6, June 1952, p. 89.
5 Mining World, New Mexico's No Agua Perlite Processed at Schundler Plant: Vol. 14, No. 1, January 1952, pp. 44–45.
6 Western Industry, vol. 17, No. 11, November 1952, p. 92.

The Perlite Manufacturing Co., Carnegie, Pa., was reported to have expanded its plant facilities to meet the heavy demand for its products in the Pittsburgh area.[7]

A perlite-processing plant was built in the Cincinnati, Ohio, area. The new firm, Indoken Perlite Co., St. Bernard, Ohio, will operate under a franchise agreement with one of the large producers of crude rock.[8]

The El Paso Perlite Co. was reported to have erected, at Gage, N. Mex., a pilot plant for crushing crude perlite rock from a large deposit 19 miles northwest of Gage.[9]

CONSUMPTION AND USES

Crude Perlite.—Although small quantities may find other applications, in this chapter consumption statistics refer only to the material from which expanded perlite is made. The consumption of crude perlite in the United States is the sum of the quantity sold by producers and that used by producers at their own expansion units. These figures are shown in table 1.

Expanded Perlite.—The quantity and value of expanded perlite sold or used in 1951 and 1952 are shown in table 2; totals for earlier years appear in table 1. The Bureau of Mines does not make a canvass of consumption, by uses, but it is known that the uses discussed in the following paragraphs constitute the principal commercial applications of this material.

Although probably not so important, percentagewise, as during the past several years, the use of perlite as aggregate in hardwall and fireproofing plasters consumed well over half the total tonnage used. Expanded perlite apparently is finding increasing usage in lightweight concretes, particularly in roof decks and in reinforced structural panels, and an estimated 30 percent of the 1952 output went for this purpose.

A development of interest to the industry is the growing use of premixed perlite-gypsum plaster, which is now being manufactured and sold by at least six large gypsum-producing companies. This product is packaged to appeal to those home owners and plasterers who use relatively small quantities at a time.

Several processors report considerable quantities of expanded perlite going into oil-well muds and concretes,[10] with 1 or 2 firms devoting virtually their entire outputs to this use. Certain grades of perlite are used in the foundry industry, where the material is employed to insulate risers and as an additive to core and facing sands.[11]

Other uses include: Loose-fill insulation, filtering medium for water and chemicals, exterior cement stucco work, refractory brick, roofing tile, soil reconditioner, filler in paints and plastics, and numerous special purposes that utilize its light weight, insulating characteristics, inertness, or other physical qualities.

---

[7] Pit and Quarry, vol. 44, No. 10, April 1952, p. 107.
[8] Pit and Quarry, Indoken Perlite Co. Builds Plant at St. Bernard, Ohio: Vol. 44, No. 11, May 1952, p. 75.
[9] Mining Congress Journal, Perlite Operations in New Mexico: Vol. 38, No. 11, November 1952, p. 80; Pit and Quarry, El Paso Perlite Begins New Operation: Vol. 45, No. 4, October 1952, p. 61.
[10] Johnson, S. W., Perlite (Review of 1952): Eng. and Min. Jour., vol. 154, No. 2, February 1953, pp. 108–109, 240.
[11] Rock Products, Perlite Meeting: Vol. 55, No. 12, December 1952, p. 128.

Disposal of the fine material that is unavoidably produced during furnacing presents a continuing problem to many processors. During a work stoppage of several months in the principal diatomaceous earth-producing area in the United States, perlite fines were widely used as a filter additive by the liquor, chemical, and dry-cleaning industries, but when diatomaceous earth became again available, many users returned to that product. Other uses for fines are in trowel and brush finishes, fillers, air-entraining agents, and abrasives.

PRICES

The mill value of crude perlite (crushed and sized) sold by producers averaged $6.46 per short ton in 1952, while the average book value of crude material processed by the companies by which it was mined was $4.36 per short ton. Average value for all milled crude perlite sold or used in the United States in 1952 was $6.08 per short ton.

As reported in the July 1952 issue of the California Division of Mines publication, Mineral Information Service, the cost of crude perlite rock, crushed and graded, delivered in the Los Angeles area, was $12.80 to $14.75 per short ton for concrete-aggregate grades and $11.80 to $13.75 for plaster-aggregate grades. Napa crude delivered in the San Francisco–Oakland area was quoted at $10.50 to $14.00 per ton.

The average value of expanded material in bags at the plant was $51.74 per short ton in 1952, compared to $54.39 in 1951. The principal declines in value were noted in California and Illinois, while the average value in Texas was several dollars per ton higher than in the previous year. Average values in most of the Eastern States were steady.

TECHNOLOGY

During the year five patents on perlite-processing furnaces were granted by the United States Patent Office.

The Zoradi patent discussed in considerable detail the technology and science of expanding perlite. It emphasized the importance of removing clay streaks and other impurities, using only perlite analyzing between 3 and 4 percent combined water and grading furnace crude to a screen size of minus 20-, plus 150-mesh to obtain a product weighing 8 to 12 lb. per cu. ft. The Zoradi furnace is a short, horizontal rotary unit (with preheater) into which the particles are fed right angles to the flame.[12]

A second furnace patented is a circular, horizontally rotating furnace bed comprising a number of expansion chambers or pockets. Flames are projected downward onto the particles, which have been separated and uniformly spaced by mechanical means.[13]

A third patent describes a horizontal rotary kiln in which the particles are heated by "off-center" firing, that is, by not subjecting the material to a direct flame.[14]

---

[12] Zoradi, E. D. (assigned to Dant & Russell, Inc.), Method and Apparatus for Expanding Perlite: U. S. Patent 2,602,782, July 8, 1952.

[13] McDonald, G. H., Apparatus for Expanding Perlite: U. S. Patent 2,603,471, July 15, 1952.

[14] Johnson, W. E., et al. (assigned to Great Lakes Carbon Corp.), Method for Expanding Perlitic Minerals: U. S. Patent 2,621,160, Dec. 9, 1952.

Other patents were granted on a vertical stationary furnace,[15] and a horizontal stationary unit in which the expanded material is separated from the gases by a system of baffles and carried out of the kiln by a conveyor.[16]

Three perlite products were patented. A concrete aggregate composed of a mixture of perlite and finely ground diatomaceous earth is claimed to reduce the stratification of aggregate and cement that often occurs in a regular perlite-cement mix, to impart to the concrete a marked higher strength, and to show other desirable characteristics.[17] Another patent covered the composition and method of manufacture of a building material composed of expanded perlite, waterglass (sodium silicate), and calcium borate. The material is said to be suitable for use in building and insulating blocks, boards, roof decking and sheets, and in reinforced structural slabs and panels.[18] A third product patent described the manufacture of an insulating pipe-covering material composed of expanded perlite, sodium silicate as a binder, and rock salt as a setting agent. The mixture is compression molded in the desired size and shape.[19]

The American Society for Testing Materials released tentative specifications covering the use of several aggregates, including perlite, in interior plasters.[20]

A published article described the manufacture and application in roofs and floors of precast perlite-concrete slabs. The slabs are 3 inches thick, weigh only 10 lb. per sq. ft., and are said to combine strength, light weight, and good insulating properties.[21]

The 30-story Alcoa Building, Pittsburgh, Pa., is said to be the lightest structure of its size and type ever built. Contributing to the light weight was the use of reinforced-aluminum facing panels on which a 4-inch-thick backup layer of perlite concrete was sprayed. In addition, the underside of all floor decking was fireproofed with perlite plaster on metal lath.[22]

Another article described the Alcoa Building and the Equitable Gateway Center Group of office buildings. The exterior wall panels of the Equitable group are factory-assembled units of reinforced stainless steel backed with a 4½-inch thick layer of perlite concrete.[23]

The press reported the results of fire tests made on perlite structural units and on H-columns protected with perlite-gypsum plaster. Ratings of 2 to 4 hours were assigned to the various units.[24]

[15] Stecker, G. (assigned to Great Lakes Carbon Corp.), Apparatus for Expanding Minerals: U. S. Patent 2,621,034, Dec. 9, 1952.

[16] Slavick, J. V. (partial interest assigned to H. D. White), Apparatus for Heat-Treating Mineral Material: U. S. Patent 2,612,263, Sept. 30, 1952.

[17] Bollaert, A. R., et al. (assigned to Great Lakes Carbon Corp.), Lightweight Concrete Mixture: U. S. Patent 2,585,366, Feb. 12, 1952.

[18] Bowen, O. G., et al. (secondary interest assigned to Bowen), Building Material and Process of Making Same: U. S. Patent 2,583,292, Jan. 22, 1952.

[19] Thomas, H. K., Insulating-Pipe Covering Composition: U. S. Patent 2,600,812, June 17, 1952.

[20] American Society for Testing Materials, Tentative Specifications for Inorganic Aggregates for Use in Interior Plastering: Spec. C 35-52T, 1952, 3 pp.

[21] Concrete, Precast Roof Slabs Using Perlite Aggregate: Vol. 60, No. 1, January 1952, pp. 12–13, 38.

[22] Engineering News-Record, Skyscraper Sheathed in Aluminum: Vol. 148, No. 14, Apr. 3, 1952, pp. 67–71.

[23] Business Week, Skyscrapers Clad in Metal Coats: No. 1178, Mar. 29, 1952, pp. 72–74, 77.

[24] Business Week, Perlite Passes Fiery Tests: No. 1176, Mar. 15, 1952, pp. 104, 106; Rock Products, Perlite Fire Tests: Vol. 55, No. 10, October 1952, p. 89; Engineering News-Record, Lightweight Fireproofing for Steel Framing: Vol. 149, No. 19, Nov. 6, 1952, pp. 34–36, 39; Pit and Quarry, Laboratory Test Establishes Fire Resistance of Perlite: Vol. 44, No. 12, June 1952, p. 74; Pit and Quarry, Perlite-Covered Columns Pass Fire Test at Chicago: Vol. 45, No. 4, October 1952, p. 160.

Tests made at the Tokyo, Japan, Institute of Technology show that treating powdered perlite in an autoclave produces a sericite-like product that is richer in silica and poorer in alumina than the original raw material.[25]

The comminution of crude perlite, which is highly abrasive, is said to be accomplished with efficiency in the impact crusher, or hammer-mill type of attrition crusher. It is claimed that a minimum of fines is produced by impact crushing.[26]

[25] Raisaku, K., and Ito, Y., Studies on Hydrothermal Reactions of Silicates, I: Jour. Ceramic Assn. Japan, vol. 60, 1952, pp. 53–56; abs. in Chem. Abs., vol. 46, No. 12, June 25, 1952, col. 5793, item i.

[26] West, W. W., Impact Crushing for Reduction of Hard-Abrasive Ores: Min. Eng., vol. 4, No. 6, June 1952, pp. 563–564.

Phosphate Rock

By E. Robert Ruhlman [1] and Gertrude E. Tucker [2]

THE OUTPUT of marketable phosphate rock set a new record in 1952, with over 12 million long tons produced, according to reports by producers. Mine production of phosphate rock ore was estimated as 32.8 million long tons. Florida, Tennessee, and the Western States all increased marketable production. The quantity

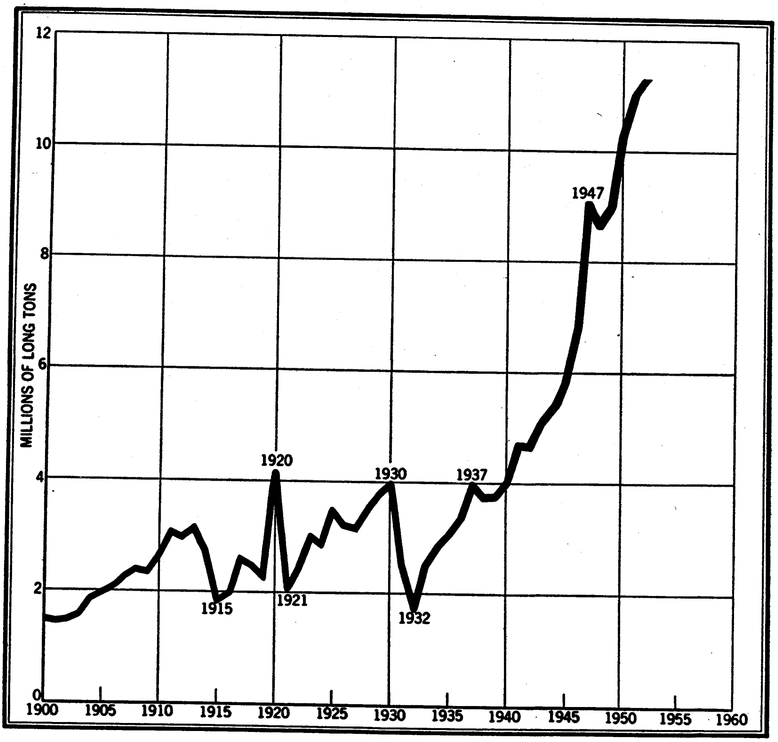

FIGURE 1.—Marketed production of domestic phosphate rock, 1900–52.

sold or used by producers was greater in Florida and Tennessee but less in the Western States in 1952. Stocks in producers' hands at the year end were 30 percent more than at the same time in 1951. The world production of phosphate rock was approximately 25 million metric tons.

---

[1] Commodity-industry analyst.
[2] Statistical assistant.

TABLE 1.—Salient statistics of the phosphate-rock industry in the United States, 1951–52

	1951				1952			
	Long tons		Value at mines		Long tons		Value at mines	
	Rock	P_2O_5 content	Total	Average	Rock	P_2O_5 content	Total	Average
Production [1]	10,775,032	3,458,265	(2)	(2)	12,031,213	3,859,556	(2)	(2)
Sold or used by producers:								
Florida:								
Land pebble	8,329,033	2,800,135	$49,185,072	$5.91	8,624,186	2,901,008	$50,483,421	$5.85
Soft rock	92,183	18,694	495,243	5.37	75,853	15,358	433,203	5.71
Hard rock	75,615	26,647	582,247	7.70	81,086	28,575	625,175	7.71
Total Florida	8,496,831	2,845,476	50,262,562	5.92	8,781,125	2,944,941	51,541,799	5.87
Tennessee	1,419,892	391,518	10,604,638	7.47	1,452,508	386,039	10,874,760	7.49
Western States:								
Idaho [3]	695,026	184,790	1,750,974	2.52	620,551	172,532	2,163,608	3.49
Montana	304,507	90,808	2,353,381	7.73	332,299	95,793	2,620,764	7.89
Wyoming	178,948	57,059	1,186,523	6.63	137,675	44,114	919,987	6.68
Total Western States	1,178,481	332,657	5,290,878	4.49	1,090,525	312,439	5,704,359	5.23
Total United States	11,095,204	3,569,651	66,158,078	5.96	11,324,158	3,643,419	68,120,918	6.02
Imports	[4] 93,417	(2)	[4, 5] 1,437,936	[4, 5] 15.39	110,371	(2)	[5] 2,357,569	[5] 21.36
Exports [6]	1,677,076	(2)	10,873,460	6.48	1,401,949	(2)	8,878,393	6.33
Apparent consumption [7]	[4] 9,511,545	(2)			10,032,580	(2)		
Stocks in producers' hands Dec. 31: [6]								
Florida	1,033,000	342,000	(2)	(2)	1,422,000	470,000	(2)	(2)
Tennessee	[4] 631,000	[4] 174,000	(2)	(2)	[8] 558,000	[8] 148,000	(2)	(2)
Western States	[4] 270,000	[4] 71,000	(2)	(2)	535,000	142,000	(2)	(2)
Total stocks	[4] 1,934,000	[4] 587,000	(2)	(2)	2,515,000	760,000	(2)	(2)

1 See table 2 for kind of material produced.
2 Data not available.
3 Includes a small quantity from Utah.
4 Revised figure.
5 Market value (price) at port of shipment and time of exportation to the United States.
6 As reported to the Bureau of Mines by domestic producers.
7 Quantity sold or used by producers plus imports minus exports.
8 Includes a small quantity of washer-grade ore (matrix).

DOMESTIC PRODUCTION

Marketable phosphate rock produced in the United States in 1952 reached a record high of over 12 million long tons. In previous years, this output was recorded as mine production, whereas actually it was a composite of salable products from washers and concentrators of Florida hard rock, Florida land pebble, and Tennessee brown rock; drier production of Florida soft rock; and mine production of Western States phosphate rock, plus tonnages of Florida land pebble and Tennessee brown rock ore (matrix) used directly. The actual mine production of phosphate-rock ore (total tons of material mined) in 1952 in the United States was estimated as 32.8 million long tons.

Florida continued to be the area of largest production, followed by Tennessee and the Western States. In addition to company activity, the Tennessee Valley Authority carried on exploration in the phosphate areas of Florida and acquired title to nearly 600 acres of land-pebble deposits.[3] Numerous expansion programs were in various stages of

3 Federal Register, Executive Order 10278: Vol. 16, No. 156, Aug. 11, 1951, p. 7917.

TABLE 2.—Phosphate rock produced in the United States, 1943–47 (average), and 1948–52, by States, in long tons

Year	Florida [1]	Tennessee [2]	Western States [3]	United States
1943–47 (average)	4,447,473	1,469,718	532,716	6,449,907
1948	7,184,297	1,499,547	704,316	9,388,160
1949	6,695,407	1,403,469	778,598	8,877,474
1950	8,597,227	1,472,017	1,044,915	11,114,159
1951	8,211,820	1,424,516	1,138,696	10,775,032
1952	9,205,138	1,444,737	1,381,338	12,031,213

[1] Salable products from washers and concentrators of land pebble and hard rock, plus a small tonnage of land pebble ore (matrix) used directly and drier production of soft rock (collodial clay).
[2] Salable products from washers and concentrators of brown rock, brown-rock ore (matrix) used directly, blue rock in 1945–46, and a small quantity of apatite from Virginia in 1943–47.
[3] Mine production of ore (rock).

completion at the close of 1952.[4] In addition to increasing the production of phosphate rock, elemental phosphorus, and phosphate chemicals, more emphasis was placed on the recovery of byproducts, such as alumina, fluorine, vanadium, and uranium.[5]

CONSUMPTION AND USES

The apparent consumption of phosphate rock increased 5 percent in 1952 compared to 1951. Data on phosphate rock sold or used by producers are shown in tables 4 through 9. Production, shipments, and stocks of superphosphates are shown in table 10.

TABLE 3.—Apparent consumption [1] of phosphate rock in the United States, 1943–47 (average), and 1948–52, in long tons

Year	Long tons	Year	Long tons
1943–47 (average)	5,796,322	1950	8,580,925
1948	7,700,081	1951	[2] 9,511,545
1949	7,735,005	1952	10,032,580

[1] Quantity sold or used by producers plus imports minus exports.
[2] Revised figure.

TABLE 4.—Phosphate rock sold or used by producers in the United States, 1943–47 (average), and 1948–52

Year	Long tons	Value at mines		Year	Long tons	Value at mines	
		Total	Average			Total	Average
1943–47 (average)	6,439,468	$28,290,437	$4.39	1950	10,253,552	$59,027,848	$5.76
1948	8,668,769	50,501,598	5.83	1951	11,095,204	66,158,078	5.96
1949	8,986,933	51,415,027	5.72	1952	11,324,158	68,120,918	6.02

[4] Chemical and Engineering News, vol. 30, No. 39, Sept. 29, 1952, p. 4009; No. 43, Oct. 20, 1952, p. 4467.
Chemical Engineering, vol. 59, No. 6, June 1952, p. 285; No. 8, August 1952, pp. 235 and 306; No. 10, October 1952, pp. 362–365.
Mining Engineering, vol. 4, No. 4, April 1952, p. 354.
Mining World, vol. 14, No. 2, February 1952, p. 82; No. 9, August 1952, pp. 92–93; No. 10, September 1952, p. 107.
Oil, Paint and Drug Reporter, vol. 162, No. 11, Sept. 15, 1952, pp. 4 and 86; No. 13, Sept. 29, 1952, p. 4.
Pit and Quarry, vol. 44, No. 12, June 1952, p. 75; Vol. 45, No. 3, September 1952, p. 78.
Rock Products, vol. 55, No. 10, October 1952, pp. 79 and 160.
[5] Chemical and Engineering News, vol. 30, No. 24, June 16, 1952, p. 2552.
Chemical Engineering, vol. 59, No. 9, September 1952, pp. 104–108.
Commercial Fertilizer, vol. 84, No. 2, February 1952, p. 40.
Oil, Paint and Drug Reporter, vol. 162, No. 11, Sept. 15, 1952, p. 3.
Rock Products, vol. 55, No. 10, October 1952, pp. 77 and 101; No. 12, December 1952, p. 79.

TABLE 5.—Florida phosphate rock sold or used by producers, 1943–47 (average) and 1948–52, by kinds

Year	Hard rock			Soft rock [1]		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1943–47 (average)	60,066	$429,342	$7.15	77,732	$304,345	$3.92
1948	48,198	368,586	7.65	69,335	293,927	4.24
1949	23,804	173,211	7.28	77,088	344,787	4.47
1950	71,319	538,601	7.55	81,542	408,595	5.01
1951	75,615	582,247	7.70	92,183	495,243	5.37
1952	81,086	625,175	7.71	75,853	433,203	5.71

Year	Land pebble			Total		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1943–47 (average)	4,475,613	$18,438,378	$4.12	4,613,411	$19,172,065	$4.16
1948	6,421,725	37,070,381	5.77	6,539,258	37,732,894	5.77
1949	6,715,097	37,339,985	5.56	6,815,989	37,857,983	5.55
1950	7,933,009	44,430,646	5.60	8,085,870	45,377,842	5.61
1951	8,329,033	49,185,072	5.91	8,496,831	50,262,562	5.92
1952	8,624,186	50,483,421	5.85	8,781,125	51,541,799	5.87

[1] Includes material from waste-pond operations.

TABLE 6.—Tennessee phosphate rock [1] sold or used by producers, 1943–47 (average) and 1948–52

Year	Long tons	Value at mines		Year	Long tons	Value at mines	
		Total	Average			Total	Average
1943–47 (average)	1,340,537	$6,530,772	$4.87	1950	1,384,473	$10,028,404	$7.24
1948	1,307,507	8,231,251	6.30	1951	1,419,892	10,604,638	7.47
1949	1,344,470	9,067,589	6.74	1952	1,452,508	10,874,760	7.49

[1] Includes small quantity of Tennessee blue rock in 1943–47 and Virginia apatite in 1943–47 and 1949.

TABLE 7.—Western States phosphate rock sold or used by producers, 1943–47 (average), and 1948–52

Year	Idaho [1]			Montana		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1943–47 (average)	300,505	$1,540,529	$5.13	174,646	$988,974	$5.66
1948	434,375	2,122,089	4.89	248,683	1,720,254	6.92
1949	471,305	1,915,125	4.06	355,169	2,574,330	7.25
1950	573,044	2,125,065	3.71	210,165	1,496,537	7.12
1951	695,026	1,750,974	2.52	304,507	2,353,381	7.73
1952	620,551	2,163,608	3.49	332,299	2,620,764	7.89

For footnotes, see end of table.

TABLE 7.—Western States phosphate rock sold or used by producers, 1943–47 (average), and 1948–52—Continued

Year	Wyoming			Total		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1943–47 (average)[2]	10,369	$58,097	$5.60	485,520	$2,587,600	$5.33
1948	138,946	695,110	5.00	822,004	4,537,453	5.52
1949	([1])	([1])	([1])	826,474	4,489,455	5.43
1950	([1])	([1])	([1])	783,209	3,621,602	4.62
1951	178,948	1,186,523	6.63	1,178,481	5,290,878	4.49
1952	137,675	919,987	6.68	1,090,525	5,704,359	5.23

[1] Idaho includes Utah in 1946–48. 1950-52, and Wyoming in 1949–50.
[2] Includes Wyoming data for 1947 only.

TABLE 8.—Phosphate rock sold or used by producers in the United States, 1951–52, by grades and States

Grades—B. P. L.[1] content (percent)	Florida		Tennessee		Western States		Total United States	
	Long tons	Percent of total	Long tons	Percent of total	Long tons	Percent of total	Long tons	Percent of total
1951								
Below 60	227,183	3	[2] 832,750	[2] 59	516,209	44	[2] 1,576,142	[2] 14
60 to 66			[2] 291,094	[2] 20	69,263	6	[2] 360,357	[2] 3
68 basis, 66 minimum	759,161	9	193,468	14	235,981	20	1,188,610	11
70 minimum	763,631	9	101,605	7	258,100	22	1,123,336	10
72 minimum	1,297,467	15			98,928	8	1,396,395	13
75 basis, 74 minimum	3,616,625	42	975	([3])			3,617,600	33
77 basis, 76 minimum	1,832,764	22					1,832,764	16
Total	8,496,831	100	1,419,892	100	1,178,481	100	11,095,204	100
1952								
Below 60	189,761	2	1,058,848	73	450,738	41	1,699,347	15
60 to 66	336	([3])	228,150	16	77,917	7	306,403	3
68 basis, 66 minimum	685,928	8	83,283	6	191,525	18	960,736	9
70 minimum	928,174	11	81,640	5	370,345	34	1,380,159	12
72 minimum	1,521,811	17					1,521,811	13
75 basis, 74 minimum	4,157,456	47	587	([3])			4,158,043	37
77 basis, 76 minimum	1,297,659	15					1,297,659	11
Total	8,781,125	100	1,452,508	100	1,090,525	100	11,324,158	100

[1] Bone phosphate of lime, $Ca_3(PO_4)_2$.
[2] Revised figure.
[3] Less than 0.5 percent.

TABLE 9.—Phosphate rock sold or used by producers in the United States, 1951–52, by uses and States

Uses	Florida		Tennessee		Western States		Total United States	
	Long tons	Percent of total	Long tons	Percent of total	Long tons	Percent of total	Long tons	Percent of total
1951								
Domestic:								
Superphosphates	5,493,396	65	322,607	23	294,510	25	6,110,513	55
Phosphates, phosphoric acid, phosphorus, ferrophosphorus	739,414	9	867,165	61	564,235	48	2,170,814	20
Direct application to soil	710,710	8	210,780	15	72,394	6	993,884	9
Fertilizer filler	392	(1)	16,454	1			16,846	(1)
Stock and poultry feed	120,493	1	1,663	(1)			122,156	1
Undistributed [2]			1,223	(1)	2,692	(1)	3,915	(1)
Exports [3]	1,432,426	17			244,650	21	1,677,076	15
Total	8,496,831	100	1,419,892	100	1,178,481	100	11,095,204	100
1952								
Domestic:								
Superphosphates	5,953,922	68	249,902	17	291,097	27	6,494,921	57
Phosphates, phosphoric acid, phosphorus, ferrophosphorus	620,127	7	925,941	64	478,138	44	2,024,206	18
Direct application to soil	866,329	10	237,786	16	101,878	9	1,205,993	11
Fertilizer filler	363	(1)	15,374	1			15,737	(1)
Stock and poultry feed	157,286	2	21,680	2	220	(1)	179,186	2
Undistributed [2]	341	(1)	1,825	(1)			2,166	(1)
Exports [3]	1,182,757	13			219,192	20	1,401,949	12
Total	8,781,125	100	1,452,508	100	1,090,525	100	11,324,158	100

[1] Less than 0.5 percent.
[2] Includes phosphate rock used in pig-iron blast furnaces, parting compounds, research, defluorinated phosphate rock, refractories, and other uses.
[3] As reported to the Bureau of Mines by domestic producers.

TABLE 10.—Production, shipments, and stocks of superphosphates, 1943–47 (average) and 1948–52, in short tons

[Bureau of the Census]

	1943–47 (average)	1948	1949	1950	1951	1952
Ordinary superphosphates: [1]						
Production	7,499,881	9,319,697	9,075,903	9,296,051	[2] 9,493,472	9,805,555
Shipments	4,278,736	4,789,668	4,845,175	5,065,101	[2] 4,910,273	4,860,254
Stocks in manufacturers' hands Dec. 31	779,155	1,216,788	1,139,372	[2] 1,056,234	[2] 1,090,830	1,276,267
Concentrated superphosphates: [3]						
Production	306,434	468,711	548,504	686,855	716,488	862,345
Shipments	300,723	443,951	496,975	718,925	696,274	833,583
Stocks in manufacturers' hands Dec. 31	45,494	70,681	104,310	55,252	66,356	87,110

[1] 18 percent available phosphoric acid.
[2] Revised figure.
[3] 45 percent available phosphoric acid.

PRICES

Price quotations for Florida land pebble and Tennessee brown-rock phosphate remained unchanged during 1952. The price quotations of the Oil, Paint and Drug Reporter of January 7 and December 29, 1952, are given in table 11. Prices for Western States phosphate rock are not quoted in the trade journals. Price quotations of elemental phosphorus and some phosphate compounds are published in the Oil, Paint and Drug Reporter.

TABLE 11.—Prices per long ton of Florida and Tennessee unground, washed, and dried phosphate rock, in bulk, f. o. b. cars at mine, in 1952, by grades

[Oil, Paint and Drug Reporter

Grades (percent) [1]	Florida land pebble		Tennessee brown rock	
	Jan. 7, 1952	Dec. 29, 1952	Jan. 7, 1952	Dec. 29, 1952
70/68 B. P. L	$4.35–4.40	$4.35–4.40		
72/70 B. P. L	5.00	5.00		
75/74 B. P. L	6.00	6.00		
77/76 B. P. L	7.00	7.00		
27–26 P_2O_5			$6.45	$6.45
30–29 P_2O_5			7.21	7.21

[1] B. P. L. signifies bone phosphate of lime, $Ca_3(PO_4)_2$.

FOREIGN TRADE [6]

Data on imports and exports of phosphate rock and phosphatic materials are given in tables 12 through 15.

Sales or shipments of phosphate rock for export, as reported by domestic producers to the Bureau of Mines, are given in the section on Consumption and Uses.

Imports.—Crude phosphate rock imported into the United States increased 18 percent in 1952 compared to 1951, with over 86 percent coming from the Netherland Antilles (Curaçao). Imports of superphosphates were 215 percent of the 1951 figure, coming predominantly from Canada, with lesser quantities from The Netherlands and the United Kingdom. Fertilizer-grade ammonium phosphate imports in 1952 were less than in 1951, with 99 percent originating in Canada. Other phosphatic fertilizer materials imported came from several European and South American countries and Egypt. The imports from Canada were largely fertilizers processed from United States phosphate rock.

TABLE 12.—Phosphate rock and phosphatic fertilizers imported for consumption in the United States, 1951–52

U. S. Department of Commerce

Fertilizer	1951		1952	
	Long tons	Value	Long tons	Value
Phosphates, crude, not elsewhere specified	[1] 93,417	[1] $1,437,936	110,371	$2,357,569
Superphosphates (acid phosphate):				
Normal (standard), not over 25 percent P_2O_5 content	2,455	73,535	5,826	187,684
Concentrated (treble), over 25 percent P_2O_5 content	160	10,739	2,387	150,351
Ammoniated			12	445
Total superphosphates	2,615	84,274	8,225	338,480
Ammonium phosphates, used as fertilizer	120,502	8,450,659	119,032	8,722,516
Bone dust, or animal carbon and bone ash, fit only for fertilizer	43,455	2,654,660	42,127	2,673,007
Guano	137	10,568	58	5,641
Slag, basic, ground or unground	96	2,757		
Precipitated bone, fertilizer-grade	[1] 13,197	[1] 1,159,667	21,096	1,787,881

[1] Revised figure.

[6] Figures on imports and exports (unless otherwise indicated) compiled by Mae B. Price and Elsie D. Page of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 13.—Phosphate rock exported from the United States, 1951–52, by grades and countries of destination

[U. S. Department of Commerce]

Grade and country	1951		1952	
	Long tons	Value	Long tons	Value
Florida:				
High-grade hard rock:				
Brazil			984	$14,000
Canada	2,467	$29,340	529	7,468
Mexico	26	585		
Surinam			4	106
Sweden	1,498	14,231		
Taiwan (Formosa)	10,005	87,644	11,745	108,630
Total high-grade hard rock	13,996	131,800	13,262	130,204
Land pebble:				
Argentina	4,428	42,066		
Belgium-Luxembourg	33,665	290,693	21,780	184,401
Brazil	20,862	189,955	7,038	74,067
Canada	174,377	1,271,593	173,778	1,576,820
Colombia	1,213	17,294	500	7,520
Costa Rica	178	2,400		
Cuba	18,347	143,203	16,562	112,122
El Salvador	400	5,700	1,200	6,152
Germany	34,081	276,881	[1] 152,956	[1] 1,174,077
Guatemala	100	1,425		
Italy	75,914	704,381	84,904	819,012
Japan	[2] 640,224	[2] 4,575,544	433,747	3,029,647
Liberia	3	165		
Mexico	9,022	54,847	35,401	229,179
Netherlands	179,010	1,567,211	42,294	340,828
Philippines	45	580		
Sweden	47,774	433,455	49,041	465,726
Switzerland	4,937	41,470		
Taiwan (Formosa)	29,489	258,321	41,769	365,286
Thailand			89	1,205
Union of South Africa	10,106	96,005	8,306	78,907
United Kingdom	[2] 154,387	[2] 1,237,135	109,560	887,948
Uruguay	3,468	32,946		
Venezuela	580	18,850	446	9,788
Total land pebble	[2] 1,442,610	[2] 11,262,120	1,179,371	9,362,685
Other phosphate rock: [3]				
Canada	266,506	3,293,108	228,878	2,836,200
Cuba	50	825	204	3,688
El Salvador			1,072	14,112
Italy			45	835
Japan	2,044	26,572		
Mexico	1,628	20,432	53	865
Union of South Africa			6,399	76,836
Total other phosphate rock	270,228	3,340,937	236,651	2,932,536
Grand total	[2] 1,726,834	[2] 14,734,857	1,429,284	12,425,425

[1] West Germany.
[2] Revised figure.
[3] Includes colloidal matrix; sintered matrix; soft phosphate rock; and Tennessee, Idaho, and Montana rock.

TABLE 14.—"Other phosphate material"[1] exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Long tons	Value	Year	Long tons	Value
1948	1,002	$188,163	1951	2,316	$372,685
1949	3,225	224,375	1952	1,037	180,765
1950	1,350	247,880			

[1] Class includes animal carbon, apatite, basic slag, bone ash dust, bone meal, char dust, defluorinated phosphate rock, duplex basic phosphate, permanente thermosphos (granular), tricalcium phosphate (fused).

TABLE 15.—Superphosphates (acid phosphates) exported from the United States, 1951–52, by countries of destination

[U. S. Department of Commerce]

Country	1951		1952	
	Long tons	Value	Long tons	Value
Brazil	24,061	$760,754	12,693	$478,517
Canada	169,185	3,349,733	168,240	3,827,072
Chile	44	4,459	15	1,489
Colombia	491	17,605	268	9,895
Costa Rica	2,157	106,549	809	46,800
Dominican Republic	934	66,979	2,073	98,692
Ecuador	272	10,996	750	39,440
El Salvador	1,630	36,089	89	3,155
Guatemala	94	3,932	45	1,575
Iceland	570	43,065		
Indochina	984	23,373		
Italy			89	7,470
Korea, Republic of			32,712	998,944
Mexico	686	58,280	1,548	106,926
Peru	113	11,380	272	12,407
Philippines	1,027	29,920		
Saudi Arabia	30	2,234	125	9,693
Taiwan (Formosa)	2,069	94,997		
Thailand			893	28,530
Venezuela	854	32,850	234	13,871
West Indies:				
British	27	1,907		
Cuba	61,333	1,187,253	38,200	800,716
Haiti	5	575	8	817
Other countries	123	4,708	28	1,680
Total	266,689	5,847,638	259,091	6,487,689

Exports.—Exports of all grades of phosphate rock were 17 percent less in 1952 than in 1951. Taiwan received nearly all the Florida hard-rock exports. Florida land-pebble exports mainly went to Japan (37 percent), Canada (15 percent), Germany (13 percent), and the United Kingdom (9 percent). The exports of phosphate rock from Montana to Canada largely represented material shipped for processing, which was returned to the United States for use. Superphosphate exports from the United States were less in 1952 than in 1951. The major recipients were Canada, Cuba, South Korea, and Brazil.

TECHNOLOGY

Phosphate mining in Florida was described at the United Nations Scientific Conference on the Conservation and Utilization of Resources, as one of the highest mechanized types of mining.[7] The output per man-day varied from 205 to 372 tons of matrix and 1,000 to 2,000 tons of overburden. Another subject discussed at the United Nations Conference was utilization of low-grade ores. It was brought out that much of the progress made towards the solution of this problem was by interchange of technical information.[8]

Open-pit mining of the Simplot Fertilizer Co. on the Fort Hall Indian Reservation was begun in 1946. The main high-grade bed of 32–34 percent P_2O_5, 6 feet thick, is overlain by a 21-foot-thick bed of lower grade phosphate rock, averaging 24 percent P_2O_5, which was

[7] Barr, J. A., and Ware, T. M., Mechanization of Nonmetallic Mines: Proc. United Nations Sci. Conf. on Conservation and Utilization of Resources, United Nations Dept. of Ec. Affairs, vol. 2, 1951, pp. 128–137.

[8] Diamond, R. W., Swanson, C. O., and Sutherland, B. P., New Processes for the Utilization of Low-Grade Ores: Proc. United Nations Sci. Conf. on Conservation and Utilization of Resources, United Nations Dept. of Ec. Affairs, vol. 2, 1951, pp. 140–145.

sold for elemental phosphorus manufacture. The four steps in mining the phosphate rock are: Topsoil stripping, waste-shale stripping, furnace-grade rock mining, and acid-grade rock mining. The operations all are mechanized. Tractors, power shovels, and dump trucks are used to strip overburden and mine the phosphate beds.[9]

In attempting to develop definite requirements for the construction of pipelines to transport solids, the experience at the Noralyn mine in the Florida land-pebble field was discussed. It was found that when the pulp contained more than 10 percent of solids (plus-14-mesh material) additional pumps were required to prevent settling. Varying conditions were tried, and the results were tabulated in the article.[10]

The Noralyn plant of International Minerals & Chemical Corp. near Bartow, Fla., produced 2 grades of phosphate—75 and 77 percent bone phosphate of lime (B. P. L.). The planned capacity of this plant was 1.5 million tons of pebble phosphate per year. About 12 acres were mined per month—nearly 10 million cubic yards of overburden and matrix annually.[11]

A new type of storage system to handle washed phosphate was installed by the American Cynamid Co. at its Brewster, Fla., drying plant. This system, including a rotary stacker conveyor and underground conveyor belts, increased the storage capacity and permitted more precise blending of the various grades of washed phosphate rock.[12]

The development and growth of the phosphorus industry in the United States was described by Aall.[13] The first elemental phosphorus produced in the United States was at Niagara Falls, N. Y., by the Oldbury Electro-Chemical Co. in 1896. The annual capacity of the domestic industry at the beginning of 1952 was about 317 million pounds. The increased demand for phosphorus is shown in table 16.

The expanding elemental phosphorus industry in the Western States helped supply the chemical requirements for phosphorus compounds. The largest single use was for production of tetrasodium pyrophosphate used to manufacture washing detergents. A large part of the elemental phosphorus produced at Pocatello was used in this compound, commonly referred to as T. S. P. P.[14]

TABLE 16.—Production of elemental phosphorus in the United States, selected years, 1930–50, in millions of pounds (including TVA) [1]

Year:	*Millions of pounds*	Year:	*Million of pounds*
1930	21	1947	185
1935	43	1948	224
1940	97	1949	276
1945	160	1950	307
1946	167		

[1] Source: Aall, C. H., The American Phosphorus Industry: Ind. Eng. Chem., vol. 44, No. 7, July 1952, pp. 1520–1525.

[9] Sweetwood, C. W., Western Phosphate Mining: Min. Eng., vol. 4, No. 9, September 1952, pp. 863–865.
[10] Tillotson, I. S., Burt, R. B., and Barr, J. A., Pipeline Transportation of Phosphate: Min. Eng., vol. 4, No. 3, March 1952, pp. 273–282.
[11] Avery, W. M., Noralyn Revisited: Pit and Quarry, vol. 45, No. 4, October 1952, pp. 84–88, 95.
[12] Manufacturers Record, New-Type Storage System for Phosphate: Vol. 121, No. 3, March 1952, p. 33. Mining World, New Phosphate Storage Facilities: Vol. 14, No. 4, April 1952, p. 85.
[13] Aall, C. H., The American Phosphorus Industry: Ind. Eng. Chem., vol. 44, No. 7, July 1952, pp. 1520–1525.
[14] Miller, J. G., Idaho Phosphorus and its Ultimate Usage: Mines Mag., vol. 42, No. 8, August 1952, pp. 25–27, 47.

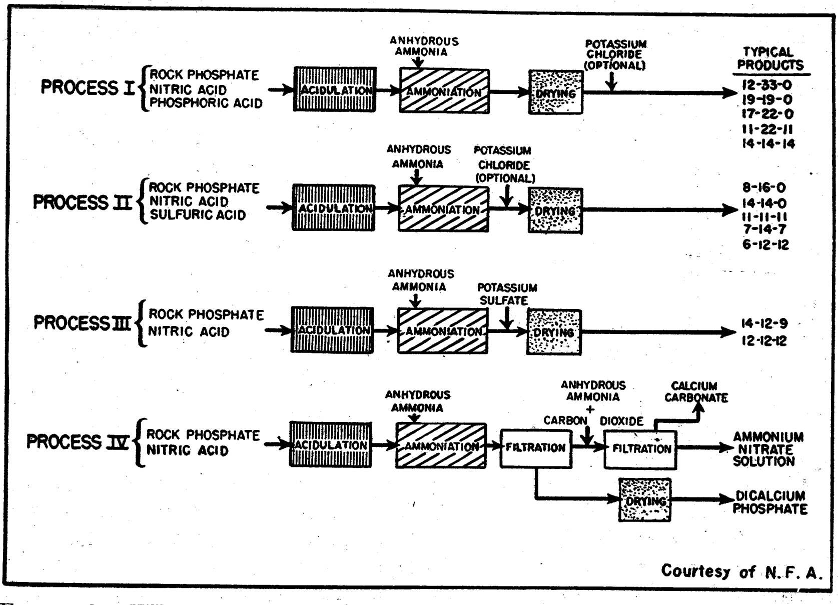

FIGURE 2.—TVA processes for production of fertilizers from rock phosphates, nitric acid and ammonia.

In attempting to develop more rapid methods of curing superphosphates, studies were conducted under varying conditions. It was found that using 40–60 percent sulfuric acid, drying with air, and keeping the temperature below 275° F. yielded the best product.[15] Other studies were made on the effect of iron and aluminum on superphosphate. It was found that when the combined content of the oxides (R_2O_3) of these two elements was over 5 percent R_2O_3, the solubility of the phosphorus decreased with age.[16]

The past shortage of sulfur and the possibility of it being in short supply in the future prompted industry to investigate methods of making phosphatic fertilizers that minimize the use of sulfuric acid. Data pertaining to production, handling, and use of elemental phosphorus and phosphoric acid were published to demonstrate the feasibility of utilizing them in the fertilizer industry.[17] Although acidulation of phosphate rock with nitric acid is not a new development, having been used for 20 years or more in Europe, processes using nitric acid received considerable attention from industry and research groups in the United States during 1952. After studying the various European processes, the Tennessee Valley Authority selected four of the most promising for further study and pilot-plant investigation. The main steps in these processes are shown in figure 2. Results of these studies were published by the National Fertilizer Association.[18] Two plants using modifications of these

[15] Bridger, G. L., and Kapusta, E. C., Quick Curing of Superphosphate: Ind. Eng. Chem., vol. 44, No. 7, July 1952, pp. 1540–1546.
[16] Marshall, H. L., and Hill, W. L., Composition and Properties of Superphosphate: Ind. Eng. Chem., vol. 44, No. 7, July 1952, pp. 1537–1539.
[17] Hill, W. L., Elemental Phosphorus and Phosphoric Acid in Fertilizer Industry: Ind. Eng. Chem., vol. 44, No. 7, July 1952, pp. 1526–1532.
[18] The National Fertilizer Association, Process Progress; Vol. 1, Nos. 1-11, February–December, 1952.

processes were planned, one at Sheffield, Ala., by Associated Cooperative, Inc., and the other at South Point, Ohio, by Allied Chemical & Dye Corp. Both plants will produce complete high-analysis fertilizers.

Acidulation with a mixture of sulfuric and phosphoric acids also received renewed interest. Discussion of the possibilities of this method under current conditions and the technologic problems involved was published.[19]

The growing chemical use of phosphorus was pointed out at the symposium on phosphorus chemistry during the national meeting of the American Chemical Society at Buffalo. It was stated that phosphorus compounds may become as important to industry as the silicones. Important uses included the manufacture of agricultural chemicals and the fireproofing of fabrics.[20]

TVA, which has been building and operating electric furnaces to produce elemental phosphorus, issued a bulletin on the design of electric furnaces.[21]

The technologic advances in the phosphate industry were discussed in a book published during 1952.[22]

The confusing names of the many phosphorus compounds instigated the American Chemical Society, working in cooperation with the (London) Chemical Society, to propose standard names for the 300 phosphorus compounds.[23]

The efficiency of protective phosphate coatings on steel and the means of testing this efficiency and their resistance to corrosion were the subjects of a meeting in London, where numerous papers were presented and discussed.[24]

The use of phosphate compounds as bonding agents in refractories continued to be investigated. Monoaluminum and monomagnesium phosphate were used and a series of mortars were tested for various properties.[25]

RESERVES

According to the report of President's Materials Policy Commission, domestic reserves represent a supply for more than 1,300 years at the present rate of consumption. Reserves in deposits minable under present conditions total 2.4 billion tons in Florida, 1.5 billion tons in the Western States, and 0.1 billion ton in Tennessee. Good-grade phosphate rock not minable under present conditions represents a potential reserve of more than 8 billion tons, of which 6.5 billion tons occurs in the Western States.[26]

---

[19] Fox, E. J., and Hill, W. L., Superphosphate Acidulation With Mixtures of Sulfuric and Phosphoric Acids: Ind. Eng. Chem., vol. 44, No. 7, July 1952, pp. 1532–1536.

[20] Chemical and Engineering News, Phosphorus Provides New Family of Compounds for Industry: Vol. 30, No. 14, Apr. 7, 1952, p. 1386.

[21] Curtis, H. A., The Design of a Phosphate Smelting Electric Furnace: TVA Chem. Eng. Bull. 1, October 1952, 63 pp.

[22] Waggaman, W. H., Phosphoric Acid, Phosphates and Phosphatic Fertilizers: Reinhold Publishing Co., Am. Chem. Soc. Mono. 34, 1952, 683 pp.

[23] Patterson, A. M., Words About Words: Chem. Eng. News, vol. 30, No. 22, June 2, 1952, pp. 2336–2337.

[24] Chemical Age (London), The Corrosion of Steel: Vol. 67, No. 1743, Dec. 6, 1952, pp. 765–768.

[25] Kingery, W. D., Fundamental Study of Phosphate Bonding in Refractories: IV, Mortars Bonded With Monoaluminum and Monomagnesium Phosphate: Jour. Am. Ceram. Soc., vol. 35, No. 3, March 1, 1952, pp. 61–63.

[26] McKelvey, V. E., James, E. L., and Waggaman, W. H., Phosphate—A Plentiful Material, in President's Material Policy Commission, Resources for Freedom, vol. 2, The Outlook for Key Commodities: June 1952, pp. 156–157.

The important world deposits of phosphate rock including those in the United States, U. S. S. R., North Africa, and certain islands in the Pacific and Indian Oceans were described.[27]

The phosphate-rock reserves of Wyoming were described, listing the active properties in Lincoln County and the prospects in Fremont, Lincoln, Sublette, and Teton Counties.[28]

WORLD REVIEW

NORTH AMERICA

Canada.—Large quantities of phosphate rock are imported for the manufacture of phosphatic fertilizers. The Electric Reduction Sales Co., Ltd., is expanding its plant. Two 15,000 kw. furnaces were being constructed and were scheduled for completion in 1953.[29]

Netherlands Antilles (Curaçao).[30]—Except for short periods, phosphate rock has been produced in Curaçao continuously since 1875. The present company, the N. V. Mijnbouwmaatschappij Curaçao, of English and Netherland ownership, has been operating since 1913. Before 1945 Europe received the production from Curaçao for the manufacture of superphosphate. Beginning in 1945 phosphate rock was shipped to the United States for use in cattle feed. In 1952 the total production was shipped to the United States. The fluorine content is less than 0.5 percent compared to 3 to 4 percent for United States phosphate, and the phosphate rock does not require treatment before use.

The phosphate rock is mined by open-pit methods from a hill about 300 feet above sea level and is hand-sorted at the mine. The rock is lowered, in balance, to the crushing plant, crushed to minus-2½-inch, and stored for shipment. Conveyor belts load ships at the rate of 1,000 tons per 8 hours.

SOUTH AMERICA

Brazil.—Apatite continued to be produced by Quimbrasil-Seriana at Jacupiranga, near Sao Paulo. The expansion under way in 1952 was planned to triple the output. Poor transportation was said to be hindering more efficient operations.[31]

An important phosphate discovery was reported at Olinda, near Recife, Pernambuco.[32] The bed is 6 to 9 feet thick and ranges from 20 to 25 percent P_2O_5. Reserves were estimated from 30 to 100 million metric tons. Plans were under way to develop the deposit.

Venezuela.—Discovery of a large phosphate deposit was reported in the State of Falcon.[33]

---

[27] Johnson, B. L., Phosphate Rock; chap. in Van Royen, W., and Bowles, O., The Mineral Resources of the World: Prentice-Hall, Inc., 1952, pp. 141–146.
[28] Osterwald, F. W., and Osterwald, D. B., Wyoming Mineral Resources: Geol. Survey Wyoming, Bull. 45, June 1952, pp. 116–122.
[29] Canadian Chemical Processing, 50 Years of Phosphorus in Canada: Vol. 36, No. 13, December 1952, p. 11.
[30] Mining Journal (London), Phosphate Mining in Curaçao: Vol. 238, No. 6088, Apr. 25, 1952, p. 419.
[31] Mining World, vol. 14, No. 3, March 1952, p. 73; No. 9, August 1952, p. 76.
[32] Mining World, vol. 14, No. 9, August 1952, p. 76.
[33] United States Department of Commerce, Foreign Commerce Weekly: Vol. 46, No. 1, Jan. 7, 1952, p. 17.

TABLE 17.—World production of phosphate rock by countries,[1] 1948–52 in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
North America:					
Canada	----	18	117	5	----
United States	9,538,840	9,019,957	11,292,541	10,947,971	12,224,314
West Indies:					
Netherlands Antilles	58,827	92,784	104,240	107,144	106,902
South America:					
Brazil (apatite)	2,667	4,553	13,850	(3)	(3)
Chile (apatite)	59,529	49,311	13,437	37,182	(3)
Europe:					
Belgium	68,938	44,643	50,846	129,065	58,983
France	84,580	59,643	73,752	110,000	102,000
Germany, West	473	----	----	----	----
Ireland [4] [5]	----	----	29,000	25,000	(3)
Spain	23,012	23,093	24,080	22,830	23,474
Sweden (apatite)	1,441	1,604	2,044	1,033	(3)
U. S. S. R.[4]	2,336,915	2,540,125	2,540,125	2,794,000	3,000,000
Asia:					
British Borneo (guano)	427	508	653	659	707
China [4]	20,000	20,000	20,000	20,000	20,000
Christmas Island (Indian Ocean) (exports)	108,311	255,236	320,423	338,693	[4] 352,600
India (apatite)	1,132	588	3,074	423	(3)
Indonesia [4]	----	5,000	5,000	(3)	(3)
Israel	----	----	----	[6] 297	17,200
Japan	3,590	684	258	143	----
Jordan	[4] 4,000	----	----	[7] 6,591	23,800
Philippines (guano)	----	10,998	32,606	4,821	4,231
Africa:					
Algeria	670,591	648,202	684,657	776,575	702,587
Angola	(3)	(3)	1,033	943	----
Egypt	377,005	350,480	397,207	499,976	522,214
French Morocco	3,226,700	3,693,000	3,872,241	4,716,800	3,953,100
French West Africa (aluminum phosphate)	3,965	5,675	11,035	23,580	43,150
Madagascar	----	----	----	----	1,300
Seychelles Islands (exports)	21,722	14,171	10,005	4,547	11,120
Southern Rhodesia	----	67	36	----	----
South-West Africa (guano)	1,038	957	581	785	1,675
Tanganyika Territory	313	157	468	345	101
Tunisia	1,863,710	1,441,918	1,524,800	1,678,905	2,264,641
Uganda	----	----	467	2,242	5,010
Union of South Africa	39,656	56,471	51,844	81,840	96,568
Oceania:					
Angaur Island	76,713	157,049	[4] 119,000	[8] 144,843	[8] 83,905
Australia	2,170	11	1,653	8,056	[4] 4,000
Makatea Island (French Oceania)	187,344	265,082	270,300	216,400	229,723
Nauru Island (exports)	544,298	802,070	1,070,358	942,945	1,164,038
Ocean Island (exports)	126,854	265,087	251,218	256,451	249,542
Total (estimate)[1]	19,500,000	19,850,000	22,800,000	24,000,000	25,500,000

[1] In addition to countries listed, Korea and Poland may produce phosphate rock; but data of output are not available, and no estimates by the author of the chapter have been included in the total.
[2] This table incorporates a number of revisions of data published in previous Phosphate Rock chapters.
[3] Data not available; estimate by author of chapter included in total.
[4] Estimate.
[5] Year ended June 30 of year stated.
[6] Production began second half of December 1951.
[7] All production occurred during last half of the year
[8] Exports.

AFRICA

Algeria.—Production of phosphate rock declined almost 10 percent in 1952.

The exports of phosphate rock from Algeria, 1950 to 1952, are shown in table 18.

Egypt.[34]—Egypt was the fourth largest producer of phosphate rock in Africa in 1952. The important phosphate rock areas are as follows: (1) The Nile Valley, including the deposits at Hamama, Qurn, Sibaiya,

[34] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 2. August 1952, pp. 31-34.

and Mahmid; (2) the Libyan Desert, west of the Nile Valley including deposits of the Kharga and Dakhla Oasis; and (3) the Red Sea district, east of the Nile Valley, including Um Huetat, Gasus, Duivi, Hamadot, Asthana deposits, and the undeveloped area near Hamraivein. The Red Sea district was the largest producing area in 1952.

TABLE 18.—Exports of phosphate rock from Algeria, 1950–52, by country of destination, in metric tons [1]

Country	1950	1951	1952
Belgium-Luxembourg, Netherlands	100,028	67,877	39,225
Czechoslovakia	8,748	29,230	14,400
France	146,801	176,837	115,619
Germany, West	74,331	166,801	120,561
Hungary	26,355	12,390	11,900
Italy	9,015		1,000
Poland	9,275	50,000	36,250
Portugal	8,195	24,270	38,435
Spain	28,035	4,500	65,075
United Kingdom and Ireland	161,586	118,985	118,928
Yugoslavia		10,180	14,800
French overseas territories	11,220	3,900	4,800
Other	7,110	15,928	10,140
Total	590,699	680,898	591,133

[1] Source: Algerian customs.

The phosphate-rock producers in Egypt, in order of importance, were as follows: Societa Egiziana per l' Estrazione ed il Commercio dei Fosfati, Egyptian Phosphate Co., Ltd., S. A. Tracades, and the Hamata Mining Co. All of the major mining operations are underground. Reserves in Egypt were estimated to be 10 million metric tons.

About 80 percent of the phosphate rock produced in Egypt was exported. Exports from the port of Kosseir, Egypt, in 1950 and 1951 are shown in table 19. Data for 1952 are not available.

French Morocco.—Production of phosphate rock was 16 percent less in 1952 than in 1951. The hyperphosphate (finely ground phosphate rock) and superphosphate plants were being expanded. Exports of phosphate rock for 1950–52 are shown in table 20.

Tunisia.—The production of phosphate rock in Tunisia increased nearly 35 percent in 1952 compared to 1951. The major portion of the phosphate rock was exported crude, although ordinary superphosphate, concentrated superphosphate, and hyperphosphate were

TABLE 19.—Exports of phosphate rock from the port of Kosseir, Egypt, 1950–51 by country of destination, in metric tons [1]

Country	1950	1951
Belgium-Luxembourg	20,816	
Finland	10,480	15,440
Germany, West		9,130
Greece		9,330
India	30,237	
Italy	110,706	56,618
Japan	160,315	157,101
Netherlands	9,702	
Sweden	5,500	342
Union of South Africa		16,612
Yugoslavia	10,360	10,003
Total	358,116	274,576

[1] Source: Statistical Department, Egyptian Government.

produced. Phosphate processing plants were being expanded. The exports of phosphate rock from Tunisia from 1950–52 are shown in table 21.

TABLE 20.—Exports of phosphate rock from French Morocco, 1950–52, by country of destination, in metric tons [1]

Country	1950	1951	1952
Belgium-Luxembourg	292,800	288,115	201,901
Denmark	243,900	273,123	213,230
France	572,800	544,108	407,215
Germany	244,000	234,199	[2] 321,267
Italy	255,400	540,424	477,999
Netherlands	378,800	303,104	313,386
Poland	105,200	178,100	96,058
Portugal	171,800	168,095	175,256
Spain	288,900	344,546	437,881
Sweden	277,000	317,896	236,691
Union of South Africa	377,600	295,348	249,741
United Kingdom and Ireland	770,600	711,759	561,844
Other	319,600	251,386	213,588
Total	4,298,400	4,450,203	3,906,057

[1] Source: 1950–51, Office Cherifien de Controle et d'Exportation; Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 45.
[2] West Germany only.

TABLE 21.—Exports of phosphate rock [1] from Tunisia, 1950–52, by country of destination, in metric tons [2]

Country	1950	1951 [3]	1952
Belgium	14,499		69,100
Brazil	11,200		31,500
Canada	16,499		4,000
Chile	2,000		15,475
Czechoslovakia	24,570		27,700
Denmark			7,440
Finland	42,088		59,295
France	256,985		344,173
Germany	94,335		133,225
Greece	22,150		63,865
Hungary	10,930		
Indochina	6,000		16,200
Italy	148,782		408,747
Japan			10,000
Madagascar			2,000
Netherlands	37,250		70,345
New Zealand	46,005		18,034
Poland	33,005		
Portugal			26,325
Spain	83,150		170,191
Sweden	8,100		7,890
Switzerland	3,200		950
Turkey	6,150		15,558
Union of South Africa			70,708
United Kingdom and Ireland	112,589		593,347
Uruguay			1,726
Yugoslavia	530		7,750
Other			30
Total	980,017	2,240,952	[4] 2,175,574

[1] Includes hyperphosphate.
[2] Source: Bureau of Mines, Mineral Trade Notes: Vol. 32, No. 4, April 1951, p. 50; vol. 36, No. 2, February 1953, p. 56.
[3] Distribution by country not available.
[4] Corrected total.

Other African Countries.[35]—Phosphate deposits in several other African countries received attention in 1952. Deposits of apatite in Ruanda-Urundi, in the Belgian Congo, are believed to be sizable. The Government of Southern Rhodesia granted an option to African Explosives & Chemical Industries, jointly owned by I. C. I. and DeBeers, to develop the Dorowa phosphate deposits in the Sabi Valley, about 50 miles west of Umtali. The phosphate deposit at Torro, in the Mount Elgon area, Uganda, was investigated. New power facilities near Torro were under construction. In the Union of South Africa, the Ministry of Economic affairs submitted plans to Parliament for a Government-sponsored phosphate industry to produce 36,000 tons per year of phosphatic concentrates (33 percent P_2O_5) from deposits in northeastern Transvaal.

ASIA

Israel.[36]—Exploration continued on the phosphate deposits in the northern Negev area. Operations began in June 1951, and it was planned to increase production as soon as equipment arrived. The phosphate was shipped to Haifa and made into superphosphate for local consumption.

Jordan.[37]—The only developed phosphate-rock deposit in Jordan is about 15 miles northeast of Amman. Development was begun in 1936, but no production was reported until 1939. The mines are operated by the Transjordan Phosphate Mines, Ltd., with headquarters at Amman. The phosphate rock was shipped to several European countries during 1952 from the port of Beirut.

India.[38]—Production of apatite continued in 1952. The Govern ment of Madras investigated processes for producing fertilizer phos phate from the phosphatic nodules occurring in the Trichinopoly district.

Philippines.—The supply of phosphate in the Philippine Islands is limited to scattered bat guano deposits. Descriptions of many deposits and analyses for P_2O_5 content were published.[39]

OCEANIA

Nauru and Ocean Islands.[40]—The British Phosphate Commission, jointly controlled by Great Britain, Australia, and New Zealand has administered the phosphate-rock deposits on Nauru and Ocean Islands since 1920. Before that year the Pacific Island Co. had been

[35] United States Department of Commerce, Foreign Commerce Weekly: Vol. 47, No. 3, Apr. 21, 1952, p. 18; No. 12, June 23, 1952, p. 18.
Mining Journal (London), vol. 240, No. 6124, Jan. 2, 1953, p. 19.
Mining World, vol. 14, No. 7, June 1952, p. 67.
[36] Chemical Engineering, Israeli Face Chemical Problems: Vol. 60, No. 4, April 1952, p. 222.
United States Department of Commerce, Foreign Commerce Weekly: Vol. 46, No. 8, Feb. 25, 1952, p. 17.
Mining Journal (London), Israel Exploiting Mineral Deposits in the Negev: Vol. 238, No. 6081, Mar. 7, 1952, p. 240.
[37] United States Department of Commerce, Foreign Commerce Weekly: Vol. 47, No. 3, Apr. 21, 1952, p. 18. Engineering and Mining Journal, vol. 153, No. 5, May 1952, p. 170; No. 7, July 1952, p. 164.
[38] Chemical Age (London), vol. 67, No. 1738, Nov. 1, 1952, p. 597.
[39] Philippines Department of Agriculture and Natural Resources, Guano and Phosphate Deposits in Philippine Caves: Philippines Bureau of Mines Inf. Cir. 11, 1952, 13 pp.
[40] Rock Products, Phosphate Resources in the Pacific: Vol. 55, No. 6, July 1952, p. 76.

granted the exclusive mineral rights on Ocean Island by the British Government, and had obtained mineral rights for Nauru Island from Germany. The deposits were extensively mechanized by the Commission, with power shovels used in the open-pits and trains to transport the ore to the processing plant. The ore is washed and dried before going to storage for shipment. At Nauru, the ore is loaded by a belt-conveyor cantilever loader at a rate of 1,500 tons per hour. The Japanese forces occupied both islands during the war but were unable to utilize the deposits because the Commission destroyed the plants upon evacuation. Production in 1952 was greater than pre-World War II output.

Platinum-Group Metals

By James E. Bell[1] and Kathleen M. McBreen[2]

HIGHLIGHTS of the platinum-group metals in 1952 were large domestic industrial consumption for the third consecutive year and continuation of Government controls on sales of platinum, including the establishment of a ceiling price. Prices remained at high levels throughout the year. Total sales of platinum-group metals to domestic consumers were 2 percent less in 1952 than in the preceding year. Controls of the National Production Authority adopted in April 1951, prohibiting sale or purchase of platinum for unessential uses continued in effect through 1952. A ceiling price of platinum of $93 per fine troy ounce was established by the Office of Price Stabilization in April 1952. Total imports of platinum-group metals in 1952 were 25 percent below those of the record year of 1951.

TABLE 1.—Salient statistics of platinum-group metals in the United States 1951–52, in troy ounces

	1951	1952		1951	1952
Production:			Stocks in hands of refiners, importers, and dealers, Dec. 31:		
Crude platinum from placers and byproduct platinum-group metals	[1] 36,951	[1] 34,409	Platinum	138,977	130,136
			Palladium	138,099	116,786
Refinery production:			Other	36,815	35,451
New metal:					
Platinum	36,007	41,810	Total	313,891	282,373
Palladium	6,520	6,746			
Other	10,534	3,919	Imports for consumption:		
			Unrefined materials	[2] 63,611	35,602
Total	53,061	52,475	Refined metals	537,812	417,216
Secondary metal:			Total	[2] 601,423	452,818
Platinum	22,470	28,628			
Palladium	27,999	25,540	Exports:		
Other	2,889	4,433	Ore and concentrates	732	
			Refined metals and alloys, including scrap		
Total	53,358	58,601		60,848	26,296
			Manufactures (except jewelry)	17,348	(3)
Consumption:					
Platinum	209,695	228,698			
Palladium	222,545	204,578			
Other	30,295	20,945			
Total	462,535	454,221			

1 Includes Alaska.
2 Revised figure.
3 Beginning Jan. 1, 1952, quantity not recorded.

Platinum was refined in the United States in 1952 at a rate 20 percent greater than in 1951, but imports of refined platinum were 24 percent less. Domestic consumption as measured by sales rose 9 percent, and stocks of refiners and dealers declined 6 percent. The chemical industry was the largest user, taking 55 percent of the total sales. Demand for platinum as a catalyst for producing high-octane

1 Commodity-industry analyst.
2 Statistical clerk.

gasoline and in the manufacture of fiber glass continued strong. Reflecting the restrictions in effect throughout the year, the jewelry trade, normally the largest outlet, reported less than 1 percent of the total sales. The Government purchased platinum for stockpiling.

Palladium was refined in the United States in 1952 at a rate 7 percent under that of 1951, and imports of refined palladium were down 16 percent. Domestic consumption as measured by sales was 8 percent less, and stocks of refiners and dealers declined 15 percent. The electrical industry continued to provide the largest outlet, taking 54 percent of the total sales. Sales of palladium for jewelry and decorative uses rose moderately.

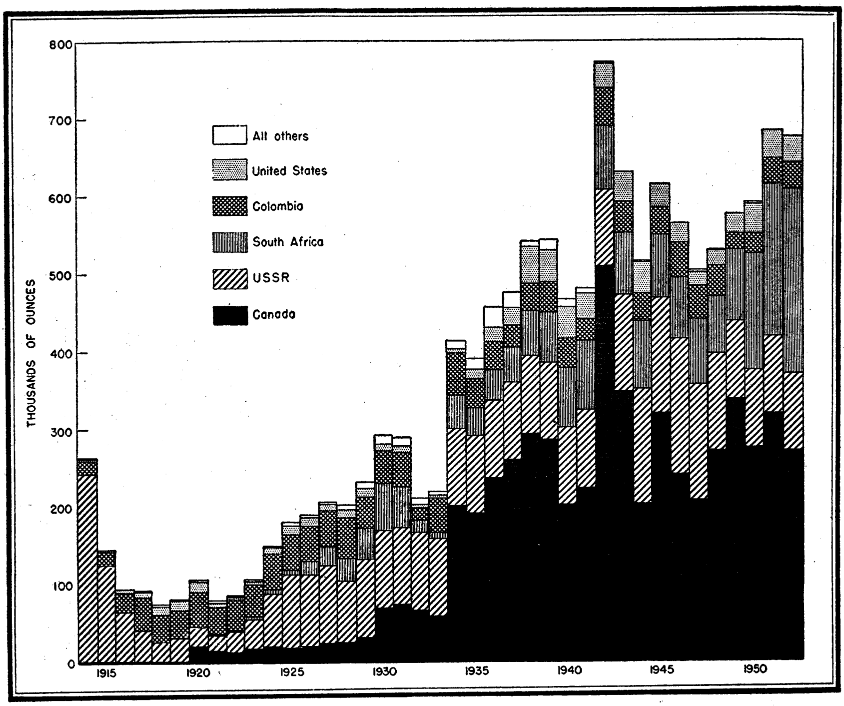

FIGURE 1.—World production of platinum-group metals, 1914–52.

Refining of iridium, osmium, rhodium, and ruthenium in the United States was 36, 23, 58, and 26 percent, respectively, below the 1951 rate. Imports of refined iridium were up 50 percent, but imports of refined osmium, rhodium, and ruthenium were 55, 70, and 57 percent less, respectively. Domestic industrial consumption of the 4 metals together decreased 31 percent, and stocks of refiners and dealers declined 4 percent. The Government purchased iridium for stockpiling.

Expansion of mining and milling facilities at properties of the Rustenburg Platinum Mines, Ltd., in the Transvaal resulted in substantially larger production of platinum-group metals in the Union of South Africa. Figure 1 shows the trends in world production of platinum-group metals since 1914.

REGULATIONS

Scarcity of platinum for the military program and essential civilian requirements led to continuation of National Production Authority Order M–54 through 1952. Adopted April 1, 1951, this order prohibits the sale or purchase of platinum for investment or for jewelry or decorative uses (finished parts in inventory excepted). An amendment of the order effective August 14, 1952, provides that manufacturers of the prohibited items may receive from refiners for reuse all platinum recovered from their platinum scrap.

With the purpose of prompting disposal of hoarded or investment stocks of platinum, Ceiling Price Regulation 136 was adopted by the Office of Price Stabilization on April 26, 1952. This regulation establishes a ceiling price of platinum at $93 per fine troy ounce, except that, until July 27, 1952, sellers could ship at prices up to $105 per ounce to permit liquidation of inventories purchased at prices over $93.

The Advisory Committee on Export Policy established export quotas on platinum metal of 2,000 troy ounces per quarter for the first and second quarters of 1952 and 1,250 ounces per quarter for the third and fourth quarters. Additional exports of platinum manufacturers and chemicals were permitted under restrictive quotas.

CRUDE-PLATINUM PRODUCTION

Mine returns and refinery reports indicate a domestic production of 34,400 troy ounces of platinum-group metals in 1952 as against 37,000 ounces in 1951. This production includes crude platinum mined at placer-platinum deposits in the Goodnews Bay district in Southwestern Alaska, byproduct crude platinum recovered from gold placer mining in California, and platinum-group metals contained in small quantities in some gold ores and copper ores and recovered as a byproduct in smelting and refining operations. No production of byproduct crude platinum was reported in Montana or Oregon in 1952.

Purchases.—Buyers in the United States reported the purchase in 1952 of 53,701 ounces of crude platinum from Alaska, California, Colombia, Union of South Africa, Mexico, and British Columbia (Canada). The corresponding quantity in 1951 was 39,426 ounces.

RECOVERY OF REFINED PLATINUM-GROUP METALS

New Metals Recovered.—Reports from refiners indicate recovery in the United States of 52,500 ounces of new platinum-group metals, compared with 53,100 ounces in 1951. Of the total new metals refined in 1952, 82 percent was recovered from crude platinum both domestic and foreign, and 18 percent was recovered as a byproduct of gold ores and copper ores; the equivalent figures for the preceding year were 79 and 21 percent, respectively.

Secondary Metals Recovered.—In the United States 58,600 ounces of platinum-group metals was recovered in 1952 from the refining of scrap, sweeps, etc., compared with 53,400 ounces in 1951.

Substantial quantities of wornout catalysts, spinnerets, laboratory ware, and other products are returned to refiners for refining or reworking. The refined platinum-group metals recovered from these items (or their equivalent in refined metals) are returned to the consumers. The platinum-group metals so recovered are not considered secondary production or included in the statistics of secondary metals.

TABLE 2.—New platinum-group metals, recovered by refiners in the United States, 1943–47 (average) and 1948–50, and 1951–52 by sources, in troy ounces

	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1943–47 (average)	135, 152	26, 014	4. 015	679	3, 415	1, 813	171, 088
1948	33, 520	4, 408	1, 009	349	156	149	39, 591
1949	42, 228	6, 008	2, 131	980	208	371	51, 926
1950	56, 757	11, 819	2, 351	1, 295	433	474	73, 129
1951							
From domestic—							
Crude platinum	16, 543	101	2. 423	483	235	50	19, 835
Gold and copper refining	5, 017	3. 999	10		125	1	9, 152
Total	21, 560	4, 100	2, 433	483	360	51	28, 987
From foreign—							
Crude platinum / Nickel and copper refining	14, 447	2, 420	1. 984	1, 233	2, 519	1, 471	24, 074
Total	36, 007	6, 520	4, 417	1, 716	2. 879	1. 522	53. 061
1952							
From domestic—							
Crude platinum	18, 809	134	2, 005	559	292	51	21, 850
Gold and copper refining	1, 969	4, 196	9		14	1	6, 189
Total	20, 778	4, 330	2, 014	559	306	52	28, 039
From foreign—							
Crude platinum / Nickel and copper refining	21, 032	2, 416	412	320	91	165	24. 436
Total	41. 810	6, 746	2. 426	879	397	217	52, 475

TABLE 3.—Secondary platinum-group metals recovered in the United States, 1943–47 (average) and 1948–52, in troy ounces

	Platinum	Palladium	Iridium	Others	Total
1943–47 (average)	61, 615	28, 323	1, 728	3, 699	95, 365
1948	58, 527	28, 418	2, 214	4, 742	93, 901
1949	41, 734	37, 209	1, 101	3, 403	83, 447
1950	33, 894	21, 167	1, 064	1, 988	58, 113
1951	22, 470	27, 999	1, 014	1, 875	53, 358
1952	28, 628	25, 540	1, 030	3, 403	58, 601

CONSUMPTION AND USES

Total sales of platinum-group metals for domestic industrial consumption in 1952 were 454,200 ounces, as against 462,500 ounces in 1951, a decline of 2 percent.

Total sales of platinum to domestic consumers in 1952 were 228,700 ounces, equivalent to 50 percent of total sales of platinum-group metals; the corresponding figures for 1951 were 209,700 ounces and 45 percent. Sales to industry were as follows: Chemical 124,900 ounces (55 percent), electrical 82,500 ounces (36 percent), dental and medical 17,100 ounces (7 percent), and miscellaneous and undistributed 2,600 ounces (1 percent). Demand continued strong for platinum as a catalyst for producing high-octane gasoline from low-grade and natural gasoline and in the manufacture of fiber glass. Because of the ban on the sale of platinum in the manufacture of jewelry, only 1,600 ounces (less than 1 percent) of this metal was sold in 1952 to the jewelry trade, which normally provides the largest market.

Total sales of palladium to domestic consumers in 1952 were 204,600 ounces, equivalent to 45 percent of the total sales of platinum-group metals; corresponding figures for the preceding year were 222,500 ounces and 48 percent. The electrical industry continued to provide the largest outlet, taking 54 percent. Sales for chemical uses declined considerably, and sales for dental and medical showed virtually no change. Sales for jewelry and decorative uses increased moderately.

Sales of iridium, osmium, rhodium, and ruthenium together declined to 20,900 ounces in 1952 from 30,300 ounces in 1951 owing mainly to a large drop in sales for chemical uses. By quantity, sales of each of the 4 metals were as follows: Iridium 4,100 ounces, osmium 1,300, rhodium 9,700, and ruthenium 5,800.

Based on their activity as catalysts, resistance to chemical action, high melting points, and workability, the platinum-group metals have specific and important uses in industry and in the arts and sciences. Platinum and iridium are among the strategic and critical metals being stockpiled. Platinum is the most widely used member of the group, and palladium is next in quantity used; the other four members are used mostly in alloying platinum or palladium. Uses of the platinum-group metals are tabulated on page 801 of the Platinum and Allied Metals chapter in Minerals Yearbook 1943.

The catalytic uses of the platinum-group metals include the production of nitric and sulfuric acids, hydrogenation and dehydrogenation, the synthesis of hydrocarbons, and hydroxylation. A recent and expanding development is the use of platinum as a catalyst for producing high-octane gasoline from low-grade and natural gasoline. Platinum-gold and platinum-rhodium alloys are widely used in spinnerets for making rayon fiber from viscose. Fiber glass is produced increasingly by forcing molten glass through banks of platinum nozzles, whence it emerges in fine streams that are stretched to filaments of minute diameter. Pure platinum and platinum-iridium alloys are used as insoluble anodes in various electroplating processes; chemical laboratories have long used platinum utensils and equipment.

The platinum-group metals have numerous electrical applications. Palladium is widely used in the contacts of telephone relays. Platinum, pure or hardened with iridium or ruthenium, is employed for contacts in voltage regulators, thermostats, relays, and high-tension magnetos. Spark plugs equipped with platinum-alloy electrodes have long life and resistance to fouling. Platinum and palladium alloys are employed in numerous delicate electrical and laboratory instruments and in electronics tubes.

Platinum hardened with iridium or ruthenium is widely accepted as the ideal metal in the jewelry and decorative arts, particularly for gem-set jewelry. Palladium alloyed with ruthenium is gaining acceptance for jewelry, particularly in Europe. Both platinum and palladium are beaten into leaf for signs and decorations. Alloys of platinum and palladium are used extensively in dentistry for dentures, pins, and anchorages. Rhodium electroplate provides a surface of high reflectivity for reflectors. Rhodium and osmium are used in many of the high-grade hard alloys for tips of fountain pens and phonograph needles. Platinum and palladium are used in special photographic printing papers. The military importance of platinum lies in its use in spark plugs and in high-duty electrical contacts for magnetos in motorized equipment, in control instruments, and as a catalyst in many chemical production processes.

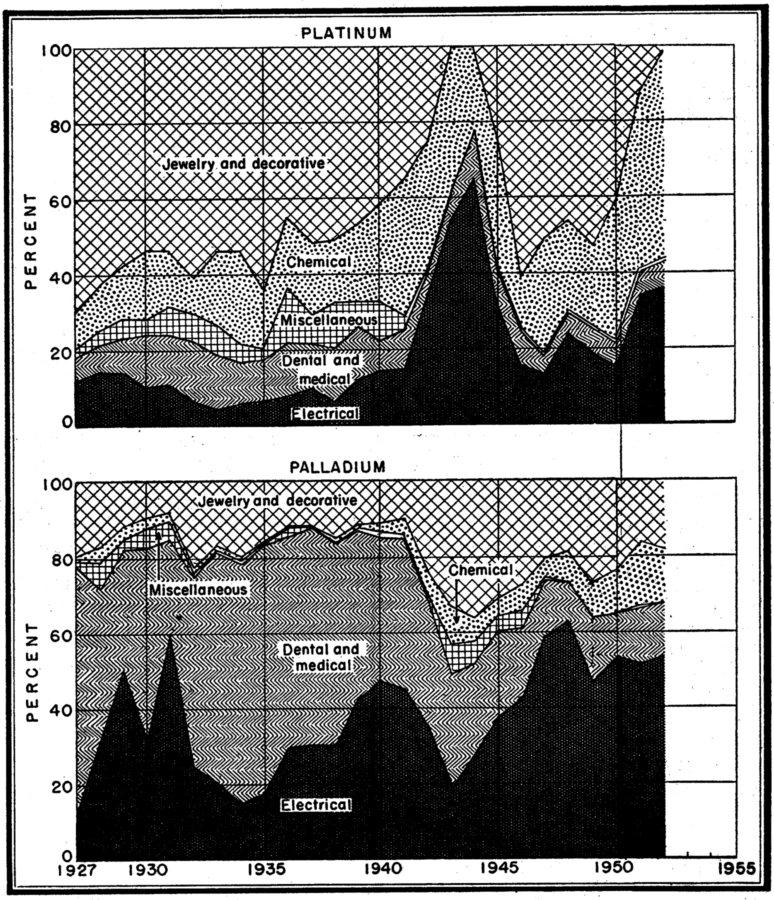

FIGURE 2.—Sales of platinum and palladium to various consuming industries in the United States, 1927–52, as percent of total.

TABLE 4.—Platinum-group metals sold to consuming industries in the United States in 1951 and 1952, in troy ounces

Industry	Platinum	Palladium	Iridium, osmium, rhodium, and ruthenium	Total
1951				
Chemical	97,813	38,527	16,834	153,174
Electrical	70,144	116,601	3,340	190,085
Dental and medical	14,475	30,497	162	45,134
Jewelry and decorative	24,759	35,500	5,379	65,638
Miscellaneous and undistributed	2,504	1,420	4,580	8,504
Total	209,695	222,545	30,295	462,535
1952				
Chemical	124,938	25,403	8,621	158,962
Electrical	82,496	110,883	4,473	197,852
Dental and medical	17,080	30,473	228	47,781
Jewelry and decorative	1,607	37,081	4,028	42,716
Miscellaneous and undistributed	2,577	738	3,595	6,910
Total	228,698	204,578	20,945	454,221

STOCKS

Stocks of platinum-group metals in all forms in the hands of refiners, dealers, and importers totaled 282,400 troy ounces on December 31, 1952, compared with 313,900 ounces on December 31, 1951, corresponding to a decrease of 10 percent.

TABLE 5.—Stocks of platinum-group metals held by refiners, importers, and dealers in the United States, December 31, 1948–52, in troy ounces

Year	Platinum	Palladium	Iridium, osmium, rhodium, and rutheninm	Total
1948	146,823	142,211	34,540	323,574
1949	138,049	122,408	35,587	296,044
1950	125,234	107,854	33,474	266,562
1951	138,977	138,099	36,815	313,891
1952	130,136	116,786	35,451	282,373

PRICES

The accepted quoted domestic retail prices of the platinum-group metals remained steady throughout 1952 and were as follows per fine troy ounce: Platinum, $93; palladium, $24; iridium, $185–$200; osmium, $200; rhodium, $125; and ruthenium, $93. However, substantial sales of platinum were reported to have been made at prices higher than $93 before adoption of ceiling price regulations on April 26, 1952, and during the "grace" period thereafter extending to July 27, 1952.

Buyers in the United States reported purchases at $90 to $109.05 an ounce for domestic and foreign crude platinum in 1952. This price range results chiefly from fluctuation in demand for refined metals and variations in the iridium content of the crude platinum.

FOREIGN TRADE [3]

Imports.—Imports of platinum-group metals into the United States in 1952 were 25 percent below the alltime record established in 1951. The principal sources were Canada (226,400 ounces), Colombia (24,500 ounces), Netherlands (80,700 ounces), the United Kingdom (72,800 ounces), and the Union of South Africa (30,200 ounces). Imports of refined metals in 1952 totaled 417,200 troy ounces, compared with 537,800 ounces in 1951; imports of unrefined metals totaled 35,600 ounces, compared with 63,600 ounces. Imports in 1952 of refined platinum, palladium, osmium, rhodium, and ruthenium declined 24, 16, 55, 70, and 57 percent, respectively, below the quantities imported in 1951; imports of iridium were 50 percent greater.

TABLE 6.—Platinum-group metals imported for consumption in the United States, 1943–47 (average) and 1948–52

[U. S. Department of Commerce]

Year	Troy ounces	Value	Year	Troy ounces	Value
1943–47 (average)	364,936	$11,929,550	1950	427,547	$23,220,709
1948	272,733	14,973,356	1951	[1] 601,423	[1] 36,307,916
1949	218,284	11,855,150	1952	452,818	25,546,520

[1] Revised figure.

[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 7.—Platinum-group metals (unmanufactured) imported for consumption in the United States, 1951–52, by countries, in troy ounces [1]

[U. S. Department of Commerce]

Country	Unrefined materials [2]				Refined metals						Total
	Ores and concentrates of platinum metals	Platinum grain and nuggets (including crude, dust, and residues)	Platinum sponge and scrap	Osmiridium	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	
1951											
Belgium-Luxembourg					366						366
Canada	42	[3] 111	248		111, 200	151, 877	1, 801		19, 260	3, 500	[3] 288, 039
China					202						202
Colombia	456	23, 465	1, 260								25, 181
Denmark			791		15						806
Hong Kong			727		252						979
Italy					306	2, 524					2, 830
Japan			33, 086		81, 645						114, 731
Lebanon						4, 534					4, 534
Netherlands					301	42, 659			138		43, 098
Norway		75			1, 650	910	100		200	425	3, 360
Panama		903									903
Switzerland					1, 682		24				1, 706
Union of South Africa				594	57, 185	15, 767	600	700	1, 050	1, 900	77, 796
U. S. S. R.						16, 075					16, 075
United Kingdom		111		1, 689	12, 379	4, 773	619	620	17	234	20, 442
Other countries			53		290	32					375
Total	498	[3] 24, 665	36, 165	2, 283	267, 473	239, 151	3, 144	1, 320	20, 665	6, 059	[3] 601, 423

For footnotes see end of table.

TABLE 7.—Platinum-group metals (unmanufactured) imported for consumption in the United States, 1951–52, by countries, in troy ounces [1]—Continued

[U. S. Department of Commerce]

Country	Unrefined materials [2]				Refined metals						Total
	Ores and concentrates of platinum metals	Platinum grain and nuggets (including crude, dust, and residues)	Platinum sponge and scrap	Osmiridium	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	
1952											
Canada	41	78	1,672	41	113,925	101,443	3,700		5,165	347	226,412
Colombia		24,463	15								24,478
Ethiopia		1,303									1,303
France					1,273		187	25		150	1,635
Italy					300						300
Lebanon						3,922					3,922
Mexico	648	593	1,902		672						3,815
Netherlands			165		200	80,376					80,741
Norway		835			1,673	925	106		150	250	3,939
Panama		416									416
Switzerland					2,368						2,368
Union of South Africa				2,149	22,570	4,026	275	275	400	500	30,195
United Kingdom		68	209	602	59,633	9,810	450	294	436	1,341	72,843
Other countries		96	306		49						451
Total	689	27,852	4,269	2,792	202,663	200,502	4,718	594	6,151	2,588	452,818

[1] On the basis of detailed information received by the Bureau of Mines from importers, certain items recorded by the U. S. Department of Commerce as "ores and concentrates" and "sponge and scrap" have been reclassified and included with other groups in this table.
[2] U. S. Department of Commerce categories are in terms of metal content. It is believed, however, that in many instances gross weights are actually reported.
[3] Revised figure.

TABLE 8.—Platinum-group metals (unmanufactured) imported for consumption in the United States, 1951–52 [1]

[U. S. Department of Commerce]

Material	1951 Troy ounces	1951 Value	1952 Troy ounces	1952 Value
Unrefined materials: [2]				
Ores and concentrates of platinum metals	498	$44, 555	689	$106, 813
Platinum grains and nuggets (including crude, dust, and residues)	[3] 24, 665	[3] 1, 960, 689	27, 852	2, 130, 875
Platinum sponge and scrap	36, 165	3, 104, 587	4, 269	395, 243
Osmiridium	2, 283	192, 101	2, 792	231, 852
Total	[3] 63, 611	[3] 5, 301, 932	35, 602	2, 864, 783
Refined metals:				
Platinum	267, 473	22, 753, 594	202, 663	16, 726, 705
Palladium	239, 151	4, 796, 263	200, 502	4, 169, 556
Iridium	3, 144	532, 892	4, 718	782, 034
Osmium	1, 320	285, 745	594	137, 698
Rhodium	20, 665	2, 195, 944	6, 151	688, 067
Ruthenium	6, 059	441, 546	2, 588	177, 677
Total	537, 812	31, 005, 984	417, 216	22, 681, 737
Grand total	[3] 601, 423	[3] 36, 307, 916	452, 818	25, 546, 520

[1] On the basis of detailed information received by the Bureau of Mines from importers, certain items recorded by the U. S. Department of Commerce as "ores and concentrates" and "sponge and scrap" have been reclassified and included with other groups in this table.
[2] U. S. Department of Commerce categories are in terms of metal content. It is believed, however, that in many instances, gross weights are actually reported.
[3] Revised figure.

Exports.—Exports of refined platinum (including scrap) were 8,600 ounces in 1952, and exports of other platinum-group metals (including scrap) were 17,700 ounces. Corresponding figures for 1951 were 8,800 and 52,100 ounces, respectively. Canada was the largest buyer of platinum in 1952, taking 4,000 ounces, and West Germany was second with 1,600 ounces. West Germany was the largest buyer of other platinum-group metals, taking 11,600 ounces.

TABLE 9.—Platinum-group metals exported from the United States, 1943–47 (average) and 1948–52 [1]

[U. S. Department of Commerce]

Year	Ore and concentrates		Platinum (bars, ingots, sheets, wire, sponge, and other forms, including scrap)		Palladium, rhodium, iridium, osmiridium, ruthenium, and osmium (metals and alloys including scrap)		Platinum-group manufactures, except jewelry	
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value
1943–47 (average)	52	$3, 068	8, 624	$465, 560	5, 713	$334, 599	4, 618	$184, 446
1948	5	500	15, 471	1, 198, 994	20, 994	495, 660	4, 874	219, 405
1949	165	1, 985	18, 150	1, 379, 976	22, 628	745, 349	20, 702	452, 824
1950	82	265	12, 753	994, 362	24, 946	802, 970	12, 640	521, 575
1951	732	117, 500	8, 760	834, 985	52, 088	1, 355, 514	17, 348	932, 085
1952			8, 599	729, 970	17, 697	513, 131	(2)	1, 023, 993

[1] Quantities are gross weight.
[2] Beginning Jan. 1, 1952, quantity not recorded.

TABLE 10.—Platinum-group metals exported from the United States, 1951–52, by countries [1]

[U. S. Department of Commerce]

Country	Platinum (bars, ingots, sheets, wire, sponge, and other forms, including scrap)		Palladium, rhodium, iridium, osmiridium, ruthenium, and osmium (metal and alloys including scrap)		Platinum-group manufactures, except jewelry	
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value
1951						
Argentina			623	$16,175	6	$775
Austria			2,000	44,000		
Belgium-Luxembourg	16	$608	1,504	33,847		
Brazil	137	14,703	386	12,742	394	11,589
Canada	499	55,825	498	41,542	15,130	841,856
Chile	13	1,173			160	4,685
Colombia			95	2,527	67	3,594
Cuba	150	13,055	240	6,034	47	328
France	4,529	424,681	510	39,300	6	1,251
Germany	1,744	160,384	35,866	853,992		
Israel	1	109	740	16,374	12	1,198
Italy	(2)	1,067	2,796	79,639	1,016	34,315
Mexico	308	32,650	502	12,253	42	3,265
Netherlands	515	48,153	50	6,150		
Peru	4	356	22	645	26	2,967
Switzerland	557	56,145	401	8,967	78	6,055
United Kingdom	183	17,019	4,558	148,665	2	168
Uruguay			416	9,963	14	963
Venezuela	78	7,479	220	5,421	115	3,641
Other countries	26	1,578	661	17,278	233	15,435
Total	8,760	834,985	52,088	1,355,514	17,348	932,085
1952						
Austria	215	20,000			(3)	
Brazil	186	20,825	480	13,620	(3)	5,519
Canada	3,958	303,520	983	52,942	(3)	700,031
Chile	45	5,128	16	390	(3)	2,442
Colombia	11	1,389	291	6,913	(3)	14,569
Cuba	34	3,323	266	6,783	(3)	3,395
France	1,378	120,595	374	19,810	(3)	3,663
Germany, West	1,561	145,150	11,578	299,130	(3)	10,347
Japan	160	14,880	24	1,580	(3)	400
Mexico	262	27,232	667	16,159	(3)	8,911
Spain	8	200	311	7,803	(3)	48,683
Switzerland			1,764	38,617	(3)	4,666
United Kingdom	639	57,741	139	22,281	(3)	8,872
Venezuela	46	2,703	208	5,543	(3)	7,592
Other countries	96	7,284	596	21,560	(3)	204,903
Total	8,599	729,970	17,697	513,131	(3)	1,023,993

[1] Quantities are gross weight.
[2] Less than 1 troy ounce.
[3] Beginning Jan. 1, 1952, quantity not recorded.

WORLD REVIEW

Canada.—Canada has held its position as the leading producer of platinum-group metals since 1934. Most of the output is obtained as a byproduct of nickel-copper ores mined in the Sudbury district, Ontario; a small quantity of crude platinum is recovered as a byproduct of gold placer mining in British Columbia. According to the Dominion Bureau of Statistics, the total production in Canada in 1952 was 120,300 ounces of platinum and 149,600 ounces of other platinum-group metals compared with 153,500 ounces and 164,900 ounces, respectively, in 1951.

Sales of platinum-group metals by the International Nickel Co. of Canada, Ltd., were 287,000 ounces in 1952 as against 375,000 ounces in 1951.

The discovery in 1952 and initial favorable exploration of a copper-nickel deposit containing significant quantities of platinum-group metals in the Kluane Lake district, Yukon Territory, was reported by the Hudson Bay Mining & Smelting Co., Ltd.[4]

Colombia.—The production of platinum-group metals of Colombia results from placer-mining operations in the Choco district, mostly by dredging. The crude platinum product for shipment averages about 85 percent platinum-group metals. Figures for the total output are difficult to obtain. The South American Gold and Platinum Co., which accounts for most of the production, recovered 23,700 ounces of crude platinum in 1952 compared with 20,300 ounces in 1951.

Southern Rhodesia.—The platinum deposits in the Belingwe area on the Great Dyke have been known for many years, and considerable underground development was done in the 1920's. Large reserves of material containing approximately 2.9 dwt. platinum-group metals per ton over a mining width of about 8 feet have been developed.[5] The Wedza Syndicate of Bulawayo entered into an agreement with the Government of Southern Rhodesia during 1952 to exploit the platinum deposits in the Belingwe area. Metallurgical tests were made and a plant purchased. Deep diamond drilling will be done in 1953; it is expected that at least 2 holes 3,000 to 4,000 feet deep will be drilled.

TABLE 11.—World production of platinum-group metals, 1943–47 (average) and 1948–52 in troy ounces [1]

[Compiled by Pauline Roberts]

Country	1943–47 (average)	1948	1949	1950	1951	1952
Australia:						
Placer platinum	1			16	8	(2)
Placer osmiridium	100	92	39	48	34	[3] 50
Belgian Congo: Palladium from refineries		209	106			(2)
Canada:						
Platinum: Placer and from refining nickel-copper matte	[4] 160,361	121,404	153,784	124,571	153,483	120,300
Other platinum-group metals: From refining nickel-copper matte	[4] 171,101	148,343	182,233	148,741	164,905	149,600
Colombia: Placer platinum	37,775	40,047	20,797	26,445	[3] 32,000	[3] 33,700
Ethiopia: Placer platinum	726	210	280	480	200	75
Italy: Platinum from refineries	13					
Japan: Platinum from refineries	390	25	106	203	245	(2)
New Guinea			4		5	2
New Zealand: Placer platinum	4				8	(2)
Papua: Placer platinum				(5)	[6] 2	5
Sierra Leone: Placer platinum	110	109	38			(2)
Union of South Africa:						
Platinum-group metals from platinum ores	76,106	22,549	30,470	144,217	190,898	232,521
Concentrates (platinum-group metal content) from platinum ores		46,374	56,904			
Osmiridium from gold ores	6,113	5,520	6,031	6,449	6,359	6,141
U. S. S. R.: Placer platinum and from refining nickel-copper ores (estimate)	150,000	125,000	100,000	100,000	100,000	100,000
United States: Placer platinum and from domestic gold and copper refining	30,773	19,253	24,807	37,855	36,951	34,409
Total (estimate)	650,000	525,000	575,000	600,000	675,000	675,000

[1] This table incorporates a number of revisions of data published in previous platinum tables.
[2] Data not available; estimate included in total.
[3] Estimate.
[4] Includes adjustments in 1945 for metals produced in Canada in 1938–44 but not included in the statistics for those years.
[5] Less than 0.5 ounce.
[6] Year ended June 30 of year stated.

[4] Hudson Bay Mining & Smelting Co., Ltd., Annual Report to Stockholders, 1952.
[5] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 22.

Union of South Africa.—Platinum-group metals are produced in the Union of South Africa from two sources—as an osmiridium byproduct from gold mining on the Rand and as the principal product of mining operations on the Merensky Reef, a horizon on the ultrabasic Bushveld igneous complex in the Transvaal.

During the past 15 years the osmiridium production on the Rand has averaged around 6,000 ounces annually. The composition of the osmiridium is variable, but the metals contained range within the limits given below:

Metal:	*Range (percent)*
Osmium	44. 60–24. 13
Iridium	40. 55–21. 33
Ruthenium	16. 83– 8. 73
Platinum	18. 99– 3. 89
Gold	14. 94– 0. 05
Rhodium	1. 04– 0. 34

The Merensky Reef has been located in widely separated points in the Brits, Rustenburg, and Potgietersrust districts; and the reserves of platinum ores it contains are believed to be very large. The structure and composition of the Merensky Reef have been described recently by Schmidt.[6] The best grade deposits are in the Rustenburg district where stretches on the reef measuring 5,000 to 18,000 feet along the strike and several hundred feet along the dip assay 0.25 to 0.35 ounce of platinum-group metals per ton over stoping widths of about 30 inches. The ore is treated by a combination of gravity concentration and flotation. By the former, a concentrate of crude metallics averaging about 22 percent platinum-group metals is produced. By the latter, a flotation concentrate is obtained that contains platiniferous sulfides of copper, nickel, and iron and gangue; it is smelted locally to a matte that averages about 43 ounces of platinum-group metal per ton. The gravity concentrate and the matte are shipped to England for recovery of refined platinum-group metals, with copper and nickel as byproducts. The Rustenburg Platinum Mines, Ltd., has absorbed a number of former producers and in 1952 was the only concern engaged in mining on the Merensky Reef. Recent expansion of mining and plant facilities of this company have resulted in a substantially greater production rate. According to the Department of Mines the production of platinum-group metals for the Union rose from 190,900 ounces in 1951 to 232,500 ounces in 1952. The average analyses of 145,400 ounces of platinum-group metals exported from the Union in 1951 was reported[7] as follows: Platinum 68.89 percent, palladium 23.14, iridium 0.31, osmium and osmiridium 0.11, rhodium 1.79, ruthenium 1.51, and gold 4.25.

Plans of the company for 1953 are reported to include the construction of a refinery to treat a portion of the output of platinum-group metals.

[6] Schmidt, E. R., The Structure and Composition of the Merensky Reef and Associated Rocks on the Rustenburg Platinum Mine: Tran. Geol. Soc. South Africa, vol. 55, 1953.
[7] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 3, September 1952, p. 22.

Potash

By E. Robert Ruhlman[1] and Gertrude E. Tucker[2]

INCREASED domestic production and substantial imports of potash set a new record in 1952, with a total supply of over 1.85 million tons of K_2O equivalent available for consumption. At the close of 1952 the 10 producing companies in the United States had a total productive capacity of 1.8 million tons of K_2O equivalent per year.

The United States Department of the Interior, through the Bureau of Land Management, modified the regulations governing the limitation on area held under prospecting permits and leases to permit increased acreage to be held by producing companies.[3]

TABLE 1.—Salient statistics of the potash industry in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Production of potassium salts (marketable) short tons	1,637,831	2,138,493	2,056,609	2,242,647	2,474,870	2,866,462
Approximate equivalent K_2O short tons	881,928	1,139,881	1,118,395	1,287,724	1,420,323	1,665,113
Sales of potassium salts by producers short tons	1,633,681	2,148,807	2,062,789	2,221,920	2,451,913	2,757,252
Approximate equivalent K_2O short tons	880,411	1,143,339	1,120,653	1,276,164	1,408,408	1,598,354
Value at plant	$30,575,234	$35,998,758	$35,105,799	$39,774,447	$44,788,880	$53,754,316
Average per ton	$18.72	$16.75	$17.02	$17.90	$18.27	$19.50
Imports of potash materials short tons	29,683	52,890	43,719	381,490	574,361	363,898
Approximate equivalent K_2O short tons	11,644	27,181	19,216	200,529	[1] 313,617	190,862
Value	$2,325,606	$3,063,547	$2,358,557	$13,993,974	$18,543,112	$13,102,739
Exports of potash materials short tons	125,293	128,068	126,757	117,137	[1] 124,211	101,200
Approximate equivalent K_2O [2] short tons	68,043	69,733	69,558	65,047	[1] 68,654	56,281
Value	$7,352,360	$8,288,955	$7,110,835	$5,534,176	[1] $7,593,646	$4,836,659
Apparent consumption of potassium salts [3] short tons	1,538,072	2,073,629	1,979,751	2,486,273	[1] 2,902,063	3,019,950
Approximate equivalent K_2O short tons	824,012	1,100,787	1,070,311	1,411,646	[1] 1,653,371	1,732,935

[1] Revised figure.
[2] Estimate by Bureau of Mines.
[3] Quantity sold by producers, plus imports, minus exports.

PRODUCTION AND SALES

The domestic production of marketable potassium salts reached a new high in 1952, a 16-percent increase above the corresponding 1951 figure and more than 126 percent over the production 10 years ago. The sales of domestic marketable salts increased 12 percent in 1952

[1] Commodity-industry analyst.
[2] Statistical assistant.
[3] Title 43—Public Lands: Interior, sec. 32, 41 Stat., 450; 30 U. S. C. 189; published in 17 F. R. 11761 of December 25, 1952.

342070—55——53

from 1951. The total value of domestic potash sales rose 20 percent in 1952 compared to 1951, reflecting an increase of $1.23 in the average value per ton.

Production of high-analysis materials (60–62 percent K_2O minimum, including refined KCl and 93–96 percent KCl) continued to increase and was 86 percent of the total potassium salts produced in the United States in 1952. Productions of the lower-grade muriate (48–50 percent K_2O minimum), manure salts, sulfate of potash, and sulfate of potash-magnesia all decreased in 1952. The production of manure salts has decreased from a high of 260,300 tons in 1948 to 8,400 tons in 1952.

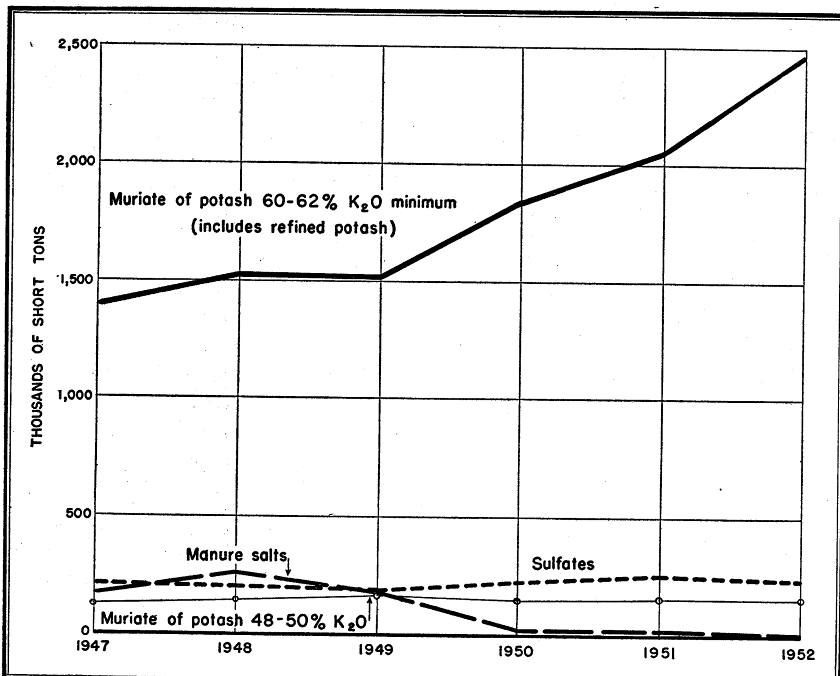

FIGURE 1.—Potassium salts produced in the United States 1947–52, by grades, in short tons.

TABLE 2.—Potassium salts produced in the United States, 1943–47 (average) and 1948–52, by grades, in short tons

Grade	1943–47 (average)	1948	1949	1950	1951	1952
Muriate of potash:						
60–62 percent K_2O minimum [1]	1,167,140	1,523,937	1,513,128	1,846,459	2,047,793	2,468,436
48–50 percent K_2O minimum	115,748	145,675	172,475	151,547	155,797	150,959
Manure salts	[2] 169,605	260,339	177,315	21,532	19,775	8,409
Sulfate of potash and sulfate of potash-magnesia	185,338	208,542	193,691	223,109	251,505	238,658
Total	1,637,831	2,138,493	2,056,609	2,242,647	2,474,870	2,866,462

[1] Includes refined potash, 1943–52, and some 93–96 percent KCl, 1946–52.
[2] Includes spillage of some higher grade salts in 1946.

California, New Mexico, and Utah continued to supply the major portion of the domestic production of potash. New Mexico supplied over 88 percent of the domestic potash marketed in the United States. A fifth major producer began operations in New Mexico late in 1952. The eastern United States (Maryland and Michigan) supplied only a small quantity.

TABLE 3.—Potassium salts produced, sold, and in producers' stocks in the United States, 1943–47 (average) and 1948–52

Year	Production			Sales				Producers' stocks, Dec. 31	
	Operators	Potassium salts (short tons)	Equivalent potash (K_2O) (short tons)	Operators	Potassium salts (short tons)	Equivalent potash (K_2O) (short tons)	Value f. o. b. plant	Potassium salts (short tons)	Equivalent potash (K_2O) (short tons)
1943–47 (average)	7	1, 637, 831	881, 928	7	1, 633, 681	880, 411	$30, 575, 234	61, 298	26, 139
1948	7	2, 138, 493	1, 139, 881	7	2, 148, 807	1, 143, 339	35, 998, 758	25, 093	11, 211
1949	8	2, 056, 609	1, 118, 395	8	2, 062, 789	1, 120, 653	35, 105, 799	18, 913	9, 066
1950	7	2, 242, 647	1, 287, 724	7	2, 221, 920	1, 276, 164	39, 774, 447	39, 640	20, 620
1951	9	2, 474, 870	1, 420, 323	9	2, 451, 913	1, 408, 408	44, 788, 880	62, 597	32, 302
1952	10	2, 866, 462	1, 665, 113	10	2, 757, 252	1, 598, 354	53, 754, 316	171, 807	99, 061

The potash-producing companies in the United States in 1952, by States, were as follows:

California:
- The American Potash & Chemical Corp., 3030 W. 6th St., Los Angeles 54, Calif. (plant at Trona, on Searles Lake, Calif.).
- A. M. Blumer, 465 California St., San Francisco, Calif. (plant at Davenport, Calif.).

Maryland:
- North American Cement Corp., 41 East 42d St., New York 17, N. Y. (plant at Security, Md.).

Michigan:
- The Dow Chemical Co., Midland, Mich. (brine wells and plant near Midland, Mich.).

New Mexico (all mines and plants in New Mexico are near Carlsbad):
- Duval Sulphur & Potash Co., 17th floor, Mellie Esperson Bldg., Houston 2, Tex.
- International Minerals & Chemical Corp., 20 North Wacker Dr., Chicago, Ill.
- Potash Company of America, Box 31, Carlsbad, N. Mex.
- The Southwest Potash Corp., Box 472, Carlsbad, N. Mex.
- United States Potash Co., Inc., 30 Rockefeller Plaza, New York 20, N. Y.

Utah:
- Bonneville, Ltd., 540 West 7th South, Salt Lake City 4, Utah (plant near Wendover, Utah).

The mine production of potassium-bearing salts in the Carlsbad region of New Mexico increased 19 percent (1.2 million tons) over 1951, breaking all previous records for potash production. The location of the mines in this area is shown in figure 2.

Since 1931, when mining of potash ores was begun in New Mexico, the grade of the ore has progressively decreased. In 1952, however, an increase was recorded, with the ore averaging 20.94 percent K_2O compared to 20.40 percent in 1951.

All five producing companies—Duval Sulphur and Potash Co., International Minerals & Chemical Corp., Potash Company of

America, Southwest Potash Corp., and United States Potash Co., Inc.,—mined sylvite (potassium chloride), and one—International Minerals & Chemical Corp.—also mined langbeinite (potassium-magnesium sulfate). All five companies processed sylvinite, a mixture of halite and sylvite, to yield 60 percent or higher grade muriate. Potassium sulfate and potassium-magnesium sulfate were produced from langbeinite by the International Minerals & Chemical Corp. in its refinery near Carlsbad.

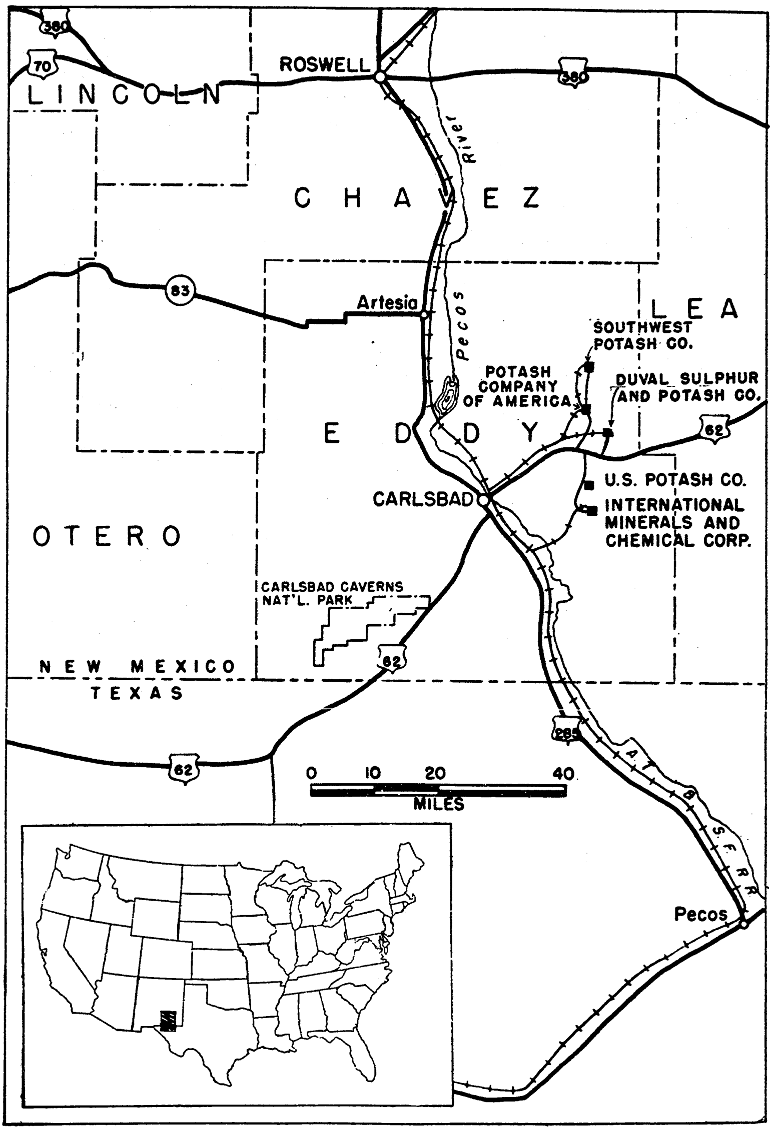

FIGURE 2.—Location of potash mines in Eddy County, N. Mex.

TABLE 4.—Production and sales of potassium salts in New Mexico, 1943–47 (average) and 1948–52, in short tons

Year	Crude salts [1]		Marketable potassium salts				
	Mine production		Production		Sales		
	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Gross weight	K_2O equivalent	Value
1943–47 (average)	4,019,571	845,772	1,389,900	738,306	1,387,017	737,478	$25,467,529
1948	5,108,372	1,069,675	1,841,054	964,940	1,850,976	967,945	29,177,328
1949	4,852,903	1,018,886	1,733,739	927,621	1,744,427	932,497	27,950,111
1950	5,802,004	1,198,021	1,904,565	1,086,996	1,878,094	1,072,772	31,944,365
1951	6,615,891	1,349,572	2,138,439	1,223,139	2,126,391	1,217,617	37,209,740
1952	7,852,732	1,644,034	2,530,596	1,468,029	2,439,042	1,411,125	46,385,452

[1] Sylvite and langbeinite.

CONSUMPTION AND USES

The apparent consumption of K_2O (producers' sales plus imports minus exports) rose 5 percent in 1952 above the corresponding figure for 1951. The apparent consumption and sales of domestic producers as reported to the Bureau of Mines are shown in figure 3. The sales of domestic potash (K_2O) were 92 percent of apparent consumption compared with 85 percent in 1951 and 90 percent in 1950.

According to the American Potash Institute, March 16, 1953:

The new high record in deliveries of potash in North America reached during 1952 amounted to 3,118,489 tons of salts containing an equivalent of 1,796,258 tons K_2O. This was an increase of 88,733 tons K_2O or 5 percent over 1951. Deliveries by the seven leading domestic producers were the highest ever achieved, 1,584,698 tons K_2O, an increase of 15 percent over last year. This was due to two new producing companies in New Mexico and increase in deliveries by the older companies. Imports were 211,560 tons K_2O, a 35 percent decrease under last year.

Deliveries for agricultural purposes in the continental United States for 1952 were 1,592,620 tons K_2O, an increase of 102,442 tons over 1951. Canada received 69,968 tons K_2O, Cuba 9,408 tons, Puerto Rico 17,068 tons, and Hawaii 16,451 tons. Exports to other countries amounted to 4,302 tons K_2O.

In this country agricultural potash was delivered in 44 States and the District of Columbia. Illinois with over 168,000 tons K_2O was the leading State followed in order by Ohio, Georgia, Indiana, Virginia, Florida and North Carolina, each taking more than 90,000 tons K_2O during the year. Due to shipments across State lines, consumption does not necessarily correspond to deliveries within a State.

Agricultural potash accounted for 95 percent of deliveries. The 60 percent muriate of potash continued to be by far the most popular material, comprising 84 percent of the total K_2O delivered for agricultural purposes. The 50 percent muriate of potash made up 9 percent, sulfate of potash and sulfate of potash magnesia 7 percent, and manure salts less than 0.1 percent of deliveries.

Deliveries for chemical purposes in 1952 were 130,887 tons of muriate of potash containing an equivalent of 82,250 tons K_2O, and 8,280 tons of sulfate of potash containing 4,191 tons K_2O. The total chemical deliveries of 86,441 tons K_2O were 5 percent of all potash deliveries and were 988 tons or 1 percent less than in 1951.

The deliveries of agricultural and chemical potash in North America from 1942 to 1952 are shown in figure 4, and the deliveries by States in 1952 are given in table 6.

TABLE 5.—Apparent consumption[1] of potassium salts in the United States, 1943–47 (average) and 1948–52, in short tons

Year	Potassium salts	Approximate equivalent K_2O	Year	Potassium salts	Approximate equivalent K_2O
1943–47 (average)	1,538,072	824,012	1950	2,486,273	1,411,646
1948	2,073,629	1,100,787	1951 [2]	2,902,063	1,653,371
1949	1,979,751	1,070,311	1952	3,019,950	1,732,935

[1] Quantity sold by producers, plus imports, minus exports.
[2] Revised figures.

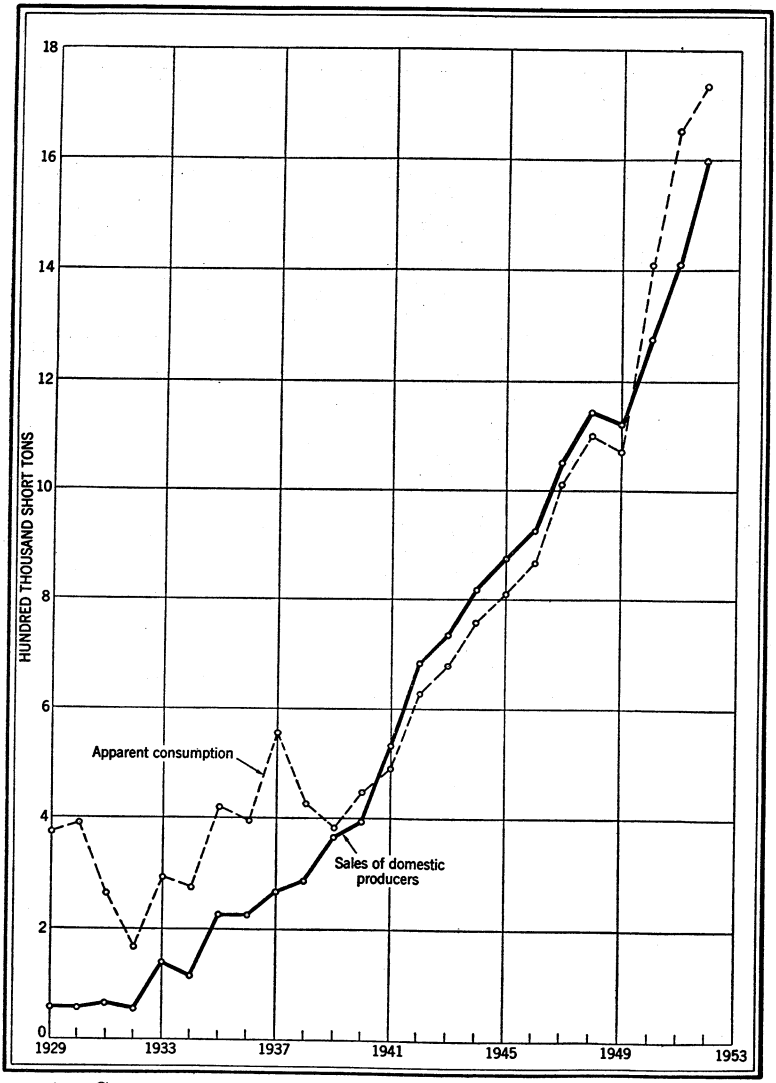

FIGURE 3.—Comparison of apparent domestic consumption of potash (K_2O) and sales of domestic producers of potash in the United States, 1929–52.

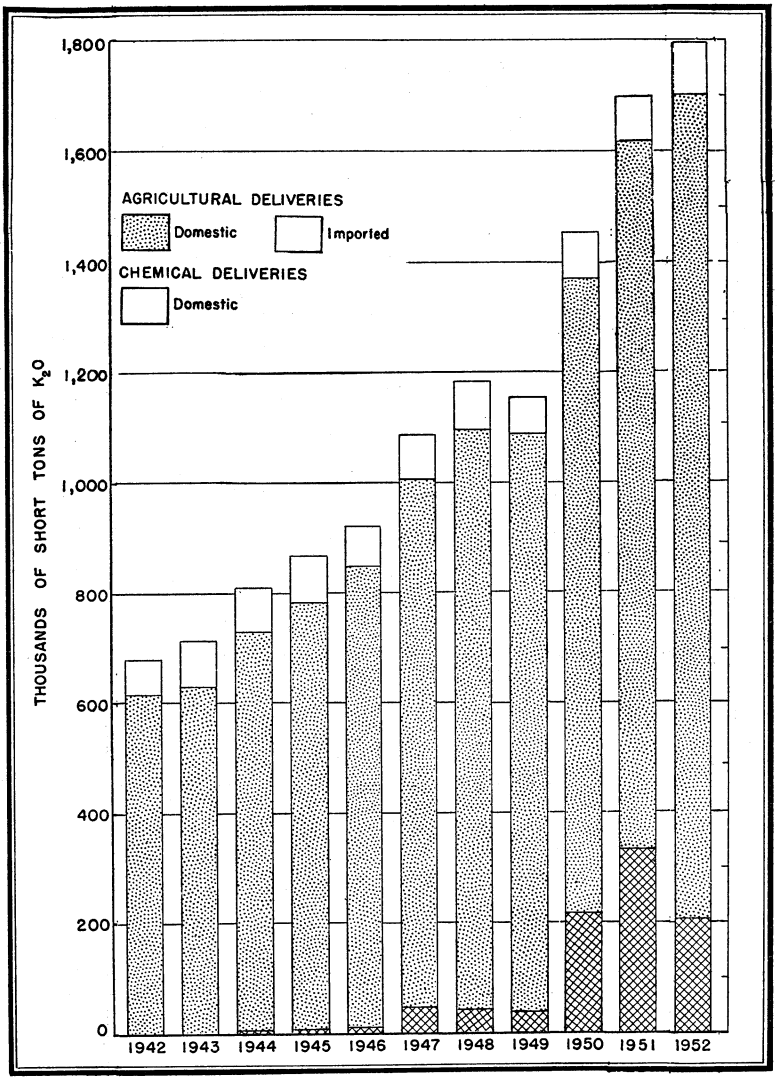

FIGURE 4.—Potash deliveries by use groups, in North America, 1942–52 (American Potash Institute).

STOCKS

Producers' stocks on hand at the end of 1952 were 174 percent greater than the 1951 figure and the highest ever recorded by the Bureau of Mines. Producers' stocks (K_2O equivalent) on hand at year end since 1926 are presented graphically in figure 5. The data for 1943–47 average and 1948–52 are included in table 3.

TABLE 6.—Deliveries of potash salts in 1952, by States of destination, in short tons of K_2O

[American Potash Institute]

State	Agricultural potash	Chemical potash
Alabama	65,440	----------
Arizona	402	----------
Arkansas	35,859	----------
California	13,776	4,847
Colorado	888	----------
Connecticut	4,009	168
Delaware	6,440	554
District of Columbia	147	----------
Florida	91,577	25
Georgia	121,122	60
Idaho	347	----------
Illinois	168,826	1,781
Indiana	105,802	189
Iowa	23,463	290
Kansas	2,260	135
Kentucky	28,824	50
Louisiana	27,143	126
Maine	20,588	38
Maryland	77,544	969
Massachusetts	13,062	103
Michigan	35,696	682
Minnesota	27,764	----------
Mississippi	33,131	----------
Missouri	35,751	823
Montana	32	----------
Nebraska	1,204	----------
Nevada	----------	2,717
New Hampshire	----------	20
New Jersey	35,973	1,495
New Mexico	71	----------
New York	31,041	54,867
North Carolina	90,080	----------
North Dakota	2,041	----------
Ohio	155,622	3,143
Oklahoma	3,812	280
Oregon	2,951	350
Pennsylvania	32,531	1,162
Rhode Island	1,256	----------
South Carolina	57,506	----------
Tennessee	62,616	889
Texas	30,786	3,201
Utah	233	81
Vermont	475	----------
Virginia	98,786	717
Washington	4,471	520
West Virginia	885	5,400
Wisconsin	40,387	25
Total	1,592,620	85,707

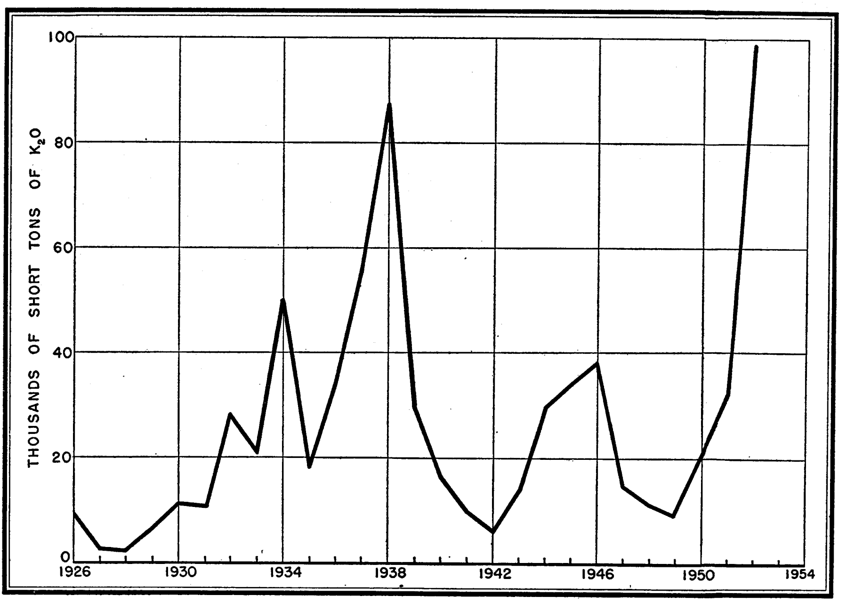

FIGURE 5.—Producers' stocks of potassium salts at end of year, 1926–52, in short tons of equivalent potash (K_2O).

PRICES

Prices for agricultural-grade potash remained under the control of the Office of Price Stabilization throughout 1952. Pursuant to section 16 of General Overriding Regulation 21, the OPS granted separate ceiling prices to each of the major producers at various times during the year. Sales of potash were not always at the ceiling prices, however.

The American Potash & Chemical Corp. issued its price schedule for agricultural-grade Trona potash for the 1952–53 season on May 29, 1952. The price for muriate of potash 60 percent K_2O minimum, f. o. b. Trona, Calif., in bulk, in carlots of not less than 40 tons, was quoted at 50.5 cents per unit K_2O. The OPS granted a new ceiling for Trona muriate of potash, and on July 15 the price of muriate was advanced to 53 cents per unit. The May 29, 1952, price of sulfate of potash, 95–98 percent K_2SO_4, was 86 cents per unit K_2O.

The list prices of both muriate and sulfate were subject to seasonal discounts. There were additional charges for shipments in bags.

Price schedules for New Mexico potash for agricultural purposes for 1952–53 were issued in May and June 1952 as shown in table 7.

TABLE 7.—Prices of agricultural potash quoted by producers, f. o. b. Carlsbad, N. Mex., for 1952–53 season [1]

Salt	Grade	Brand	Producer	Price: Period	Price: Per unit K_2O
Muriate of potash	62–63 percent K_2O	Sunshine State	U. S. P.	June 1–Sept. 15 Sept. 15–May 31	$0.42 .43
Do	60 percent K_2O minimum, standard.	Red Muriate	P. C. A.	June 1–May 31	.445
Do	60 percent K_2O minimum	International	I. M. & C.	June 1–Dec. 19 Dec. 19–May 31	.42 .43
Do	do	High-K	S. W. P. C.	June 30–May 31	.445
Do	do	Duval Muriate of Potash.	D. S. & P. C.	June 1–Sept. 20 Sept. 20–May 31	.42 .43
Do	60 percent K_2O granular	Red Muriate	P. C. A.	June 1–May 31	.465
Do	48–52 percent K_2O	Sunshine State	U. S. P.	June 1–Sept. 15 Sept. 15–May 31	.42 .43
Do.[2]	50 percent K_2O minimum	International	I. M. & C.	June 1–May 31	.42
Manure salts	22 percent K_2O minimum	Red Muriate	P. C. A.	June 1–May 31	.21
Do	Run-of-mine 20 percent K_2O minimum.	Sunshine State	U. S. P.	June 1–May 31	.21
Sulfate of potash	48.6 percent K_2O minimum.	International	I. M. & C.	June 1–May 31	.745
Sulfate of potash-magnesia.	Basis 40 percent K_2SO_4, 18% MgO.	International Sulpo-mag.	do	June 1–May 31	[3] 16.00

[1] Bulk in carlots (minimum 40 tons). Subject to seasonal discounts.
[2] International Minerals & Chemical Corp. quoted muriate of potash 50–51 percent K_2O, packed in 5-ply plain paper bags, 100 pounds each, at $25.75 per short ton June 1–May 31.
[3] Per short ton.

FOREIGN TRADE [4]

Imports.—The imports of fertilizer and chemical potash materials decreased sharply in 1952, 37 percent below 1951. The average value per ton of imports of fertilizer-grade potash materials at the port of origin was nearly $3.50 higher than in 1951. Details of imports from

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

East Germany and West Germany are given separately in 1952. The principal supplying countries were West Germany, East Germany, France, Spain, and Chile.

Imports of Fertilizer-grade potash materials constituted 98 percent of total imports, 1 percent higher than in 1951.

The average K_2O content of potash imports declined 2 percent compared with 1951. Muriate, the principal potash salt imported in 1952, came mainly from East Germany, West Germany, France, and Spain. The imports of potassium sulfate came mainly from West Germany, with smaller quantities from East Germany and France. Chile supplied the United States with nearly 90 percent more potassium sodium nitrate in 1952 than in 1951.

TABLE 8.—Potash materials imported for consumption in the United States, 1951–52

[U. S. Department of Commerce]

Material	Approximate equivalent as potash (K_2O) (percent)	1951 Short tons	1951 Approximate equivalent as potash (K_2O) Short tons	1951 Approximate equivalent as potash (K_2O) Percent of total	1951 Value	1952 Short tons	1952 Approximate equivalent as potash (K_2O) Short tons	1952 Approximate equivalent as potash (K_2O) Percent of total	1952 Value
Used chiefly in fertilizers:									
Muriate (chloride)	56.4	492,632	277,844	88.6	$12,696,703	280,179	158,021	82.8	$7,538,286
Potassium nitrate, crude	40.0	[1] 3,367	[1] 1,347	[1] 0.4	[1] 145,868	20,199	8,080	4.2	926,109
Potassium-sodium nitrate mixtures, crude	14.0	[1] 8,655	[1] 1,212	0.4	[1] 389,897	16,460	2,304	1.2	830,693
Potassium sulfate, crude	50.0	[1] 55,035	[1] 27,518	[1] 8.8	[1] 1,809,024	40,262	20,131	10.6	1,493,534
Other potash fertilizer material	6.0								
Total fertilizer		559,689	[1] 307,921	98.2	15,041,492	357,100	188,536	98.8	10,788,622
Used chiefly in chemical industries:									
Bicarbonate	46.0	55	25		13,585	65	30		16,026
Bitartrate:									
Argols	20.0	7,635	1,527		1,178,031	3,393	679		754,429
Cream of tartar	25.0	707	177		337,883	424	106		189,640
Carbonate	61.0	2,226	1,358		294,187	171	104		26,150
Caustic	80.0	1,645	1,316		355,214	74	59		32,333
Chlorate and perchlorate	36.0	369	133		96,532	741	267		245,650
Chromate and dichromate	40.0	59	24	1.8	11,811	1	(2)	1.2	234
Cyanide	70.0	935	655		793,995	909	636		735,390
Ferricyanide	42.0	271	114		245,768	178	75		129,883
Ferrocyanide	44.0	9	4		4,192	8	3		6,874
Nitrate	46.0	117	54		15,460	519	239		59,190
Permanganate	29.0	62	18		18,396	136	39		56,819
Rochelle salts	22.0					2	(2)		813
All other	50.0	582	291		136,566	177	89		60,686
Total chemical		14,672	5,696	1.8	3,501,620	6,798	2,326	1.2	2,314.117
Grand total		574,361	[1] 313,617	100.0	18,543,112	363,898	190,862	100.0	13,102,739

[1] Revised figure.
[2] Less than 1 ton.

TABLE 9.—Potash materials imported for consumption in the United States, 1951–52, by countries, in short tons

[Figures in parentheses in column headings indicate, in percent, approximate equivalent as potash (K_2O)]

[U. S. Department of Commerce]

Country	Bitartrate		Carbonate (61)	Caustic (hydroxide) (80)	Chlorate and perchlorate (36)	Cyanide (70)	Muriate (chloride) (56.4)	Potassium nitrate, crude (40)	Potassium sodium nitrate mixtures, crude (14)	Potassium sulfate, crude (50)	All other [1]	Total	
	Argols or wine lees (20)	Cream of tartar (25)										Short tons	Value
1951													
Algeria	2,000											2,000	$290,315
Belgium-Luxembourg				298		1	11,957			1,600	50	13,906	536,253
Canada					5		144	5	3		1	158	10,292
Chile	347							[2] 3,306	[2] 8,652			12,305	597,677
China			(3)					(3)				(3)	63
Czechoslovakia				1							124	125	100,976
Ecuador							340					340	13,905
France	970	55	495	252	28	16	54,309			2,898	170	59,193	2,124,040
French Morocco	223											223	40,790
Germany			1,605	657		625	320,392	56		[2] 48,597	477	372,409	10,420,207
Hong Kong			1									1	287
Italy	1,720	317				6					24	2,067	420,913
Japan											6	6	2,433
Netherlands			125	220							136	481	165,570
Norway											(3)	(3)	995
Peru	5											5	1,350
Poland-Danzig							9,815			1,940		11,755	303,003
Portugal	1,845	2										1,847	320,654
Spain		305					94,573					94,878	2,645,664
Sweden				217							99	316	106,851
Switzerland					336						16	352	88,429
Tunisia	525											525	67,229
United Kingdom		28				287	1,102				52	1,469	285,216
Total	7,635	707	2,226	1,645	369	935	492,632	[2] 3,367	[2] 8,655	[2] 55,035	1,155	574,361	18,543,112
1952													
Algeria	1,983											1,983	432,981
Belgium-Luxembourg						18	1,991				165	2,174	188,178
Brazil	17											17	3,939
Canada					3						(3)	3	3,226
Chile	112				39			11,354	16,460			27,965	1,307,295
Czechoslovakia						68						68	47,350
France	708	23	6			13	66,208			3,702	68	70,728	2,569,594
French Morocco	387											387	76,517
Germany:													
East							90,999			5,817	55	96,871	2,459,871
West			164			561	80,491	3,580		30,743	507	116,046	4,010,498
Hong Kong			1									1	559
India											(3)	(3)	42
Italy	21	225				51					1	298	139,939
Japan											25	25	9,706
Netherlands		(3)				12		5,265			200	5,477	393,127
Portugal	165	6										171	37,307
Spain		166					40,490					40,656	983,694
Sweden				74	16						28	118	39,046
Switzerland		1			683	9						693	236,255
United Kingdom		3				177					37	217	163,615
Total	3,393	424	171	74	741	909	280,179	20,199	16,460	40,262	1,086	363,898	13,102,739

[1] Approximate equivalent as potash (K_2O)—1951: 42 percent; 1952: 40 percent.
[2] Revised figure.
[3] Less than 1 ton.

Exports.—Exports of potash materials were 19 percent less than in 1951, the smallest since 1942, reflecting decreases in both Fertilizer and Chemical grades. More than 97 percent of the exports were to countries in the Western Hemisphere. Canada, Cuba, Brazil, and Mexico were the major recipients of the potash exports.

TABLE 10.—Potash materials exported from the United States, 1943–47 (average) and 1948–52

[U. S. Department of Commerce]

Year	Fertilizer		Chemical		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	105, 209	$3, 106, 093	20, 084	$4, 246, 267	125, 293	$7, 352, 360
1948	104, 176	3, 498, 240	23, 892	4, 790, 715	128, 068	8, 288, 955
1949	111, 156	3, 818, 006	15, 601	3, 292, 829	126, 757	7, 110, 835
1950	107, 972	3, 813, 000	9, 165	1, 721, 176	117, 137	5, 534, 176
1951	109, 139	4, 023, 434	[1] 15, 072	[1] 3, 570, 212	[1] 124, 211	[1] 7, 593, 646
1952	94, 678	3, 320, 689	6, 522	1, 515, 970	101, 200	4, 836, 659

[1] Revised figure.

TECHNOLOGY

Exploration for extensions of present ore bodies and discovery of new mines in the United States continued throughout the year. In addition to the 5 producers in New Mexico, 3 other companies—American Potash & Chemical Corp., Freeport Sulphur Co., and the Farmers Union Service Corp.—conducted exploration in the Carlsbad potash area. It was reported that Freeport Sulphur Co. and the Farmers Union Service Corp outlined sizable ore bodies.[5]

Shaft sinking by freezing, which was first used in Belgium in 1885–87, was employed in the Carlsbad area by the Potash Company of America, after two attempts to grout the water-bearing horizon failed. The ground surrounding the planned 15-foot-diameter shaft was frozen through a series of 28 holes. Each of the holes was cased with 6-inch tubing, and then 2-inch tubing was inserted to within 18 inches of the bottom of the hole to permit free circulation of the brine. Approximately 2½ months was required to freeze a shell of ground around the shaft site to a depth of 350 feet. By continuous pumping of the water from within the frozen cylindrical shell, no ground disturbance was noted. Following the freezing, sinking of the shaft proceeded with little trouble.[6]

Increased mine production in the Carlsbad area resulted from the introduction of new and improved equipment, including continuous mining machines, belt conveyors, and diesel-powered trucks, better power-distribution facilities, and improved methods of crushing, loading, and hoisting.[7]

[5] Ware, T. M., Potash and Phosphate: Min. Cong. Jour., vol. 39, No. 2, February 1953, pp. 62–65.
Huttl, J. B., More Potash from Carlsbad: Eng. and Min. Jour., vol. 153, No. 7, July 1952, pp. 98–100.

[6] Latz, J. E., Freezing Method Solves Problem in Carlsbad, N. Mex., Shaft: Min. Eng., vol. 4, No. 10, October 1952, pp. 942–947.

[7] Chafetz, A. B., More Power for Potash Mines Through Better Distribution: Eng. and Min. Jour., vol. 153, No. 12, December 1952, pp. 92–96.
Gardner, H. L., 810-ft. Belt Conveyor in Potash Plant: Western Ind., vol. 17, No. 8, August 1952, pp. 121–123.

Refinery expansion and improvement continued during the year. Expansion by International Minerals & Chemical Corp. included facilities for the production of magnesium oxide and hydrochloric acid. This corporation announced development of a new dry beneficiation process (the Baron-Lawver process) and began to construct a pilot plant. This process, if commercially feasible, will reduce substantially the volume of process water required.

Concentration of the Dead Sea brines by solar evaporation received considerable attention before the present methods were developed.[8]

TABLE 11.—Potash materials exported from the United States, 1951–52, by countries of destinations

[U. S. Department of Commerce]

Country	Fertilizer				Chemical			
	1951		1952		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Argentina	----	----	----	----	683	$274,285	364	$118,818
Australia	----	----	----	----	77	23,006	12	7,080
Austria	----	----	----	----	4	1,822	----	----
Belgium-Luxembourg	----	----	----	----	380	102,156	67	14,616
Brazil	16,707	$865,867	3,396	$196,707	2,655	737,464	884	221,696
Canada	75,997	2,539,273	75,384	2,587,597	3,671	603,455	2,910	459,857
Chile	----	----	----	----	95	27,160	100	21,398
Columbia	111	6,920	50	1,410	355	100,352	218	58,946
Costa Rica	545	23,448	5	311	29	9,238	28	7,791
Cuba	9,678	333,937	11,232	343,809	269	79,895	292	84,779
Dominican Republic	581	21,650	675	27,424	5	1,216	4	1,041
Ecuador	50	2,950	----	----	33	9,709	15	4,485
El Salvador	235	11,522	100	3,641	27	10,445	19	6,696
France	----	----	----	----	288	136,800	161	64,795
Germany	----	----	----	----	5	2,291	[1] 43	[1] 11,228
Greece	----	----	----	----	116	25,685	8	4,293
Guatemala	17	494	----	----	115	28,991	94	24,247
Honduras	----	----	105	3,627	15	4,144	9	2,691
Hong Kong	----	----	----	----	5	1,211	----	----
India	----	----	----	----	267	81,571	23	4,866
Italy	----	----	----	----	464	85,278	103	17,418
Japan	----	----	----	----	17	7,276	28	5,632
Leeward Islands	22	942	----	----	1	498	1	672
Mexico	2,798	106,914	2,247	81,286	1,052	298,588	438	112,671
Netherlands	----	----	----	----	61	17,845	33	9,570
New Zealand	----	----	----	----	117	21,660	12	2,252
Norway	----	----	----	----	16	5,148	13	4,129
Pakistan	----	----	----	----	51	24,747	33	21,673
Peru	20	1,147	----	----	67	24,153	36	11,674
Philippines	766	32,437	753	36,219	[2] 208	[2] 57,729	85	32,260
Portugal	----	----	----	----	30	6,544	33	13,512
Sweden	165	7,484	----	----	1,485	65,922	(3)	1,510
Switzerland	5	285	330	16,221	113	28,663	12	3,618
Turkey	----	----	----	----	231	45,423	36	11,427
Union of South Africa	----	----	----	----	297	91,679	121	37,658
United Kingdom	----	----	----	----	512	187,811	36	28,489
Uruguay	661	26,575	----	----	548	115,798	20	4,938
Venezuela	722	37,799	292	15,546	200	62,879	118	36,164
Yugoslavia	----	----	----	----	127	24,026	(3)	176
Other countries	59	3,790	109	6,891	381	137,649	113	41,204
Total	109,139	4,023,434	94,678	3,320,689	[2] 15,072	[2] 3,570,212	6,522	1,515,970

[1] West Germany.
[2] Revised figure.
[3] Less than 1 ton.

[8] Bloch, M. R., Use of Solar Energy in Evaporation of Dead Sea Brine: Proc. United Nations Sci. Conf. on the Conservation and Utilization of Resources, United Nations Department of Economic Affairs, 1951, pp. 261–264.

The rate of evaporation is the most important factor in the operation and is influenced by color of the evaporating pans and of the brine. Large quantities of sodium chloride must be returned to the Dead Sea because of low demand.

In discussing mechanization of nonmetallic mines, the Alsace potash mines of France were described in detail.[9] Changes brought about by mechanization included improved safety, more efficient use of power and labor, more complete ore recovery, and mining of lower grade materials.

RESERVES

Estimates of world reserves of highly soluble potassium minerals have ranged from 16 billion to 55 billion tons of K_2O. Only a small percentage of this total occurs in the United States. Although the world reserves are adequate for a long period, the developed deposits are located in only a few countries, notably East Germany, West Germany, Russia, France, Spain, Israel, Jordan, and the United States. Large deposits in Canada and England have not been sufficiently explored to estimate their extent. Table 12 shows the range of estimated reserves in the major deposits of the world.[10]

The Proceedings of the United Nation Scientific Conference on the Conservation and Utilization of Resources, held at Lake Success, N. Y., included a number of papers on sources of inorganic fertilizer materials in the world.[11] The data concerning potash in the papers by J. LeCornec and K. D. Jacob included brief geological descriptions and reserve estimates of all the major world deposits. The other papers presented problems of distribution and the most effective methods for utilizing potash and other fertilizer materials.

The leucite deposits in Sweetwater County, Wyo., containing some 197 million tons of potash (K_2O), were described,[12] and the location, a brief geological description, and the estimated reserves of 17 properties were given.

---

[9] Blum-Picard, L., The Mechanization of Nonmetallic Mines: Proc. United Nations Sci. Conf. on the Conservation and Utilization of Resources, United Nations Department of Economic Affairs, 1951, pp. 119–124.

[10] Jones, C. L., and Waggaman, W. H., Potash—1,000 Years Supply: Chap. in President's Materials Policy Commission, Resources for Freedom, vol. 2, The Outlook for Key Commodities, June 1952, pp. 157–158.
Johnson, B. L., Potash: Chap. in Van Royen, W. and Bowles, O., The Mineral Resources of the World, Prentice-Hall, Inc., 1952, pp. 147–152.

[11] United Nations Conference on the Conservation and Utilization of Resources, Inorganic Fertilizers in Conservation: Proc., United Nations Department of Economic Affairs, New York, vol. 2, 1951, pp. 269–300. Chapters as follows:
LeCornec, J., Estimate of World Supplies of the Principal Plant Nutrients by Cost Range: Pp. 270–274.
Jacob, K. D., World Resources of Principal Inorganic Plant Nutrients: Pp. 274–278.
Nordengren, Sven, Resources of Minerals Containing Phosphorus and Potassium in Sweden and Their Utilization in the Fertilizer Industry: Pp. 278–281.
Curtis, H. A., The Economics of World Supply of Fertilizer Materials and Their Use: Pp. 281–285.
Grimmett, R. E. R., and Elliott, I. L., The Economics of World Availability and Use of Fertilizer Materials: Pp. 285–288.
Ray, J. N., Economics of World Availability and Use of Fertilizer Materials: Pp. 288–291.
Diaz-Vial, Carlos, Economics of World Availability and Use of Fertilizer Materials: Pp. 291–294.

[12] Osterwald, F. W., and Osterwald, D. B., Wyoming Mineral Resources: Geol. Survey Wyoming, Bull. 45, 1952, pp. 124–127.

TABLE 12.—Estimates of world potash resources [1]

[Millions of short tons of K_2O]

Country	Tonnage	Country	Tonnage
West Germany	2-20,000	East Germany	14,000
Israel and Jordan (Dead Sea)	1,200-1,400	United States	±250
France	300-400		
Spain	270-500	Total	16,722-54,950
Russia	700-18,400		

[1] SOURCE: President's Materials Policy Commission: Resources for Freedom, vol. 2—The Outlook for Key Commodities, June 1952, p. 158.

WORLD REVIEW

Available statistics of potash output in the various producing countries, as well as estimated world production totals, are shown in table 13.

Australia.—The plant of the State Alunite Works of Western Australia at Lake Campion was closed. Alunite continued to be produced in New South Wales.

Canada.[13]—To encourage exploration and development of potash, the prospecting regulations of Saskatchewan were revised, allowing three ways to obtain crown land: "Withdrawal" or "preprospecting," "exploration permit," and "lease."

Under the withdrawal or preprospecting method, a company can conduct preliminary investigations for a period of 6 months, on up to 100,000 acres, at a rental of 1½ cents per acre. Although no specific expenditure requirements are stated, "substantial expenditures" must be made on "wildcat" drilling.

The exploration permit, valid for a maximum of 3 years on areas up to 100,000 acres, at an annual rental of 5 cents per acre, requires a minimum of $220,000 to be spent on exploration and development within the 3-year period.

Leases, issued when a company desires to start producing potash, are valid for 21 years on areas from 640 to 10,000 acres.

The withdrawal regulations allow companies to cooperate in prospecting for potash and oil, sharing the costs of the drilling operations.

The consumption of potash in Canada has been about 100,000 tons a year. The development of a potash industry in Canada would result in independence from foreign markets.

Western Potash Corp., Ltd., continued its exploration program in the Unity-Vera district of Saskatchewan throughout 1952, and a number of holes were drilled during the year which intersected potash beds ranging from 5½ to 17½ feet thick and assaying 19 to 38 percent KCl. Additional drilling was planned to ascertain the most favorable area to lease. Western Potash Corp. has contracted with Forsberg &

[13] Canadian Chemical Processing, Potash in Saskatchewan: Vol. 36, No. 11, October 1952, p. 22.
Canadian Mining Journal: vol. 73, No. 1, January 1952, pp. 89-90; No. 7, July 1952, p. 96; No. 9, September 1952, p. 112; No. 12, December 1952, pp. 80, 82.
Chemical Age, Potash Search in Canada: Vol. 66, No. 1720, June 28, 1952, p. 978.
Chemical Week, vol. 71, No. 24, Dec. 13, 1952, p. 60.
Commercial Fertilizer, vol. 84, No. 1, January 1952, p. 28.
Foreign Commerce Weekly, Potash Discovered in Canada: Vol. 47, No. 11, June 16, 1952, p. 15.
Mining World, vol. 14, No. 2, February 1952, pp. 56, 58.
Northern Miner, vol. 37, No. 47, Feb. 14, 1952, p. 16; No. 48, Feb. 21, 1952, p. 6; vol. 38, No. 22, Aug. 21, 1952, p. 2; No. 28, Oct. 2, 1952, p. 19.
Precambrian, vol. 25, No. 11, November 1952, p. 45.
Rock Products, vol. 55, No. 10, October 1952, p. 160.

TABLE 13.—World production of potassium salts and equivalent K_2O, by countries,[1] 1947–52, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1947		1948		1949		1950		1951		1952	
	Potassium salts	Equivalent K_2O	Potassium salts	Equivalent K_2O	Potassium salts	Equivalent K_2O	Potassium salts	Equivalent K_2O	Potassium salts	Equivalent K_2O	Potassium salts	Equivalent K_2O
North America: United States	1,728,882	934,282	1,939,998	1,034,077	1,865,715	1,014,586	2,034,485	1,168,197	2,245,153	1,288,489	2,600,397	1,510,557
South America: Chile	3,259	900	6,655	1,913	5,020	1,422	(3)	1,442	(3)	(3)	(3)	(3)
Europe:												
France (Alsace)	4,168,725	632,844	4,470,260	683,585	5,285,649	798,510	5,562,000	1,017,800	5,518,800	987,600	[4] 6,200,000	1,054,000
Germany:												
West Germany	3,455,586	342,409	5,276,348	538,507	7,290,000	748,800	8,927,219	1,094,286	10,847,520	1,323,913	12,585,300	1,553,700
East Germany	(3)	[4] 720,000	(3)	[4] 823,000	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Spain	917,865	195,892	992,743	151,185	918,156	151,542	1,013,333	161,619	1,058,884	172,870	1,052,016	172,644
Asia:												
India	4,211	2,032	3,020	2,540	6,456	3,048	5,589	2,743	6,486	3,251	(3)	(3)
Israel and Jordan [5]	123,163	60,830	[6] 9,724	[6] 5,834	----------	----------	----------	----------	----------	----------	----------	----------
Japan	2,259	135	1,984	[4] 120	3,544	213	3,396	203	3,897	(3)	2,614	157
Africa: Eritrea	----------	----------	115	(3)	420	203	555	264	----------	----------	----------	----------
Australia:												
New South Wales	406	30	712	53	436	33	406	30	456	34	[4] 425	[4] 30
Western Australia	34,882	572	39,759	652	32,782	1,471	919	84	----------	----------	----------	----------
Total (estimate)	----------	3,000,000	----------	3,500,000	----------	3,900,000	----------	4,500,000	----------	4,900,000	----------	5,500,000

[1] In addition to countries listed, China, Ethiopia, Italy, Korea, and U. S. S. R. are reported to produce potash salts, but statistics of production are not available; estimates by senior author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous potassium salts chapters.
[3] Data not available; estimate by author of the chapter included in total.
[4] Estimate.
[5] Year ended June 30 of year stated; 1947–48 is for Palestine. Extracted from waters of Dead Sea.
[6] Production ceased April 1948, when work was discontinued owing to destruction of the Palestine Potash, Ltd., large plant during hostilities of 1948.

Co., Ltd., of Winnipeg, to sink a 7- by 12-foot shaft to a depth of 3,500 feet about 9 miles northwest of Unity, near the discovery site. At the end of 1952 the concrete shaft collar had been poured. Construction of a quarter-mile spur from the Canadian National Railway was underway to supplement the recently completed road. Living quarters and mine buildings were under construction. It was announced that the corporation plans to dissolve the sylvinite underground and pump the solution to the surface for recovery of potassium chloride by evaporation and recrystallization in a refinery capable of treating 1,000 tons of ore per day.

A second company, Liberal Petroleums, Ltd., held prospecting permits covering 100,000 acres in the Palo district 45 miles southwest of Unity.

The Potash Company of America, one of the major United States producers, actively participated in the search for Canadian potash. PCA was granted preprospecting permits on 175,000 acres of land southeast of Saskatoon in June 1952 and conducted exploratory drilling throughout the remainder of the year.

Chile.—The Chilean nitrate industry had numerous labor strikes throughout the year, resulting in a 40-percent increase in wages. These interruptions decreased production substantially.

France.—The Mines Dómaniales de Potasse d'Alsace shut down its Amélie mines for a short period during 1952 to install new mining equipment obtained from the United States. Production is expected to increase substantially from this increased mechanization.

Exports of potash materials from France decreased 16 percent in 1951 as compared with 1950 (table 14). The data for 1952 are not yet available. European countries continued to be the major recipients, taking 65 percent of the exports in 1951 and 69 percent in 1950. The Western Hemisphere received about 14 percent of France's potash exports, the United States taking about half.

TABLE 14.—Potash materials exported from France 1950–51, by countries, in short tons

Country	1950	1951	Country	1950	1951
Europe:			Oceania: Australia and New Zealand		20,865
Austria	18,315	19,146	Africa: Algeria		25,334
Belgium-Luxembourg	167,827	105,887	South America:		
Denmark	57,172	28,626	Argentina		989
Finland	1,838	9,796	Brazil	20,346	19,122
Italy	29,218	36,999	Colombia		11,822
Netherlands	245,054	195,696	North America:		
Norway	9,744	13,387	Canada	27,181	21,910
Sweden	48,698	21,676	Cuba		6,232
Switzerland	30,215	31,055	United States	55,098	74,436
United Kingdom	205,250	173,357	Other countries	152,896	69,124
Yugoslavia		7,248			
Asia:			Total	1,174,820	982,713
Ceylon	13,193	21,158			
China	6,566	8,413			
India and Burma		7,250			
Japan	86,209	50,007			
Philippines		3,178			

East Germany.—The 5-year plan [14] inaugurated in 1951 called for an increase in production from 1.5 million tons K_2O per year to 1.68 million tons by 1955.

With nearly two-thirds of Germany's prewar potash industry, East Germany is striving to build up world markets for its increased production.

The port of Wismar on the Baltic Sea was enlarged to permit handling of larger vessels. This port has become the main transshipment port for potash materials, especially to the Far East.

West Germany (Federal Republic of Germany).—The major producing companies in West Germany (Salzdetfurth, Wintershall, Burbach, and Kalichemie) continued to increase potash production by modernizing the active mines and rehabilitating many of the abandoned mines.

Reconstruction of the Königshall and Hindenburg shafts, which were flooded in 1939, was completed by the Burbach Co. This company conducted experiments with flotation methods for processing the potash ores, but no results were announced.

The Hildesia and Glückauf shafts are resuming production.

West German potash consumption was increasing slowly, and German producers depended mainly on exports to consume the largest share of the expanded production.

Exports of potash materials from West Germany, by countries of destination from 1950–52, are shown in table 15. Total exports in 1952, the highest since before World War II, were 44 percent above those of 1951. Europe received 76 percent of the potash exported from West Germany in 1952 compared to 40 percent in 1951 and 35 percent in 1950. The quantity exported to the United States was 58 percent less in 1952 than in 1951 and was less than 10 percent of the total exports from West Germany in 1952.

Israel.—A new corporation, The Dead Sea Works, Ltd., purchased the British-owned potash works at the southern end of the Dead Sea. The voting stock in the new corporation was owned 51 percent by the Israel Government, 16 percent by Palestine Potash, Ltd., and the remainder by the public.[15] The road from the plant to Beersheba was completed during 1952, and it was planned to begin operations during 1953.

Japan.—The production of alunite continued during 1952 but the bulk of Japan's requirements were met by imports from the major European producers.

Jordan.—The Government of Jordan in December 1952 revoked the concession under which Palestine Potash, Ltd., recovered minerals of the Dead Sea. This concession had been in force for 23 years. Future recovery operations are expected to be conducted by a new joint government and private corporation.

---

[14] Fertilizer and Feeding Stuffs Journal, East German Potash: Vol. 38, No. 23, November 12, 1952, pp. 749, 751.

[15] Mining World, Israel: Vol. 14, No. 10, September 1952, p. 76.
Chemical Age, Palestine Potash Pact: Vol. 66, No. 1719, June 21, 1952, p. 945.

TABLE 15.—Potash materials exported from West Germany 1950–52, by countries, in short tons [1]

Country	1950	1951	1952
South America: Brazil	-----------	12,196	1,929
North America:			
Canada	6,393	7,220	6,425
Puerto Rico	-----------	-----------	11,657
United States	84,088	204,934	85,224
Europe:			
Austria	-----------	-----------	11,910
Belgium-Luxembourg	8,958	19,260	145,505
Denmark	1,246	57,022	150,733
Greece	7,738	13,240	-----------
Irish Free State	1,334	19,395	11,947
Italy	10,003	14,904	8,406
Netherlands	311	7,253	211,586
Portugal	-----------	1,819	2,204
Sweden	278	-----------	11,791
Switzerland	7,170	3,685	18,221
United Kingdom	106,000	114,091	126,588
Oceania: Australia and New Zealand	-----------	-----------	5,387
Asia:			
Ceylon	2,812	4,795	831
Formosa	-----------	19,324	-----------
India	21	5,998	685
Indonesia	4,641	1,651	-----------
Japan	140,007	94,392	54,758
Korea	2,615	-----------	7,167
Turkey	165	1,213	3,582
Africa: Union of South Africa and Northern and Southern Rhodesia	2,055	13,150	11,279
Other countries	19,055	18,724	27,277
Total	404,890	634,266	915,092

[1] SOURCE: Germany (Federal Republic) Statistisches Bundesamt. 1950 and 1951 includes chloride and sulfate only. 1952 includes crude salts, chloride, sulfate, magnesium sulfate, and beet ash.

Spain [16].—Mechanization of the mines of Potasas Espanoles, S. A., was scheduled to be completed in 1953. This operation was made possible by a $1.5 million Export-Import Bank loan in 1951.

Fodina, S. A., was formed by Instituto Nacional de Industria (INI) to exploit the potash deposits in Catalunya and planned initial production by 1955.

Results of the exploration done by Empresa Nacional "Adaro" de Investigaciones Minerales (INI subsidiary) had not yet been published. This company drilled deposits of potassium salts discovered by the Spanish Geological Institute in the Province of Navarro. Tentative plans called for sinking two shafts for further exploration of these deposits, which contain 16 to 18 percent K_2O. Production was obtained from deposits containing 13 to 14 percent K_2O material.

Exports of potash materials from Spain were 31 percent higher in 1951 than in 1950 (table 16). Data for 1952 are not yet available

[16] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 2, August 1952, pp. 34–36; vol. 35, No. 3, September 1952, pp. 49–50.

Countries of Europe received 50 percent of the exports in 1951 as compared to 72 percent in 1950. The United States received the largest tonnage—about one-third of the total exports from Spain in 1951.

TABLE 16.—Potash materials exported from Spain [1] 1949–51, in short tons

Country	1949	1950	1951
North America: United States	------------	32,419	88,075
Europe:			
Belgium-Luxembourg	73,360	48,715	48,064
Irish Free State	------------	5,500	5,368
Italy	2,381	------------	13,209
Netherlands	18,421	5,907	4,189
Norway	15,653	11,473	13,297
Portugal	11,356	8,859	10,979
Sweden	------------	4,409	------------
United Kingdom	57,783	63,262	39,222
Asia:			
Korea	43,069	------------	------------
Japan	39,793	20,139	43,216
Other countries	2,422	5,573	5,192
Total	264,238	206,256	270,811

[1] SOURCE: 1949–50—Estadistica del Commercio Exterior de Espana. 1951 Preliminary Spanish Tariff figures. Includes sulfate and chloride and other potash compounds used as fertilizers.

Pumice and Pumicite

By Henry P. Chandler[1] and Annie L. Marks[2]

BEFORE 1944 the principal use for pumice and pumicite (volcanic ash) in the United States was for abrasives, with smaller quantities employed in concrete aggregate, acoustic plaster, and a number of miscellaneous uses; the total production for 1944 was 88,757 short tons. By 1951 these uses had risen to 749,942 short tons, concrete aggregates taking 96 percent of that year's output. The output of pumice and pumicite, however, declined during 1952.

DOMESTIC PRODUCTION

Pumice and pumicite were mined in 14 States during 1952; 57 operating units reported to the Bureau of Mines. From a record output of 749,942 short tons in 1951, production declined over 20 percent in 1952 to 597,044 short tons, and its value decreased 18 percent to $2,266,981.

New Mexico was the largest pumice-producing State in 1952, with 7 firms reporting, followed in order by California with 23, Idaho with 4, and Colorado with 2. No commercial output was reported east of Kansas, and Alaska reported no production that year.

Pumice and pumicite usually are mined by opencut methods, although in some instances systems of adits and drifts are used.

CONSUMPTION AND USES

Pumice and pumicite are light in weight—1 cubic yard in pebble form weighing between 825 and 900 pounds—as compared with ordinary sand and gravel, which range from 2,600 to 3,000 pounds per cubic yard. The dead air cells in pumice give it excellent insulating properties against heat and sound, and its composition makes it virtually fireproof.

A reduction of 166,271 short tons in the use of pumice and pumicite as a concrete aggregate and admixture from the preceding year accounted for the overall decline in use during 1952, as the other uses for pumice showed slight increases.

Concrete aggregates and admixtures consumed 93 percent of the 1952 production; abrasive uses, 4 percent; and acoustic plaster and other uses, 3 percent.

Pumice was used in concrete largely near its areas of production, as usually it cannot compete with other lightweight aggregate materials in the field of construction when freight charges to distant points are added to the original price. On the eastern seaboard, imported

[1] Commodity-industry analyst.
[2] Statistical clerk.

pumice has found a market in competition with other lightweight aggregates at several points.

Besides its use as an abrasive and for acoustic plaster, minor uses of pumice included insecticides, insulation, brick manufacturing, filtration, surfacing and ice control of roads, absorbents, and as a soil conditioner.

A firm in Maryland started the production of concrete block, using pumice aggregate imported from Greece. Three companies on the eastern seaboard now produce concrete block with pumice from the same source.[3]

TABLE 1.—Pumice and pumicite sold or used by producers in the United States, 1943–47 (average) and 1948–52

Year	Short tons	Value	Year	Short tons	Value
1943–47 (average)	218,671	$1,194,855	1950	719,356	$2,661,052
1948 [1]	607,746	2,501,906	1951 [1]	749,942	2,752,907
1949	716,742	2,369,082	1952	597,044	2,266,981

[1] Includes Alaska.

TABLE 2.—Pumice and pumicite sold or used by producers in the United States, 1950–52, by States

State	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
California	157,497	$970,826	264,411	$1,228,569	129,780	$793,716
Idaho	93,990	121,044	83,528	133,192	88,085	141,253
New Mexico	351,642	1,109,883	245,564	884,311	217,482	755,139
Oregon	79,653	320,530	47,026	137,136	59,578	201,809
Utah	8,719	10,891	9,422	11,478	(1)	(1)
Washington	11,013	22,672	5,105	10,832	3,604	8,089
Wyoming	1,460	6,353	1,867	9,141	2,851	10,918
Other States [2]	15,382	98,853	93,019	338,248	95,664	356,057
Total	719,356	2,661,052	749,942	2,752,907	597,044	2,266,981

[1] Included with "Other States" to avoid disclosure of individual company operations.
[2] Includes State indicated by footnote 1 and, Alaska (1951), Arizona (1951–52), Colorado, Kansas, Montana (1950–51), Nebraska, Nevada, Oklahoma, and Texas.

TABLE 3.—Pumice and pumicite sold or used by producers in the United States, 1950–52, by uses

Use	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Abrasive:						
Cleansing and scouring compounds and hand soaps	15,362	$198,053	8,205	$124,314	17,308	$177,609
Other abrasive uses	12,214	410,243	4,485	318,013	5,121	248,977
Acoustic plaster	6,662	151,766	3,761	112,518	3,934	100,097
Concrete admixture and concrete aggregate	672,125	1,750,269	720,170	1,988,204	553,899	1,525,331
Other uses [1]	12,993	150,721	13,321	209,858	16,782	214,967
Total	719,356	2,661,052	749,942	2,752,907	597,044	2,266,981

[1] Insecticide, insulation, brick manufacture, filtration, solvents, roads (surfacing and ice control), absorbents, soil conditioner, and miscellaneous uses.

[3] Pit and Quarry, Pumice Block: Vol. 55, No. 9, September 1952, p. 154.

STOCKS

As production of sales of pumice and pumicite are usually in balance, stocks of material on hand are relatively constant and small and are not covered by the Bureau of Mines canvass.

PRICES

As reported in the Oil, Paint and Drug Reporter, the quotations on domestic and imported pumice remained at nearly the same levels as the previous year and were as follows: Domestic, common, ground, coarse to fine, in bags, ton lots, 3⅝ to 4¼ cents a pound; smaller lots, 3⅞ to 4½ cents a pound. Italian, silk-screen, coarse, bags, ton lots, 6½ cents a pound; fine, bags, ton lots, 4 cents a pound; sun-dried, coarse, bags, ton lots, 2½ to 4 cents a pound; fine, bags, ton lots, 2½ to 4 cents a pound. Pumice in barrels is ½ cent a pound higher. The E&MJ Metal and Mineral Markets quoted per pound, f. o. b., New York or Chicago, in barrels, powdered, 3 to 5 cents; lump, 6 to 8 cents.

The value of pumice and pumicite at the mine in 1952 for the 57 producers reporting to the Bureau of Mines is shown in table 4.

TABLE 4.—Crude and prepared pumice and pumicite sold or used by producers in the United States in 1952

	Short tons	Value	Average value
Crude	230,977	$508,285	$2.20
Prepared	366,067	1,758,696	4.80
Total	597,044	2,266,981	3.80

Average domestic values per ton at the mine for the preceding 3 years were: 1951, $3.67; 1950, $3.70; 1949, $3.31.

FOREIGN TRADE[4]

During 1952 the importations of crude or unmanufactured pumice into the United States totaled 21,986 short tons valued at $135,305, or $6.15 a ton. Imports of wholly or partly manufactured pumice totaled 478 short tons valued at $9,792, or $20.49 a ton. Also other types of pumice not otherwise specified, valued at $6,301, were imported. The duty on imported pumice was: Unmanufactured, valued at $15 or less a short ton, $1 a ton; valued at over $15 a short ton, ⅛ cent a pound; manufactured pumice, ½ cent a pound.

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

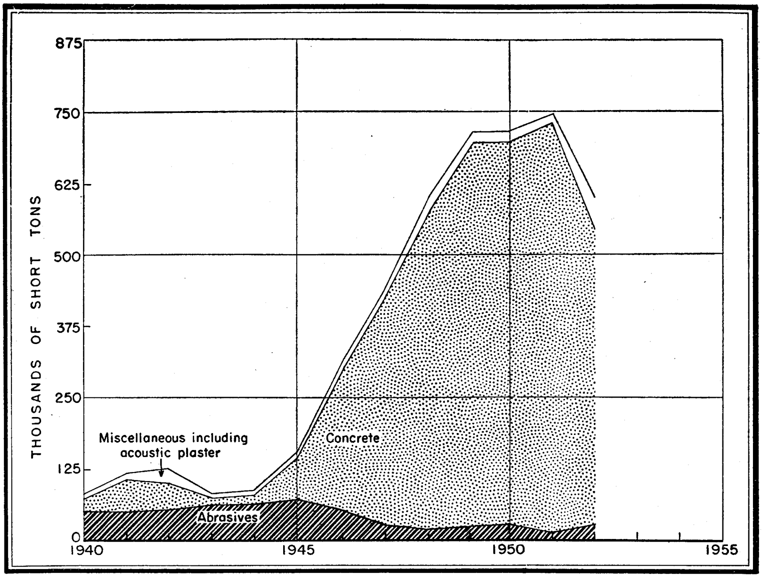

FIGURE 1.—Pumice and pumicite sold or used, by specified uses, 1937–52.

TABLE 5.—Pumice and pumicite imported for consumption in the United States in 1952

[U. S. Department of Commerce]

Country	Crude or unmanufactured				Wholly or partly manufactured	
	Valued at $15 or less a ton		Valued at over $15 a ton			
	Short tons	Value	Short tons	Value	Short tons	Value
Italy	6, 926	$63, 719	690	$13, 659	478	$9, 792
Greece	14, 370	57, 927				
Total	21, 296	121, 646	690	13, 659	478	9. 792

TABLE 6.—Pumice and pumicite imported for consumption in the United States, 1950–52

[U. S. Department of Commerce]

	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Crude or unmanufactured	19, 268	$125, 726	15, 752	$182, 737	21, 986	$135, 305
Wholly or partly manufactured	982	18, 356	750	18, 041	478	9, 792
Manufactures, n. s. p. f.		953		2, 591		6, 301

TECHNOLOGY

Description of certain pumice deposits in Oregon, with discussion of the economic factors relating to the profitable utilization of pumice, especially its use as a lightweight aggregate, appeared in a recent survey.[5]

Alaskan pumice deposits were the subject of an article in a trade publication.[6]

WORLD REVIEW

Next to the United States, Italy is the largest producer of pumice and pumicite, the deposits on the island of Lipari being the most important. In Greece, pumice from the deposits on the island of Santorini in the Aegean Sea found a market both in Europe and the United States.

TABLE 7.—World production of pumice, by countries [1], 1948–52, in metric tons

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
Egypt	800	450	380	[2] 400	400
France	17,070	15,038	17,578	[2] 18,000	[2] 18,000
Greece [3]	37,000	47,000	53,000	65,000	30,965
Italy	31,501	76,877	103,597	123,884	[2] 125,000
New Zealand	6,973	13,335	9,872	8,915	9,766
Spain	212	984	[2] 1,000	[2] 1,000	[2] 1,000
United States (sold or used by producers)	551,335	650,214	652,585	680,332	541,626
Total (estimate)	695,000	850,000	890,000	940,000	780,000

[1] Pumice is also produced in Argentina, Canada, Germany, Japan, U. S. S. R., and a few other countries, but data on production are not available; estimates by author of chapter included in total.
[2] Estimate.
[3] These figures include the following tonnages of Santorini earth: 1948: 30,000 tons; 1949: 35,000 tons; 1950: 38,000 tons; 1951: 45,000 tons; 1952: 18,528 tons.

[5] News Letter, Raw Materials Survey, Inc., Pumice Deposits of Klamath Indian Reservation, Klamath County, Oreg.: Geol. Survey Circ. 128, issue 1, ser. 52, Mar. 10, 1952, p. 3.
[6] Rock Products, Alaskan Pumice Deposits: Vol. 55, No. 6, June 1952, p. 89.

Radio-Grade Quartz

By Waldemar F. Dietrich[1] and Gertrude E. Tucker[2]

THIS CHAPTER is confined to radio-grade or piezoelectric quartz crystal, which became an important strategic material during World War II when quartz-crystal oscillators were adopted by the United States Army Signal Corps for frequency control in mobile communication units. Other uses for quartz crystal, usually less exacting, are for optical applications (for example, prisms, wedges, and lenses), gems, and fusing stock.

The consumption of radio-grade quartz crystal and the number of piezoelectric units produced reached post-World War II peaks in 1952 owing to expanded military requirements of frequency control equipment.

Brazil continued to supply about 97 percent of the optical- and radio-grade quartz crystal used in the United States. Domestic production was negligible.

CONSUMPTION AND USES

During 1952 the number of piezoelectric units produced per pound of radio-grade quartz increased progressively from 9.6 in the first quarter to 13.7 in the fourth quarter. The yearly average for 1952 of 12.3 units per pound was an increase over 1951, but the figure was considerably below the peak of 20.3 units per pound recovered in 1949. New types of units and the higher precision required by new specifications and the continued trend toward the use of small crystals in the range of 50 to 200 grams decreased the potential maximum number of units obtainable per pound of crystal.

Radio-grade quartz-crystal cutters and producers of quartz piezoelectric units were distributed in 20 States and the Territory of Hawaii, as shown in table 1. Over one-third of the radio-grade quartz consumption and production of piezoelectric units in the United States was in Pennsylvania, although the largest number of individual companies was in California. Most of the 42 consumers were also producers of finished piezoelectric units, and some of them supplied blanks to those among the 51 piezoelectric unit producers that do not cut crystals.

PRICES

Radio-grade quartz crystals continued to be priced in accordance with weight, percent usability, type and distribution of flaws, and whether faced or unfaced. The Brazilian Government maintained a schedule of prices, known as a "Tabela", for various weight groups and quality classes as a basis for minimum declared values of export

[1] Chief, Ceramic and Fertilizer Materials Branch.
[2] Statistical assistant.

TABLE 1.—Consumption of radio-grade quartz and production of piezoelectric units in the United States in 1952, by States

State	Consumption of radio-grade quartz		Production of piezoelectric units [1]	
	Number of consumers	Number of pounds consumed	Number of producers	Number of units produced
California	8	34,500	9	567,800
Connecticut and Massachusetts	3	8,900	3	79,900
Florida and Georgia	3	16,500	3	302,200
Illinois, Iowa, and Kansas	6	172,400	9	1,800,700
Maryland and New Jersey	5	48,000	5	452,300
Missouri, Nebraska, and Oklahoma	1	(2)	3	297,200
New York	3	18,300	4	210,800
North Carolina	1	1,100	1	3,700
Pennsylvania	5	178,000	6	2,274,400
Texas	1	100	3	4,600
Other States [3]	6	[4] 24,700	5	187,900
Total	42	502,500	51	6,181,500

[1] Includes oscillators, resonators, and other piezoelectric units.
[2] Included under "Other States" to avoid revealing individual company figure.
[3] Includes Hawaii, Louisiana, Ohio, Virginia, and a small quantity unspecified by State.
[4] Includes consumption of radio-grade quartz in Nebraska to avoid revealing individual company figure. No consumption of quartz was recorded for Missouri and Oklahoma.

TABLE 2.—Minimum allowable declared value of quartz-crystal exports from Brazil in 1952 [1]

[Dollars per pound] [2]

Weight group (grams)	Quality class [3]		
	1	2	3
200 or less			1.25
201-300	4.50	2.50	1.25
301-500	7.50	3.75	1.88
501-700	10.00	5.00	2.50
701-1,000	15.00	6.25	3.12
1,001-2,000	20.50	7.50	3.75
2,001-3,000	24.75	8.75	4.38
3,001-4,000	28.75	10.00	5.00
4,001-5,000	32.50	11.25	5.62

[1] Established by the National Department of Mineral Resources of the Brazilian Ministry of Agriculture.
[2] 1 cruziero per kilogram—$0.025 per pound (approx.)
[3] The first 2 classes cover first-quality crystals exceeding 200 grams in weight; crystals in class 1 have over 60 percent usability; and crystals in class 2 have 30 to 60 percent usability. Class 3 includes crystals up to 200 grams in weight with over 60 percent usability; and crystals weighing over 200 grams with a minimum of 30 percent usability.

shipments (table 2). In 1952 the declared values at Rio de Janeiro, Brazil, of the exports to the United States, were about the same as the Tabela prices. Resale prices in the United States were negotiated between buyer and importer.

FOREIGN TRADE

Statistics on imports of quartz crystal for previous years combined radio-, optical- and fusing-grade quartz and small quantities of ornamental quartz. Industry advices and interpolation from Brazilian export statistics were used to prepare the estimates of imports of radio- and optical-grade quartz crystal (1940-52) given in table 3. The differences between the total imports of uncut quartz crystal and the estimated imports of radio- and optical-grade quartz crystal represent the estimated quantities and values of fusing-grade quartz imported from Brazil. Imports of uncut quartz crystal for ornamental purposes were believed to be negligible.

In 1952 imports totaling 31,400 pounds of radio- and optical-grade quartz crystal were reported from France, Japan, and Madagascar, and a total of 300 pounds was imported from West Germany and India. The imports from France probably originated in Madagascar, and those from Japan probably were surplus stocks from various sources. All imports of fusing-grade and the balance of imports of radio- and optical-grade quartz crystal came from Brazil.

Exports of raw quartz crystal in 1952 were valued at $18,466.

TABLE 3.—Imports of uncut quartz crystal, estimated imports of radio- and optical-grade quartz crystal, consumption of radio-grade quartz, and production of piezoelectric units in the United States, 1940–52

Year	Total imports of uncut quartz crystal [1]		Estimated imports of radio- and optical-grade quartz crystal [2]			Consumption of radio-grade quartz [3] (pounds)	Piezoelectric units [4]	
	Pounds	Value	Pounds	Value	Value per pound		Production (number)	Number per pound
1940	126,521	$264,436	(5)	(5)	(5)	31,000	(5)	(5)
1941	2,237,608	3,830,344	1,674,900	$3,779,700	$2.26	59,000	(5)	(5)
1942	2,612,106	8,987,108	2,431,400	8,969,000	3.69	682,000	6,888,000	10.1
1943	3,356,000	11,409,803	3,356,000	11,409,800	3.40	1,588,000	22,575,000	14.2
1944	2,300,506	11,178,643	2,118,500	11,115,000	5.25	1,858,000	29,939,000	16.1
1945	1,329,798	6,190,621	1,329,800	6,190,600	4.66	1,040,000	18,918,000	18.2
1946	370,556	2,376,598	216,400	2,328,800	10.76	172,400	1,744,100	10.1
1947	473,788	1,815,468	264,800	1,782,000	6.73	68,100	1,052,400	15.5
1948	1,238,820	4,209,531	1,224,900	4,205,500	3.43	61,600	1,225,400	19.9
1949	319,631	1,462,018	306,800	1,460,200	4.76	46,200	937,100	20.3
1950	310,251	791,412	241,200	785,900	3.26	114,300	1,614,000	14.1
1951	[6] 1,287,398	[6] 2,090,061	843,200	2,045,600	2.43	282,300	3,290,000	11.7
1952	1,576,791	2,885,437	1,049,300	2,881,600	2.75	502,500	6,181,500	12.3

[1] From U. S. Department of Commerce: Includes radio-, optical-, ornamental- and fusing-grade quartz crystal.
[2] Estimated from industry advices and Brazilian Government statistics.
[3] 1940–44, War Production Board.
[4] 1942–44, War Production Board.
[5] Data not available.
[6] Revised figure.

TECHNOLOGY

Considerable progress was made in the hydrothermal synthesis of quartz crystals, principally through research and pilot-plant studies sponsored by the United States Army Signal Corps. The Brush Development Co., Cleveland, Ohio,[3] and the Bell Telephone Laboratories, Inc., Murray Hill, N. J., operated pilot plants that produced substantial quantities of synthetic quartz crystals. Various other Signal Corps cooperators, including the Edward Washken Laboratories, University of Minnesota, Antioch College, Pennsylvania State College, Washington University, and Harvard University contributed to various aspects of the fundamental science of crystal growth[4] and

[3] Hale, Danforth R., The Properties of Synthetic Quartz Crystals and Their Growing Technique: Brush Strokes, The Brush Development Co., Cleveland, Ohio, December 1952, pp. 1–6.
[4] Unpublished papers presented at the Sixth Annual Frequency Control Review of Technical Progress, Asbury Park, N. J., May 6–8, 1952.

the properties of synthetic quartz crystals. Research in the same field was conducted in England.[5]

The conditions necessary for the growth of α-quartz in alkali halide solutions using fused quartz as a source material and α-quartz as seed were described by Corwin and Swinnerton.[6]

Studies of the inversion-temperature range of natural and synthetic quartz indicated that variations in the range were due to the presence of impurities in solid solution. The inversion temperature is a criterion of the temperature of formation of quartz in similar chemical environments, and there may be a relationship between the inversion temperature and geologic occurrence.[7] The darkening observed in natural and synthetic crystals on exposure to X-rays is also attributed to impurities.[8]

The status of synthetic-quartz-crystal developments at the end of 1952 indicated that quartz-crystal synthesis may compete commercially with natural crystal in terms of finished oscillator units. Synthetic crystals have a higher usability factor than natural crystals, and the uniformity of size and shape favors efficient factory production of piezoelectric units.

Recent studies indicate that it may be possible to develop commercial processes that will operate at temperatures and pressures for which standard high-pressure steam-pipe fittings are suitable. Most prior research was done in the range of 500 to 1,000 atmospheres pressure and at temperatures up to about 850° F., conditions that require autoclaves of heavy construction and special alloys.

The quartz-crystal deposits of western Arkansas were described by Engel,[9] based on field work in 1942–43.

[5] Brown, C. S., Kell, R. C., Thomas, L. A., Wooster, Nora, and Wooster, W. A., The Growth and Properties of Large Crystals of Synthetic Quartz: Mineral. Mag., vol. 29 (217), June 1952, pp. 858–874.

[6] Corwin, James F., and Swinnerton, A. C., Growth of Quartz in Alkali Halide Solutions: Jour. Am. Chem. Soc., vol. 73, No. 8, 1951, pp. 3598–3601.

[7] Keith, M. L., and Tuttle, O. F., Significance of Variation in the High-Low Inversion of Quartz: Am. Jour. Sci., Bowen vol., Pt. 1, 1952, pp. 203–252.

[8] Brown, C. S., and Thomas, L. A., Response of Synthetic Quartz to X-Ray Irradiation: Nature, vol. 169 (4288), 1952, pp. 35–36.

[9] Engel, A. E. J., Quartz-Crystal Deposits of Western Arkansas: Geol. Survey Bull. 973–E, 1952, pp. 173–260.

Salt

By Joseph C. Arundale[1] and Flora B. Mentch[2]

NEARLY 20 million short tons of salt was produced in the United States in 1952, only slightly less than the record output in 1951. Large-scale production of brine in Alabama was begun to supply a new chlorine and caustic soda plant. Several new technologic developments were announced.

TABLE 1.—Salient statistics of the salt industry in the United States,[1] 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Sold or used by producers:						
Dry salt:						
Evaporated (manufactured) short tons	3,303,165	3,207,403	3,284,361	3,329,288	3,654,808	3,641,885
Rock salt do	3,475,895	3,846,846	3,444,341	3,927,267	4,662,194	4,567,531
Total do	6,779,060	7,054,249	6,728,702	7,256,555	8,317,002	8,209,416
Value	$38,268,519	$46,430,927	$45,956,223	$51,795,728	$58,425,022	$59,757,322
Average per ton	$5.65	$6.58	$6.83	$7.14	$7.02	$7.28
In brine:						
Short tons	8,723,238	9,349,044	8,843,513	9,373,254	11,890,129	11,335,798
Value	$6,984,253	$7,900,855	$7,670,015	$8,115,615	$11,309,978	$11,252,767
Total salt:						
Short tons	15,502,298	16,403,293	15,572,215	16,629,809	20,207,131	19,545,214
Value [2]	$45,252,772	$54,331,782	$53,626,238	$59,911,343	$69,735,000	$71,010,089
Imports for consumption:						
Short tons	3,505	5,621	6,309	7,869	4,329	7,056
Value	$34,164	$40,748	$60,605	$58,819	$46,831	$53,059
Exports:						
Short tons	208,581	387,601	359,776	190,377	439,114	349,971
Value	$2,025,743	$5,930,170	$3,353,115	$1,776,062	$3,501,904	$3,458,363
Apparent consumption: [3] short tons	15,297,222	16,021,313	15,218,748	16,447,301	19,772,346	19,202,299

[1] Includes Hawaii (1952) and Puerto Rico.
[2] Values are f. o. b. mine or refinery and do not include cost of cooperage or containers.
[3] Quantity sold or used by producers, plus imports, minus exports.

DOMESTIC PRODUCTION

Production of salt in the United States in 1952 declined slightly from the record high in the previous year; this decrease consisted largely of a drop of a little more than half a million tons in the production of salt in brine and reflected the decreasing production of soda ash. In January 1952 the Defense Production Administration announced an annual domestic production of 3,430,000 short tons of chlorine as a goal to be reached by 1955, an increase of about 1,230,000 tons over capacity in 1950.

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.

Michigan continued to lead the country in salt production, with New York and Ohio, respectively, in second and third place; Texas was a close fourth, followed by Louisiana. Output in most major producing States except Texas decreased slightly; in that State it increased nearly a quarter million tons. Production of all types of salt, except vacuum pan, figured in the national decrease.

The first large-scale production of salt in Alabama began in 1952, when Mathieson Chemical Corp. completed construction of a chlorine and caustic soda plant for its subsidiary, the Mathieson Alabama Chemical Corp., which will utilize brine from wells near McIntosh about 43 miles north of Mobile. Operation of these newly constructed facilities commenced in August of 1952.

Salt has been produced in California, in the San Francisco Bay area, for nearly 100 years. Here, the Leslie Salt Co. operates the largest and most highly mechanized solar evaporation salt works in the world; it was described in some detail in an article.[3]

TABLE 2.—Salt sold or used by producers in the United States, 1950–52, by States

State	1950			1951			1952		
	Quantity		Value	Quantity		Value	Quantity		Value
	Short tons	Percent of total		Short tons	Percent of total		Short tons	Percent of total	
California	868, 496	5	$3, 816, 655	1, 275, 574	6	$5, 261, 780	1, 148, 693	6	$4, 880, 392
Kansas	846, 374	5	5, 914, 514	900, 917	5	6, 639, 343	911, 744	5	6, 850, 027
Louisiana	2, 278, 811	14	6, 902, 502	2, 737, 149	14	7, 662, 179	2, 553, 448	13	7, 807, 693
Michigan	4, 446, 667	27	18, 178, 765	5, 137, 639	25	21, 221, 330	4, 778, 347	24	21, 446, 382
New York	2, 806, 927	17	14, 405, 362	3, 518, 715	17	16, 552, 890	3, 417, 443	17	16, 746, 462
Ohio	2, 515, 205	15	5, 491, 553	3, 112, 472	15	5, 848, 478	2, 827, 455	14	5, 991, 626
Puerto Rico	13, 545	(1)	137, 225	10, 566	(1)	119, 338	12, 676	(1)	122, 158
Texas	1, 852, 138	11	2, 846, 789	2, 401, 063	12	4, 000, 100	2, 640, 209	14	4, 402, 032
Utah	116, 694	1	511, 938	131, 444	1	570, 379	136, 125	1	522, 721
West Virginia	367, 942	2	1, 238, 588	379, 299	2	1, 314, 818	392, 519	2	1, 438, 490
Other States [2]	517, 010	3	467, 452	602, 293	3	544, 365	726, 555	4	802, 106
Total	16, 629, 809	100	59, 911, 343	20, 207, 131	100	69, 735, 000	19, 545, 214	100	71, 010, 089

[1] Less than 0.5 percent.
[2] Includes Alabama (1952), Hawaii (1952), Nevada, New Mexico, Oklahoma, and Virginia.

TABLE 3.—Salt sold or used by producers in the United States,[1] 1951–52, by method of recovery

Method of recovery	1951		1952	
	Short tons	Value	Short tons	Value
Evaporated:				
Bulk:				
Open pans or grainers	450, 835	$7, 860, 364	441, 534	$8, 303, 464
Vacuum pans	1, 912, 223	19, 287, 970	1, 946, 911	26, 099, 173
Solar	1, 007, 489	3, 750, 780	974, 985	3, 370, 097
Pressed blocks	284, 261	3, 936, 356	278, 455	3, 862, 723
Rock:				
Bulk	4, 591, 597	22, 801, 609	4, 499, 709	23, 285, 272
Pressed blocks	70, 597	787, 943	67, 822	836, 593
Salt in brine (sold or used as such)	11, 890, 129	11, 309, 978	11, 335, 798	11, 252, 767
Total	20, 207, 131	69, 735, 000	19, 545, 214	71, 010, 089

[1] Includes production in Hawaii (1952) and Puerto Rico.

[3] Schrier, Elliot, Passing the Salt: Chem. Eng., vol. 59, No. 10, October 1952, pp. 139–141.

TABLE 4.—Evaporated salt sold or used by producers in the United States, 1950–52, by States

State	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Kansas	344, 751	$4, 066, 310	360, 785	$4, 659, 036	358, 887	$4, 775, 741
Louisiana	115, 308	1, 119, 300	119, 368	1, 170, 304	111, 713	1, 134, 991
Michigan	868, 349	10, 736, 781	818, 845	11, 081, 126	847, 873	11, 260, 605
New York	487, 245	6, 375, 966	502, 216	6, 419, 061	508, 317	6, 674, 698
Ohio	472, 966	4, 274, 738	479, 246	3, 908, 141	461, 289	4, 189, 883
Puerto Rico	13, 545	137, 225	10, 566	119, 338	12, 676	122, 158
Texas	(1)	(1)	87, 644	1, 137, 376	97, 663	1, 259, 164
Other States [2]	1, 027, 124	5, 649, 977	1, 276, 138	6, 341, 088	1, 243, 467	6, 218, 217
Total	3, 329, 288	32, 360, 297	3, 654, 808	34, 835, 470	3, 641, 885	35, 635, 457

[1] Included with "Other States" to avoid disclosure of individual company operations.
[2] Includes California, Hawaii (1952), Nevada, New Mexico, Oklahoma, Texas (1950), Utah, and West Virginia.

TABLE 5.—Rock salt sold by producers in the United States, 1943–47 (average) and 1948–52

Year	Short tons	Value	Year	Short tons	Value
1943–47 (average)	3, 475, 895	$13, 133, 603	1950	3, 927, 267	$19, 435, 431
1948	3, 846, 846	16, 970, 742	1951	4, 662, 194	23, 589, 552
1949	3, 441, 341	16, 232, 479	1952	4, 567, 531	24, 121, 865

TABLE 6.—Pressed-salt blocks sold by original producers of the salt in the United States, 1943–47 (average) and 1948–52

Year	From evaporated salt		From rock salt		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	268, 925	$2, 705, 364	83, 602	$741, 801	352, 527	$3, 447, 165
1948	274, 511	2, 933, 694	48, 830	459, 986	323, 341	3, 393, 680
1949	268, 838	3, 270, 664	62, 749	602, 855	331, 587	3, 873, 519
1950	265, 835	3, 465, 935	63, 081	704, 600	328, 916	4, 170, 535
1951	284, 261	3, 936, 356	70, 597	787, 943	354, 858	4, 724, 299
1952	278, 455	3, 862, 723	67, 822	836, 593	346, 277	4, 699, 316

CONSUMPTION AND USES

The first use of salt is lost in antiquity. Since the human body has a relatively constant requirement for salt, obviously it was first employed as a food and, since earliest times, as a food seasoning and preservative. Few, if any, mineral commodities have had such a long and varied history or have greater importance to mankind, and probably no other mineral material has such an imposing number of uses. It literally has thousands of direct and indirect applications in a wide variety of products and services.

In the United States about 70 percent of the salt output is consumed as a raw material in the manufacture of other chemicals. The largest single use is in the manufacture of soda ash, which, in turn, has a multitude of applications. Other important uses of salt by the chemical industry are in the manufacture of caustic soda, sodium metal, chlorine, bleaches, chlorates, hydrochloric acid, and other chlorine and sodium compounds. To a lesser extent it is employed in manufacturing soap, dyes, textiles, and leather. In the food industry salt is indispensable in meat packing, fish curing, dairy products, refrigeration, and livestock feeds. It is used for ice and dust control on roads, in water purification, in heat-treating metals, and in smelting and refining metals. It is of interest that "table salt," the first use that comes to mind when salt is mentioned, is responsible for less than 3 percent of consumption in the United States.

TABLE 7.—Salt sold or used by producers in the United States, 1951–52, by classes and use, in thousands of short tons

Use	1951				1952			
	Evaporated	Rock	Brine	Total	Evaporated	Rock	Brine	Tota.
Chlorine, bleaches, chlorates, etc	515	917	3,277	4,709	527	907	3,817	5,251
Soda ash	(1)	--------	8,303	[1] 8,303	(1)	(2)	7,195	[1 2] 7,195
Dyes and organic chemicals	52	77	--------	129	43	67	--------	110
Soap (precipitant)	51	10	--------	61	30	11	--------	41
Other chemicals	107	728	(3)	[3] 835	118	603	(3)	[3] 721
Textile processing	21	103	(3)	[3] 124	23	104	(3)	[3] 127
Hides and leather	93	139	(3)	[3] 232	88	140	(3)	[3] 228
Meat packing	352	395	--------	747	344	420	--------	764
Fish curing	32	14	--------	46	20	11	--------	31
Butter, cheese, and other dairy products	63	6	--------	69	66	6	--------	72
Canning and preserving	173	29	--------	202	152	60	--------	212
Other food processing	221	10	--------	231	244	14	--------	258
Refrigeration	58	134	(3)	[3] 192	76	143	(3)	[3] 219
Livestock, agriculture, and general farm use [4]	735	321	--------	1,05(	777	305	--------	1,082
Highways, railroads and other dust and ice control	19	766	--------	785	17	800	--------	817
Table and other household use	496	104	--------	600	468	78	--------	546
Water treatment	295	315	(3)	[3] 610	282	338	(3)	[3] 620
Metallurgy	36	81	--------	117	35	71	--------	106
Undistributed [5]	336	513	310	1,159	332	489	324	1,145
Total	3,655	4,662	11,890	20,207	3,642	4,567	11,336	19,545

[1] Data for evaporated salt included with "Undistributed" to avoid disclosure of individual company operations.
[2] Data for rock salt included with "Undistributed" to avoid disclosure of individual company operations.
[3] Data for salt in brine included with "Undistributed" to avoid disclosure of individual company operations.
[4] Livestock salt is about 90 percent of the total.
[5] Comprises miscellaneous uses and uses for which data may not be shown separately (see footnotes 1, 2, and 3); also includes some exports and consumption in Territories and possession

TABLE 8.—Distribution (shipments) of evaporated and rock salt in the United States, 1951–52, by States of destination, in short tons

Destination	1951		1952	
	Evaporated	Rock	Evaporated	Rock
Alabama	16,898	97,996	16,782	92,770
Arizona	17,846	3,295	17,100	6,914
Arkansas	12,327	74,742	11,880	52,590
California	456,083	88,525	472,253	64,556
Colorado	47,173	69,085	48,642	51,889
Connecticut	14,159	20,836	13,407	26,215
Delaware	4,605	7,739	4,632	6,265
District of Columbia	5,696	2,139	5,479	2,653
Florida	10,341	35,667	11,252	37,546
Georgia	23,095	48,708	24,102	52,512
Idaho	18,923	1,315	21,259	2,034
Illinois	234,814	312,540	231,910	292,447
Indiana	113,024	84,245	114,792	80,279
Iowa	115,298	96,609	119,310	104,324
Kansas	56,200	193,122	56,875	208,034
Kentucky	31,660	116,450	31,363	104,528
Louisiana	19,288	130,756	19,020	130,320
Maine	10,044	72,639	13,989	85,721
Maryland	41,440	81,871	42,287	76,087
Massachusetts	51,914	94,147	51,801	111,774
Michigan	123,886	227,740	126,421	201,969
Minnesota	118,898	73,117	119,072	81,540
Mississippi	9,265	24,954	9,414	27,462
Missouri	78,831	71,168	76,134	76,381
Montana	21,779	1,024	24,914	2,041
Nebraska	65,446	64,119	65,828	66,315
Nevada	4,807	141,780	6,666	113,736
New Hampshire	5,344	70,191	4,691	86,727
New Jersey	117,470	150,451	109,072	143,625
New Mexico	12,979	30,561	11,944	38,244
New York	213,213	708,011	196,908	762,237
North Carolina	47,646	78,621	55,465	88,708
North Dakota	11,230	4,688	11,471	4,366
Ohio	211,091	320,925	200,682	282,421
Oklahoma	33,347	20,972	32,209	24,370
Oregon	98,844	470	142,140	288
Pennsylvania	139,422	142,037	137,456	133,414
Rhode Island	8,360	12,322	9,625	12,205
South Carolina	12,249	19,730	13,807	22,676
South Dakota	22,744	15,210	23,988	16,707
Tennessee	33,363	72,596	36,562	69,895
Texas	93,296	241,252	91,824	238,039
Utah	28,244	2,630	27,812	----------
Vermont	5,926	27,644	6,198	32,228
Virginia	58,766	107,744	68,212	82,237
Washington	250,943	1,040	241,311	2,093
West Virginia	160,815	115,158	158,804	105,542
Wisconsin	136,709	55,169	144,581	56,170
Wyoming	11,128	2,880	11,592	3,198
Other [1]	217,939	225,564	148,947	203,239
Total	3,654,808	4,662,194	3,641,885	4,567,531

[1] Includes shipments to Territories and possessions of the United States, exports, and some shipments to unspecified destinations.

PRICES

According to Oil, Paint and Drug Reporter, prices of salt at the beginning of 1952 were as follows: Rock salt, paper bags, carlots, works, 94 cents per 100 pounds; less than carlots, $1.15 per 100 pounds; table salt, vacuum, common fine, bags, works, carlots, $1.09 per 100 pounds; less than carlots, $1.20 per 100 pounds. These prices decreased in April and for the remainder of the year were quoted as follows: Rock salt, paper bags, carlots, works, 63 cents per 100 pounds; less than carlots, $1.09 per 100 pounds; table salt, vacuum, common fine, bags, works, carlots, 77 cents per 100 pounds; less than carlots, $1.12½ per 100 pounds.

FOREIGN TRADE [4]

Imports of salt constitute only a small fraction of United States requirements. In 1952, as in the past, the bulk of imports originated in Canada and the West Indies.

There was a substantial decrease in exports of salt from the United States in 1952, principally because of reduction in shipments to Japan. Japan was seeking and finding sources of salt in other countries to meet its growing demand.

TABLE 9.—Salt imported for consumption in the United States, 1951–52, by countries

[U. S. Department of Commerce]

Country	1951		1952	
	Short tons	Value	Short tons	Value
Bahamas	18	$630	3,640	$19,265
Canada	4,311	46,096	2,466	29,045
Cuba			85	840
Jamaica			859	3,835
Mexico			6	59
United Kingdom	(1)	105	(1)	15
Total	4,329	46,831	7,056	53,059

1 Less than 1 ton.

TABLE 10.—Salt imported for consumption in the United States, 1948–52, by classes

[U. S. Department of Commerce]

Year	In bags, sacks, barrels, or other packages (dutiable)		Bulk			
			Dutiable		Free (used in curing fish)	
	Short tons	Value	Short tons	Value	Short tons	Value
1948	1,591	$20,971	3,262	$17,033	768	$2,744
1949	2,851	40,308	3,458	20,297		
1950	3,395	43,567	4,474	15,252		
1951	2,991	37,245	1,338	9,586		
1952	2,488	29,538	4,568	23,521		

4 Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 11.—Salt exported from the United States, 1951–52, by countries

[U. S. Department of Commerce]

Country	1951		1952	
	Short tons	Value	Short tons	Value
North America:				
Bermuda	8	$746	19	$1,544
Canada	197,784	1,541,973	208,668	1,840,879
Central America:				
Canal Zone	894	38,282	781	30,439
Costa Rica	153	4,749	195	4,438
Guatemala	207	6,539	1,774	40,334
Honduras	304	12,093	439	12,451
Nicaragua	348	9,327	343	9,192
Panama	3,073	100,875	167	4,733
Mexico	6,867	159,436	6,067	173,001
West Indies:				
British:				
Jamaica	5	160	9	344
Other British	6	623	2	834
Cuba	9,899	203,844	8,764	213,752
Dominican Republic	154	12,558	175	14,367
Haiti	12	862	15	1,319
Netherlands Antilles	318	18,963	400	23,511
Other North America	219	12,290	115	3,329
South America:				
Argentina	11	1,824	2	385
Brazil	3	1,181		
Ecuador	110	3,483	10	1,239
Uruguay	(1)	138	(1)	414
Venezuela	2	1,322	(1)	320
Other South America	11	2,029	23	2,245
Europe:				
France	1	688		
United Kingdom	(1)	427		
Other Europe	12	2,040	3	1,404
Asia:				
Japan	205,291	1,237,711	82,108	522,865
Korea	10,008	34,028	35,683	476,447
Philippines	2,858	65,404	3,872	51,476
Saudi Arabia	79	4,614	144	9,020
Other Asia	20	3,793	25	2,074
Africa:				
Belgian Congo	(1)	138		
Liberia	24	1,598	1	133
Other Africa	16	1,030	20	2,151
Oceania:				
French Pacific Islands	194	7,360	113	4,750
New Zealand	223	9,776	11	360
Western Pacific Islands			23	8,613
Total	439,114	3,501,904	349,971	3,458,363

[1] Less than 1 ton.

TABLE 12.—Salt shipped to noncontiguous Territories of the United States, 1950–52

[U. S. Department of Commerce]

Territory	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
American Samoa	1	$127	3	$120	7	$1,822
Guam	103	5,740	147	9,001	92	6,678
Puerto Rico	9,822	640,277	7,108	458,207	8,378	555,474
Virgin Islands	39	3,766	40	4,177	69	6,645
Total	9,965	649,910	7,298	471,505	8,546	560,619

TECHNOLOGY

It was reported that small-package salt-refining plants designed and built by Manistee Iron Works Co., Manistee, Mich., were installed in Brazil and Venezuela early in 1952.[5]

The new units feature a diesel-powered recompression and vapor-phase heat recovery, a single-effect evaporator that operates at atmospheric pressure, and a stack-type drier that eliminates the need for the usual cooling equipment. Although the units installed in South America were designed to operate at a capacity of 24 tons of refined salt a day, it is said that similar plants can be built that will permit economical operation at a capacity as low as 10 tons of refined salt daily.

In an article that describes a new salt-refining process developed by the International Salt Co., Inc., several disadvantages of present refining methods, such as high costs for steam, scaling of tubular heating surfaces, and production-control problems, were reported overcome by design innovations in the new process. Flowsheets and a step-by-step description of the process are included.[6]

A patent assigned to the Morton Salt Co. describes a method of utilizing vapor recompression and integrating the vacuum-pan and grainer-pan processes of refining salt to achieve savings in steam costs.[7]

A method of producing noncaking sea salt which retains most of the trace elements present in sea water was the subject of a patent assigned to the Dow Chemical Co.[8]

Shell Oil Co. was said to have obtained virtually 100-percent core recovery in diamond-drilling salt beds in Oklahoma. This performance was obtained by using a saturated salt solution in the drilling mud, rotating the rotary table at slow speeds, and holding weight on the bit at a minimum. Approximately 100 pounds of salt was added per barrel of mud to obtain a saturated solution. Four pounds of starch per barrel and 10 pounds of salt-water clay were added to achieve proper mud properties. The advantages of this combination of drilling techniques are: Improved geologic evaluations of salt section and elimination of hole enlargement by preventing the solvent action normally caused by fresh-water mud in salt bearing formations.[9]

---

[5] Chemical Engineering, A Radical Tack in Salt Making: Vol. 59, No. 1, January 1952, pp. 230, 232, 234.
[6] Richards, R. B., New Salt Process Omits Usual Problems: Chem. Eng., vol. 59, No. 3, March 1952, pp. 140, 141, 143.
[7] Farnsworth, William H. (assigned to Morton Salt Co.), Brine Evaporation System: U. S. Patent 2,588,099, Mar. 4, 1952.
[8] Evans, C. W. (assigned to Dow Chemical Co.), Noncaking Sea Salt and Method of Producing the Same: U. S. Patent 2,606,839, Aug. 12, 1952.
[9] Kornfeld, Joseph A., 100-Percent Recoveries in Diamond-Coring Salt: Oil and Gas Jour., vol. 50, No. 43, Mar. 3, 1952, pp. 81, 82.

Preliminary research was reported underway at the University of California Medical Center on fluorine-containing salt as an alternative to fluorination of water for preventing dental caries.[10] The researcher stated that one advantage would be in giving the individual a free choice in the use of fluorine. A second advantage involves small groups who drink excessive quantities of water, such as persons afflicted with certain diseases and individuals who work in hot, dry environments, such as steel mills and other factories. Fluorinated salt also could be made available to rural populations that do not have access to community water supplies.

RESERVES

Over 200 salt domes are known to be present in the Gulf Coast area; a map was published showing their location. The known domes were listed, and in many instances the depth to the cap and depth to the salt was recorded.[11]

A "photogeologic" procedure used in prospecting for salt domes in the Gulf Coastal Plain was described.[12]

As revealed in aerial photographs, the pattern formed by surface faults or fracture lines is said to bear a definite relationship to deep-seated salt domes. Disturbance centers that may be underlain at depth with salt domes are said to exhibit surface expressions that show as sharply curving concentric lines and prominent transverse lines, usually radiating from some marginal point rather than from the center of the structure.

WORLD REVIEW

Angola.—Official authorization was requested to install a salt refinery at Lobito.[13]

Canary Islands.—Salt is produced in the Canary Islands by the firm of Rocar, S. L., Diego des Ordas 5, Las Palmas. Production is almost entirely from the island of Lanzarote, and annual output is about 60,000 metric tons.[14]

---

[10] Science News Letter, Fluoridated Salt Next: Vol. 61, No. 17, Apr. 26, 1952, p. 261.

[11] Oil and Gas Journal, Where Are Those Gulf Coast Salt Domes?: Vol. 51, No. 14, Aug. 11, 1952, pp. 130, 133, 134.

[12] Desjardins, Louis, Aerial Photos of Multiple Surface Faults May Locate Deep-Seated Salt Domes: Oil and Gas Jour., vol. 51, No. 13, Aug. 4, 1952, pp. 82–84.

[13] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 2, August 1952, p. 38.

[14] Bureau of Mines, Mineral Trade Notes: Vol. 37, No. 1, July 1953, p. 59.

TABLE 13.—World production of salt, 1948–52, by countries,[1] in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
North America:					
Canada	668,284	681,278	779,132	874,120	882,874
Costa Rica	6,500	8,200	8,400	5,455	2,268
Guatemala	11,474	11,962	11,502	12,061	11,974
Honduras	1,089	11,503	4,397	4,650	4,800
Mexico	[3] 156,685	(4)	(4)	(4)	(4)
Nicaragua	[3] 9,475	[3] 10,230	11,172	12,289	[3] 13,031
Panama	3,374	3,408	5,000	7,480	[3] 11,500
Salvador	21,213	[3] 16,000	[3] 16,000	[3] 27,200	[3] 18,000
United States:					
Rock salt	3,489,782	3,124,637	3,562,738	4,229,449	4,143,573
Other salt	11,390,957	11,002,165	11,523,492	14,102,056	13,587,454
West Indies:					
British:					
Bahamas	63,000	60,960	60,960	51,800	81,300
Turks and Caicos Islands	38,610	61,765	60,960	------	------
Cuba	55,339	59,874	59,266	[3] 63,500	[3] 56,250
Dominican Republic:					
Rock salt	2,365	2,412	2,304	2,270	2,603
Other salt	13,079	8,140	13,740	8,092	16,746
Haiti	[3] 8,000	[3] 8,000	(4)	(4)	30,400
Netherlands Antilles	482	370	3,000	(4)	(4)
South America:					
Brazil	781,333	805,632	794,181	1,244,444	(4)
Chile:					
Rock salt	47,164	35,079	46,709	48,927	(4)
Other salt	[3] 30,800	4,450	942	348	(4)
Colombia:					
Rock salt	99,705	102,160	106,918	110,085	167,628
Other salt	24,647	23,932	35,045	28,066	38,201
Ecuador	25,110	16,833	34,902	32,756	36,800
Peru	63,049	55,968	66,501	68,494	79,613
Venezuela	35,533	71,926	56,439	38,920	116,050
Europe:					
Austria:					
Rock salt	1,752	719	1,085	692	1,144
Other salt	278,492	304,792	327,426	362,294	334,076
Bulgaria	[3] 120,000	(4)	(4)	(4)	(4)
France:					
Rock salt and salt from springs	2,489,036	1,772,067	2,059,123	2,327,581	(4)
Other salt	446,539	742,721	604,550	343,900	
Germany, West	2,035,694	1,800,000	2,470,000	2,757,785	2,576,004
Greece	52,208	86,776	102,329	82,434	87,525
Italy:					
Rock salt and brine salt	727,083	804,435	746,153	746,321	749,526
Other salt	464,456	576,535	651,935	965,652	649,457
Malta	1,869	1,807	1,827	3,841	1,523
Netherlands	250,417	331,000	412,570	481,125	414,000
Poland	725,774	836,253	[3] 1,000,000	(4)	(4)
Portugal:					
Rock salt	49	41	42	39	45
Other salt [5]	10,660	16,903	30,765	29,374	22,953
Spain:					
Rock salt	292,881	288,896	308,228	367,809	375,257
Other salt	696,600	546,886	901,575	893,297	665,001
Switzerland	112,218	[3] 100,000	94,000	114,000	(4)
United Kingdom:					
Great Britain:					
Rock salt	41,000	41,658	41,658	54,867	(4)
Other salt	3,794,000	3,741,000	4,223,814	4,654,525	
Northern Ireland	13,000	13,000	13,000	13,251	10,808
Yugoslavia	102,300	[3] 108,900	131,000	95,646	148,378
Asia:					
Aden	275,408	308,302	259,972	309,186	292,355
Burma	45,564	31,692	21,457	64,285	(4)
Ceylon	78,300	28,780	66,093	36,990	49,215
China [3]	2,480,000	2,000,000	3,000,000	3,000,000	3,500,000
Cyprus	------	------	4,133	11,198	------
India:					
Rock salt	4,123	4,229	5,130	5,519	2,868,472
Other salt	2,296,759	2,017,831	2,609,029	2,889,377	
Indochina	64,000	113,600	75,722	93,908	[3] 144,000
Indonesia	360,000	320,000	375,000	480,592	323,000
Iran	(4)	[3] 100,000	[3] 100,000	76,252	[3] 200,000
Iraq	14,000	8,989	11,861	16,503	(4)
Israel	8,200	6,500	8,000	9,850	12,534
Japan	339,668	395,676	418,144	430,405	433,200
Jordan	(4)	(4)	(4)	2,712	7,377

See footnotes at end of table.

TABLE 13.—World production of salt, 1948–52, by countries,[1] in metric tons [2]—Continued

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
Asia—Continued					
Korea, Republic of	89,979	188,812	[3] 175,000	84,556	203,865
Lebanon [3]	5,000	2,500	6,500	7,000	(4)
Pakistan: Rock salt [6]	213,162	175,098	147,059	140,297	(4)
Philippines, Republic of the	(4)	52,276	56,283	52,280	16,770
Portuguese India	[5] 10,719	18,132	17,608	31,577	21,380
Syria	20,321	21,619	12,000	7,000	[3] 23,000
Taiwan (Formosa)	365,803	253,948	175,063	274,766	311,711
Thailand (Siam) [3]	200,000	150,000	200,000	250,000	250,000
Turkey:					
Rock salt	28,187	17,920	20,330	21,584	34,000
Other salt	238,755	298,425	284,912	249,970	302,000
Africa:					
Algeria	73,038	101,676	75,656	97,281	82,343
Anglo-Egyptian Sudan	36,238	43,029	40,754	46,215	53,311
Angola	53,423	41,286	40,473	49,228	57,510
Belgian Congo	[3] 1,000	813	550	583	600
Canary Islands	13,209	5,283	6,072	15,729	(4)
Cape Verde Islands	13,632	19,301	19,769	24,106	18,090
Egypt	126,438	349,878	539,016	687,038	498,393
Eritrea	60,963	85,760	53,922	[3] 60,000	(4)
Ethiopia: Rock salt [3]	10,000	10,000	10,000	10,000	10,000
French Equatorial Africa [3]	------------	1,800	3,600	3,900	4,300
French Morocco:					
Rock salt	10,772	} 34,100	60,000	45,971	40,000
Other salt	24,287				
French Somaliland	60,000	60,000	80,000	55,200	64,400
French West Africa [3]	50,000	50,000	66,000	66,000	(4)
Italian Somaliland [3]	(4)	3,000	1,500	2,000	5,000
Kenya	16,813	18,820	18,722	19,084	17,019
Libya:					
Cyrenaica	140	[3] 500	------------	[3] 2,500	------------
Tripolitania	6,000	[3] 6,000	9,000	12,000	12,000
Mauritius	3,400	5,200	2,606	3,400	(4)
Mozambique	10,100	11,004	9,942	[3] 8,700	(4)
South-West Africa:					
Rock salt	4,436	2,468	3,915	4,706	6,887
Other salt	10,414	13,730	12,903	39,880	33,258
Spanish Morocco [3]	254	254	254	254	(4)
Tanganyika	11,581	14,970	12,473	15,858	19,255
Tunisia	105,244	98,085	98,771	146,507	93,500
Uganda	7,011	7,400	7,413	7,869	4,108
Union of South Africa	[3] 172,000	[7] 162,936	106,396	149,795	140,574
Australia	264,173	[3] 248,932	269,253	[3] 304,815	[3] 228,611
Total (estimate) [1]	44,000,000	43,000,000	48,000,000	54,000,000	54,000,000

[1] In addition to the countries listed, salt is produced in Afghanistan, Albania, Argentina, Bolivia, Czechoslovakia, Gold Coast, Hungary, Leeward Islands, Madagascar, Nigeria, Rumania, and U. S. S. R., but figures of production are not available. Russian production is known to exceed 5,000,000 metric tons annually. Estimates by author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous Salt chapters.
[3] Estimate.
[4] Data not available; estimate by author of chapter included in total.
[5] Exports.
[6] Year ended Mar. 31 of year following that stated.
[7] Year ended June 30 of year stated.

Dominican Republic.—Additional funds were provided during the year for purchasing modern equipment in the mechanization of the salt and gypsum operations taken over by the Government Agricultural and Industrial Credit Bank in 1950. The rock-salt deposits are about 25 miles west of the port of Barahona and lie in a range of hills about 7 miles long. The engineer in charge reportedly has estimated that 250 million metric tons of salt are readily accessible in the area. A new wharf was completed at the port of Barahona. According to the engineer in charge, production will be at the annual rate of 1 million metric tons of rock salt when all installations are completed. The salt, as mined, is said to be very pure and suitable for export after crushing. It is reported that a market for Dominican rock salt has been found in Japan.[15]

By the end of the year, most of the construction work and the installation of machinery were completed but not yet in operation, pending completion of a power plant.[16]

India.—According to a news item appearing in the Delhi Hindustan Standard, August 10, 1952, West Bengal Government invited French experts to join in establishing a salt plant at Contai in the Midnapur district. It was reported that the plant would cover 8,900 acres near the seacoast and would have a target production of about 200,000 tons of salt annually.[17]

Kuwait.—It was reported that the first unit of a 28-million-dollar salt-water distillation plant began operation in Kuwait on the Persian Gulf. This first unit is said to be producing a million gallons of water daily. Eventually it will distill over 5 million gallons daily.[18]

Mexico.—Compania Internacional de Industria Salinera, S. A., was organized in 1952 for the announced purpose of harvesting sea salt in the lagoon area east of the port of Salina Cruz. The company hoped to go into production in 1953 with an initial annual output of 300,000 metric tons. The new company was organized in April 1952 and obtained an area of about 8,000 hectares along the coast. The lease covers all of the Laguna Tileme, as well as an area of dry land at the western end of the lagoon. Salt will be loaded at the port of Salina Cruz, where the company has leased a warehouse. The firm was said to be purchasing a conveyor with a daily capacity of 10,000 metric tons. The harvesting season begins in October and continues until the following May, when the rainy season starts. The company did not have any firm contracts for the sale of the salt but expected to sell in foreign markets. It was stated that annual output could be increased to about 2 million tons.[19]

Netherlands.—The Royal Dutch Petroleum Co. and the Standard Oil Co. of the United States have discovered a rock-salt deposit near the town of Winschoten in the Province of Groningen. The find is considered of economic importance because of the relatively shallow depth—about 350 meters.[20]

Philippine Republic.—On October 30, 1952, it was announced in the press that the President of the Republic had approved a proposal made by the Philippine Salt Development Syndicate for large-scale production of salt with Japanese financial and technical assistance. Japanese assistance was given with the understanding that no Philippine export restrictions be placed on salt.[21]

Spain.—Almost every Province in Spain produces rock salt, sea salt, or both; there are about 165 marine-salt works and 130 rock-salt mines, but only about a fifth of the latter are operating. The largest output of rock salt is in the Province of Santander. The Province of Cadiz has the largest number of sea-salt works—49 plants—whereas Alicante, with only 6 plants, has the largest output of sea salt. The

---

15 Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 6, June 1952, pp. 48–50.
16 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 1, January 1953, pp. 40–41.
17 Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 4, October 1952, p. 42.
18 Chemical Engineering News, vol. 31, No. 19, May 11, 1953, p. 2001.
19 Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 3, March 1953, pp. 42–44.
20 Mining World, vol. 14, No. 9, August 1952, p. 73.
21 Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 6, December 1952, p. 35.

salt production in Spain is about one-fourth rock salt and three-fourths marine salt. A statistical survey of the salt industry in Spain, with a history of some of the operations, was published.[22]

Sweden.—The Swedish Geological Survey Office announced plans for further drilling in the area near Trelleborg, where several years ago salt brine was found during drilling for oil.[23]

Taiwan (Formosa).—A report entitled "Survey of Taiwan Salt Production and Distribution," prepared by the Mutual Security Agency Mission and dated January 18, 1952, reviewed the salt industry of Taiwan in some detail. The Taiwan Salt Works was the sole producer. This organization is a part of the National Resources Commission, Ministry of Economic Affairs. Its functions include production, storage, selling, and general administration of the salt industry. The Taiwan Salt Administration, Ministry of Finance, supervises transportation and tax collection. The Taiwan Food Bureau, Taiwan Provincial Government, allocates and distributes the salt. The Central Trust of China handles exportation of the salt.[24]

Tunisia.—In October 1952 it was announced that the Tunisia Internal Monopoly, established in 1884, had been abolished and henceforth the sale of Tunisian salt would be unrestricted. Imported salt, however, is subject to a 60-percent custom duty.[25]

Turkey.—Some rock salt was produced in Turkey, but most of the salt output is from sea water. This solar salt was recovered at Camalti near Izmir. A law of February 15, 1952, which became effective 3 months later, provided that private enterprise might open new facilities for salt production or take over production facilities that are relinquished by the monopolies, on condition that the salt produced be exported. The domestic use or sale of such salt was not permitted. The new law modified the power of the monopolies to set salt export prices by restricting it to that salt sold abroad by the monopolies. This meant that a private producer might sell for export at his own price.[26]

[22] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 3, March 1952, pp. 40–48.
[23] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 6, December 1952, p. 35.
[24] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 6, June 1952, pp. 51–57.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 2, February 1953, p. 58.
[26] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 1, January 1953, pp. 41–42.

Sand and Gravel

By L. M. Otis [1] and Nan C. Jensen [2]

AN ALLTIME high was established in 1952 for sand and gravel production in the United States. Each year since 1949 has seen an increase in the total from the previous year. The value of the 1952 production also set a new high record.

In individual categories, increases and decreases showed a mixed trend compared with 1951. Exceptions were a consistent increase in sand and gravel used for paving and a substantial decrease in most industrial uses for sand.

Although a 3-percent increase was reported in the use of commercial sand for building purposes, Government-and-contractor operations,[3] as distinguished from commercial production, showed a decline for building use.

The output of all sand in 1952 was 36 percent and that of all gravel 64 percent of the combined domestic production of these commodities compared with 37 and 63 percent, respectively, in 1951.

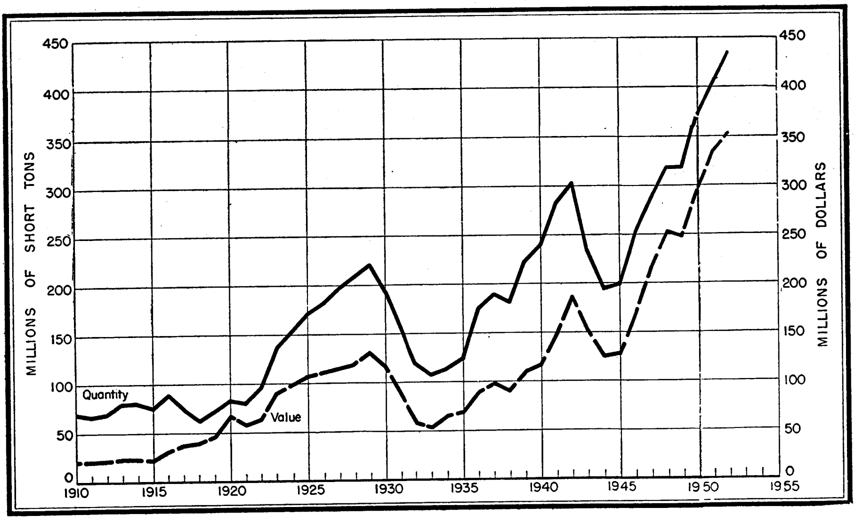

FIGURE 1.—Production of sand and gravel in the United States, 1910–52.

1 Commodity specialist.
2 Statistical assistant.
3 Production by, or solely for, States, counties, municipalities, or the Federal Government.

TABLE 1.—Sand and gravel sold or used by producers in the United States,[1] 1951–52, by class of operations and uses

	1951			1952			Percent of change in—	
	Short tons	Value		Short tons	Value		Tonnage	Average value
		Total	Average		Total	Average		
COMMERCIAL OPERATIONS								
Sand:								
Glass	5,515,588	$14,412,339	$2.61	5,227,927	$13,918,171	$2.66	−5	+2
Molding	9,107,003	16,823,440	1.85	8,253,167	16,252,433	1.97	−9	+6
Building	71,503,981	62,168,319	.87	73,660,508	63,670,537	.86	+3	−1
Paving	40,789,625	34,531,591	.85	43,666,274	36,746,584	.84	+7	−1
Grinding and polishing [2]	1,476,912	3,111,649	2.11	1,229,794	2,920,088	2.37	−17	+12
Fire or furnace	471,540	791,682	1.68	413,789	819,908	1.98	−12	+18
Engine	2,208,903	2,339,753	1.06	1,900,621	1,939,025	1.02	−14	−4
Filter	202,739	484,724	2.39	288,207	606,501	2.10	+42	−12
Railroad ballast [3]	1,087,669	604,841	.56	828,750	404,669	.49	−24	−12
Other [4]	2,793,226	3,102,669	1.11	4,037,053	4,063,914	1.01	+45	−9
Total commercial sand	135,157,186	138,371,007	1.02	139,506,090	141,341,830	1.01	+3	−1
Gravel:								
Building	62,550,990	65,648,107	1.05	64,263,744	68,212,707	1.06	+3	+1
Paving	72,335,348	65,944,983	.91	81,652,021	74,166,945	.91	+13	-----
Railroad ballast [5]	11,362,531	7,032,599	.62	10,669,141	6,487,822	.61	−6	−2
Other [6]	4,413,449	3,180,659	.72	5,637,498	4,930,002	.87	+28	+21
Total commercial gravel	150,662,318	141,806,348	.94	162,222,404	153,797,476	.95	+8	+1
Total commercial sand and gravel	285,819,504	280,177,355	.98	301,728,494	295,139,306	.98	+6	-----
GOVERNMENT-AND-CONTRACTOR OPERATIONS [7]								
Sand:								
Building	[8] 1,869,483	[8] 2,001,392	[8] 1.07	1,183,968	1,140,413	.96	−37	−10
Paving	[8] 12,563,827	[8] 4,775,708	.38	15,402,448	6,229,943	.40	+23	+5
Total Government-and-contractor sand	[8] 14,433,310	[8] 6,777,100	[8] .47	16,586,416	7,370,356	.44	+15	−6
Gravel:								
Building	7,664,694	6,905,832	.90	3,561,751	2,857,283	.80	−54	−11
Paving	[8] 92,716,945	[8] 39,854,062	.43	113,634,572	48,017,270	.42	+23	−2
Total Government-and-contractor gravel	[8] 100,381,639	[8] 46,759,894	.47	117,196,323	50,874,553	.43	+17	−9
Total Government-and-contractor sand and gravel	[8] 114,814,949	[8] 53,536,994	[8] .47	133,782,739	58,244,909	.44	+17	−6
ALL OPERATIONS								
Sand	[8] 149,590,496	[8] 145,148,107	.97	156,092,506	148,712,186	.95	+4	−2
Gravel	[8] 251,043,957	[8] 188,566,242	.75	279,418,727	204,672,029	.73	+11	−3
Grand total	[8] 400,634,453	[8] 333,714,349	.83	435,511,233	353,384,215	.81	+9	−2

[1] Includes Alaska, Hawaii, and Puerto Rico.
[2] Includes blast sand as follows—1951: 549,955 tons valued at $1,875,775; 1952: 557,305 tons, $2,016,747.
[3] Includes ballast sand produced by railroads for their own use as follows—1951: 140,111 tons valued at $17,745; 1952: 204,358 tons, $41,848.
[4] Includes some sand used by railroads for fills and similar purposes as follows—1951: 263,997 tons valued at $78,686; 1952: 208,591 tons, $64,199.
[5] Includes ballast gravel produced by railroads for their own use as follows—1951: 4,100,872 tons valued at $1,709,860; 1952: 4,867,003 tons, $2,214,808.
[6] Includes some gravel used by railroads for fills and similar purposes as follows—1951: 904,402 tons valued at $244,119; 1952: 1,623,165 tons, $794,405.
[7] Approximate figures for States, counties, municipalities, and other Government agencies directly or under lease.
[8] Revised figure.

DOMESTIC PRODUCTION

Production of sand and gravel reached an alltime high in 1952 for the third successive year. The output of 435,511,200 tons valued at $353,384,200 was 9 percent higher in quantity and 6 percent in value than in 1951. This condition reflects the sustained activity in highway and building construction.

California was the leading producer in 1952, followed by Michigan, Wisconsin, Ohio, New York, Minnesota, Illinois, and Texas, in the order named. These 8 States, each producing over 18 million tons, supplied 47 percent of total production.

Tables 3 and 4 show details of production by States and uses in 1952.

TABLE 2.—Sand and gravel sold or used by producers in the United States,[1] 1943–47 (average) and 1948–52

Year	Sand		Gravel (including railroad ballast)		Total	
	Quantity (thousand short tons	Value (thousand dollars)	Quantity (thousand short tons)	Value (thousand dollars)	Quantity (thousand short tons)	Value (thousand dollars)
1943–47 (average)	85,583	68,060	147,649	90,949	233,232	159,009
1948	118,661	107,915	200,605	144,583	319,266	252,498
1949	117,036	105,489	202,068	142,954	319,104	248,443
1950	138,900	126,311	231,555	168,729	370,455	295,040
1951	[2] 149,590	[2] 145,148	[2] 251,044	[2] 188,566	[2] 400,634	[2] 333,714
1952	156,092	148,712	279,419	204,672	435,511	353,384

[1] Includes Alaska, Hawaii, and Puerto Rico.
[2] Revised figure.

TABLE 3.—Sand and gravel sold or used by producers in the United States in 1952, by States

State	Short tons	Value	State	Short tons	Value
Alabama	3,722,555	$2,955,630	Nevada	2,098,211	$2,380,419
Alaska	10,781,926	8,650,582	New Hampshire	3,200,232	1,001,591
Arizona	1,824,330	1,635,903	New Jersey	7,060,074	9,473,428
Arkansas	5,011,095	4,977,219	New Mexico	496,921	499,589
California	53,051,260	43,633,125	New York	20,270,058	18,287,623
Colorado	8,461,039	6,268,367	North Carolina	8,724,748	5,665,169
Connecticut	2,581,247	1,933,214	North Dakota	6,557,069	1,841,216
Delaware	515,399	382,484	Ohio	20,751,493	23,069,458
Florida	4,154,613	3,848,077	Oklahoma	3,769,663	2,911,845
Georgia	2,133,970	2,029,367	Oregon	12,219,486	8,556,218
Hawaii	1,069	936	Pennsylvania	14,696,106	19,920,003
Idaho	3,925,863	2,745,201	Puerto Rico	122,730	164,166
Illinois	19,584,308	19,214,195	Rhode Island	589,451	557,396
Indiana	11,546,014	9,279,908	South Carolina	1,048,099	892,312
Iowa	10,796,979	6,032,898	South Dakota	5,846,140	2,478,314
Kansas	8,380,065	5,023,593	Tennessee	5,173,401	5,303,321
Kentucky	3,334,261	2,656,053	Texas	18,661,403	17,275,255
Louisiana	6,005,119	6,736,524	Utah	3,260,044	2,350,412
Maine	7,078,078	2,187,531	Vermont	1,264,490	749,835
Maryland	6,956,640	8,136,697	Virginia	7,136,112	5,556,953
Massachusetts	7,645,728	6,128,744	Washington	13,322,279	9,422,117
Michigan	29,193,763	22,400,879	West Virginia	4,120,105	7,275,370
Minnesota	19,825,157	6,808,763	Wisconsin	24,895,947	16,938,228
Mississippi	2,296,577	1,833,306	Wyoming	2,426,999	1,738,548
Missouri	6,790,422	6,122,195			
Montana	6,765,955	3,579,932	Total	435,511,233	353,384,215
Nebraska	5,436,540	3,874,106			

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1952, by States, uses, and class of operations

[Commercial unless otherwise indicated]

State	Sand							
	Glass		Molding		Building			
					Commercial		Government-and-contractor	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama			46,160	$89,389	781,899	$605,387	738	$500
Alaska					156,749	428,231	(1)	(1)
Arizona					305,259	339,960	5,690	1,837
Arkansas	(1)	(1)	(1)	(1)	669,973	383,742		
California	315,614	$1,226,622	61,209	208,140	12,195,416	10,443,281	235,601	89,910
Colorado					669,489	635,019		
Connecticut					739,958	592,248		
Delaware					7,741	7,741		
Florida			600	2,400	1,955,051	1,556,331		
Georgia	(1)	(1)	(1)	(1)	994,498	717,529		
Hawaii								
Idaho					278,904	342,545	8,616	1,369
Illinois	1,097,684	2,428,304	1,366,684	2,912,595	4,389,300	3,261,431		
Indiana			480,378	663,568	1,531,819	1,148,778		
Iowa			(1)	(1)	1,562,413	1,274,391		
Kansas			(1)	(1)	2,839,273	1,996,781	6,465	442
Kentucky			(1)	(1)	825,110	756,761	15,000	15,000
Louisiana			(1)	(1)	1,095,670	908,984		
Maine					37,632	17,872	(1)	(1)
Maryland	(1)	(1)			1,542,470	1,714,224		
Massachusetts			(1)	(1)	1,798,278	1,334,299	66,281	159,867
Michigan	(1)	(1)	1,932,845	1,877,446	3,297,285	2,575,620		
Minnesota	(1)	(1)	(1)	(1)	1,938,027	1,469,960	595	255
Mississippi					378,034	258,837		
Missouri	447,309	979,438	68,950	134,784	2,019,525	1,430,015		
Montana					130,828	203,316	4,534	6,939
Nebraska	1,507	1,300	10,796	11,485	763,404	575,472	892	331
Nevada	(1)	(1)	72,444	156,958	117,205	227,797	1,366	4,005
New Hampshire					96,241	81,837		
New Jersey	426,498	774,026	1,463,832	3,491,675	1,663,132	1,431,268		
New Mexico					152,347	155,744	750	1,929
New York			371,063	1,054,758	5,599,746	5,165,548	59,582	10,772
North Carolina					580,500	364,253	17,325	8,662
North Dakota					145,048	146,971	94	57
Ohio	(1)	(1)	744,356	2,094,427	4,376,602	4,364,410	7,372	4,270
Oklahoma	210,568	478,239	(1)	(1)	1,180,446	910,522		
Oregon			(1)	(1)	812,719	816,817	46,498	72,638
Pennsylvania	(1)	(1)	362,294	862,247	4,270,064	5,021,197		
Puerto Rico	14,573	36,433					3,186	3,444
Rhode Island			(1)	(1)	151,741	120,002		
South Carolina					858,066	736,450		
South Dakota					315,915	265,679	140,150	50,147
Tennessee	(1)	(1)	256,722	725,584	1,083,696	1,296,831		
Texas	(1)	(1)	4,736	7,724	3,784,154	2,911,363	714	1,665
Utah					360,568	267,026		
Vermont			340	340	36,884	28,707		
Virginia	(1)	(1)	17,649	13,241	1,171,018	948,620	45,299	15,210
Washington	(1)	(1)	(1)	(1)	1,252,613	999,003	212,350	188,500
West Virginia	1,060,369	3,102,404	(1)	(1)	418,239	620,943		
Wisconsin			(1)	(1)	2,276,143	1,759,848	78,518	48,409
Wyoming					53,416	50,946		
Undistributed [1]	1,653,805	4,891,405	992,109	1,945,672			226,352	454,255
Total	5,227,927	13,918,171	8,253,167	16,252,433	73,660,508	63,670,537	1,183,968	1,140,413

[1] Figures that may not be shown separately are combined as "Undistributed."

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1952, by States, uses, and class of operations—Continued

State	Sand—Continued							
	Paving				Grinding and polishing [2]		Fire or furnace	
	Commercial		Government-and-contractor					
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	493, 734	$329, 380	207, 425	$52, 576				
Alaska			(1)	(1)				
Arizona	242, 088	225, 414	10, 503	5, 189				
Arkansas	324, 229	242, 736	144, 855	106, 080				
California	5, 269, 028	4, 389, 199	2, 040, 822	1, 093, 561	121, 070	$372, 611		
Colorado	(1)	(1)	256, 234	202, 755				
Connecticut	459, 752	330, 762	152, 471	18, 400				
Delaware	(1)	(1)	80, 000	30, 000				
Florida	885, 121	542, 339	13, 000	2, 500	11, 957	28, 509		
Georgia	449, 712	278, 130			94, 010	195, 242		
Hawaii			57	128				
Idaho	8, 400	5, 500	119, 644	64, 548				
Illinois	2, 312, 853	1, 741, 341	28, 690	27, 221	130, 745	474, 452	35, 158	$122, 604
Indiana	2, 040, 634	1, 494, 408	16, 679	8, 367			(1)	(1)
Iowa	812, 692	605, 829	346, 021	19, 534	(1)	(1)		
Kansas	1, 453, 941	980, 352	500, 643	133, 213	(1)	(1)		
Kentucky	418, 341	358, 792	7, 140	6, 885				
Louisiana	648, 452	750, 881	134, 482	53, 800	(1)	(1)		
Maine	20, 811	22, 176	(1)	(1)				
Maryland	1, 472, 749	1, 775, 368						
Massachusetts	1, 000, 309	690, 038	170, 630	205, 239				
Michigan	3, 276, 527	2, 659, 318	525, 768	112, 436	156, 913	67, 563		
Minnesota	691, 850	459, 416	309, 387	44, 951				
Mississippi	86, 286	45, 035	135, 850	93, 280				
Missouri	738, 461	568, 170	57, 750	48, 150	206, 118	448, 265		
Montana	59, 793	61, 618	157, 708	46, 020	140	275		
Nebraska	647, 758	465, 131						
Nevada			23, 210	16, 816				
New Hampshire	136, 651	72, 616	410, 804	95, 171				
New Jersey	1, 401, 746	1, 096, 088	502	47	81, 803	286, 229	24, 164	42, 081
New Mexico	9, 675	10, 508	1, 823	3, 700	653	716		
New York	4, 912, 807	4, 212, 718	193, 053	56, 608				
North Carolina	1, 134, 150	627, 269	3, 726, 582	1, 039, 065	(1)	(1)		
North Dakota	44, 675	41, 419	41, 118	14, 368				
Ohio	3, 035, 297	2, 732, 436	30, 646	24, 951	(1)	(1)	66, 702	187, 979
Oklahoma	551, 072	454, 250	332, 946	63, 253	(1)	(1)		
Oregon	305, 062	322, 969	25, 066	33, 834				
Pennsylvania	2, 038, 867	2, 741, 982			(1)	(1)	82, 976	241, 664
Puerto Rico			68, 756	56, 266				
Rhode Island	102, 346	81, 817	48, 801	19, 865				
South Carolina	45, 413	12, 945	22, 919	7, 908	(1)	(1)		
South Dakota	177, 795	151, 328	182, 747	128, 258				
Tennessee	518, 290	545, 925	534, 427	336, 079	(1)	(1)	(1)	(1)
Texas	2, 060, 517	2, 062, 507	29, 148	9, 457	60, 712	297, 824		
Utah	(1)	(1)	42, 000	20, 500	(1)	(1)		
Vermont	54, 000	41, 675	100, 000	50, 000	35, 681	13, 202		
Virginia	915, 573	462, 639	29, 716	26, 040	(1)	(1)	(1)	(1)
Washington	508, 626	350, 071	2, 106, 808	988, 537	(1)	(1)		
West Virginia	780, 314	882, 584			13, 331	54, 718	60, 201	87, 670
Wisconsin	756, 671	558, 186	1, 723, 080	741, 045	(1)	(1)	7, 350	52, 000
Wyoming	(1)	(1)	20, 640	18, 910				
Undistributed [1]	363, 206	263, 319	291, 897	104, 432	316, 661	680, 482	137, 238	85, 910
Total	43, 666, 274	36, 746, 584	15, 402, 448	6, 229, 943	1, 229, 794	2, 920, 088	413, 789	819, 908

[1] Figures that may not be shown separately are combined as "Undistributed."
[2] Includes 557,305 tons of blast sand valued at $2,016,747.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1952, by States, uses, and class of operations—Continued

State	Sand—Continued							
	Engine		Filter		Railroad ballast[3]		Other[4]	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	(1)	(1)			(1)	(1)	14,971	$43,033
Alaska	825	$1,650					(1)	(1)
Arizona	(1)	(1)					(1)	(1)
Arkansas	(1)	(1)			(1)	(1)	(1)	(1)
California	71,392	77,280	18,277	$53,762	1,440	$792	104,148	105,469
Colorado	25,187	29,323			(1)	(1)	14,232	8,961
Connecticut			5,760	4,536			12,741	5,097
Delaware	(1)	(1)						
Florida	3,498	2,302	(1)	(1)	35,127	19,875	(1)	(1)
Georgia	29,018	13,202	(1)	(1)	31,061	18,637	209,843	238,709
Hawaii								
Idaho	4,780	3,610			11,760	5,880	16,485	10,880
Illinois	112,421	109,359	9,058	30,288	63,363	46,730	376,865	870,313
Indiana	113,421	80,794			(1)	(1)	24,257	16,827
Iowa	30,117	38,622	(1)	(1)	19,743	9,582	28,752	32,583
Kansas	94,175	69,348	34,719	81,764	238,655	70,487	328,682	118,874
Kentucky	95,632	83,131			14,600	10,013	(1)	(1)
Louisiana	6,217	2,965			(1)	(1)	(1)	(1)
Maine								
Maryland	(1)	(1)						
Massachusetts	(1)	(1)	40,554	14,290			27,036	17,300
Michigan	63,622	45,664	(1)	(1)	(1)	(1)	905,282	451,713
Minnesota	32,710	30,892	(1)	(1)	35,694	9,857	33,196	15,175
Mississippi	4,528	2,617						
Missouri	17,463	12,019	1,878	2,200	(1)	(1)	(1)	(1)
Montana							25,883	5,431
Nebraska	101,716	55,954	(1)	(1)	(1)	(1)	12,649	2,488
Nevada							(1)	(1)
New Hampshire	(1)	(1)	(1)	(1)				
New Jersey	23,726	16,382	45,629	140,143			290,597	258,325
New Mexico								
New York	(1)	(1)	44,190	37,522	(1)	(1)	127,693	85,145
North Carolina	22,113	22,113	(1)	(1)	(1)	(1)	(1)	(1)
North Dakota							1,678	452
Ohio	63,900	110,593	17,382	33,089	(1)	(1)	107,603	139,301
Oklahoma	(1)	(1)	(1)	(1)			58,993	62,577
Oregon	(1)	(1)			(1)	(1)	24,545	9,319
Pennsylvania	226,500	450,112	10,076	49,876			214,488	435,330
Puerto Rico								
Rhode Island								
South Carolina	(1)	(1)	(1)	(1)			(1)	(1)
South Dakota					(1)	(1)		
Tennessee	(1)	(1)	(1)	(1)			(1)	(1)
Texas	47,780	30,113	(1)	(1)	12,816	8,578	148,030	63,142
Utah	(1)	(1)			54	60	(1)	(1)
Vermont	3,124	2,774					11	4
Virginia	(1)	(1)					78,513	69,654
Washington	13,679	4,825					40,325	32,372
West Virginia	198,637	334,349					(1)	(1)
Wisconsin	(1)	(1)			(1)	(1)	376,617	157,830
Wyoming	(1)	(1)						
Undistributed[1]	494,440	309,032	60,684	159,031	364,437	204,178	432,938	807,610
Total	1,900,621	1,939,025	288,207	606,501	828,750	404,669	4,037,053	4,063,914

[1] Figures that may not be shown separately are combined as "Undistributed."
[3] Includes 204,358 tons of ballast sand valued at $41,848, produced by railroads for their own use.
[4] Includes 208,591 tons of sand valued at $64,199, used by railroads for fills and similar purposes.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1952, by States, uses, and class of operations—Continued

State	Gravel							
	Building				Paving			
	Commercial		Government-and-contractor		Commercial		Government-and-contractor	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	963,315	$897,406	620	$270	741,253	$699,548	81,597	$13,749
Alaska	139,372	309,552	(1)	(1)	(1)	(1)	(1)	(1)
Arizona	503,891	634,122	5,704	1,907	305,866	276,893	382,549	102,776
Arkansas	89,977	101,071			843,329	883,173	2,421,995	2,601,181
California	13,994,664	13,379,052	328,234	96,266	8,601,253	8,463,624	8,989,207	3,133,384
Colorado	670,948	736,987	260,150	145,200	573,725	486,178	5,849,327	3,803,458
Connecticut	514,388	523,628			566,603	412,976	114,230	37,430
Delaware	3,410	7,672			195,202	195,486		
Florida	1,121,819	1,505,692			(1)	(1)		
Georgia	59,880	101,190			(1)	(1)	33,792	45,938
Hawaii							1,012	808
Idaho	480,494	528,184	47,419	24,059	378,240	253,160	2,407,625	1,463,744
Illinois	4,799,964	3,947,694	10,730	1,533	3,292,323	2,366,448	444,330	255,418
Indiana	1,887,053	1,572,947			4,061,966	3,382,895	387,089	176,313
Iowa	908,622	1,341,116			2,168,638	1,363,509	4,628,993	888,729
Kansas	222,306	181,742			1,572,132	1,157,395	1,074,982	214,722
Kentucky	387,406	468,432	7,830	580	404,614	320,760	645,246	230,494
Louisiana	1,650,518	1,935,253			2,218,145	2,973,140	82,539	21,730
Maine	100,267	60,912	(1)	(1)	380,903	335,211	(1)	(1)
Maryland	1,405,260	1,913,499			1,962,358	2,576,924	504,267	59,280
Massachusetts	1,799,630	1,934,031	92,765	162,567	1,389,437	925,236	1,002,505	370,430
Michigan	3,731,275	3,623,918	142,913	10,227	8,997,827	7,340,453	5,337,959	2,489,995
Minnesota	1,199,600	1,705,354	293	314	2,303,145	1,504,613	12,073,426	1,096,834
Mississippi	563,649	576,413			659,354	538,465	314,863	257,445
Missouri	849,089	820,054			1,080,210	819,938	1,037,376	656,417
Montana	160,047	201,121	3,441	8,603	919,795	642,056	4,727,105	2,089,400
Nebraska	854,715	605,227	9	7	2,480,365	1,815,199	543,353	330,929
Nevada	119,910	224,684	41	12	(1)	(1)	1,503,490	831,302
New Hampshire	90,832	148,326			305,991	177,052	2,142,420	413,519
New Jersey	847,674	1,094,787			671,271	687,233	34,658	3,851
New Mexico	144,592	164,683			39,930	41,334	104,506	91,511
New York	3,180,138	3,854,060	54,711	4,178	3,438,375	3,053,246	1,824,923	492,090
North Carolina	(1)	(1)			2,621,160	2,970,319	456,117	443,684
North Dakota	630,238	731,199	187	112	385,162	199,761	4,649,146	361,812
Ohio	3,482,590	3,692,985			5,795,446	5,734,006	361,889	218,398
Oklahoma	(1)	(1)			(1)	(1)	1,083,158	639,494
Oregon	1,423,256	1,399,656	44,078	65,975	2,408,286	2,426,553	6,778,712	3,183,141
Pennsylvania	3,907,124	4,862,059			2,296,344	3,078,654	413,278	66,767
Puerto Rico			805	926			35,410	67,097
Rhode Island	(1)	(1)			145,301	179,118	68,172	43,663
South Carolina	(1)	(1)					85,792	52,901
South Dakota	(1)	(1)	78,265	4,801	1,678,657	928,403	3,150,560	864,064
Tennessee	888,233	1,106,351	91,798	44,890	731,056	675,275	712,863	124,991
Texas	4,003,297	4,856,851	28,742	6,280	4,110,766	4,961,223	2,604,485	655,260
Utah	499,140	375,097	69,147	43,414	403,867	270,874	1,504,401	1,158,577
Vermont	26,662	40,955			125,395	141,739	878,293	428,557
Virginia	1,292,339	1,922,983			1,432,245	1,536,154	1,867,836	266,648
Washington	1,907,556	1,482,233	808,958	741,933	2,040,157	1,522,469	3,298,878	2,402,352
West Virginia	441,292	585,536			763,979	989,261	185,104	128,215
Wisconsin	1,992,987	1,695,615	412,300	432,933	5,017,094	3,485,166	10,431,278	6,440,852
Wyoming	74,644	76,721	23	15	522,398	394,962	1,540,297	1,134,296
Undistributed [1]	249,681	285,657	1,072,588	1,060,281	622,458	980,863	14,833,539	7,163,624
Total	64,263,744	68,212,707	3,561,751	2,857,283	81,652,021	74,166,945	113,634,572	48,017,270

[1] Figures that may not be shown separately are combined as "Undistributed."

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1952, by States, uses, and class of operations—Continued

State	Gravel—Continued				Sand and gravel			
	Railroad ballast [5]		Other [6]		Total commercial		Total Government-and-contractor	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	(1)	(1)	74,668	$77,493	3,432,175	$2,888,535	290,380	$67,095
Alaska	153,139	$76,569	(1)	(1)	768,794	1,550,781	10,013,132	7,099,801
Arizona	1,443	1,443	48,260	29,285	1,419,884	1,524,194	404,446	111,709
Arkansas	245,549	195,129	57,298	60,104	2,444,245	2,269,958	2,566,850	2,707,261
California	181,257	121,851	522,628	378,321	41,457,396	39,220,004	11,593,864	4,413,121
Colorado	(1)	(1)	(1)	(1)	2,095,328	2,116,954	6,365,711	4,151,413
Connecticut	5,344	2,137	10,000	6,000	2,314,546	1,877,384	266,701	55,830
Delaware	---------	---------	---------	---------	435,399	352,484	80,000	30,000
Florida	---------	---------	---------	---------	4,141,613	3,845,577	13,000	2,500
Georgia	---------	---------	37,126	35,910	2,100,178	1,983,429	33,792	45,938
Hawaii	---------	---------	---------	---------	---------	---------	1,069	936
Idaho	52,549	6,587	110,947	35,135	1,342,559	1,191,481	2,583,304	1,553,720
Illinois	916,141	514,509	197,999	103,955	19,100,558	18,930,023	483,750	284,172
Indiana	702,331	527,348	74,747	62,934	11,142,246	9,095,228	403,768	184,680
Iowa	151,826	84,780	13,027	59,346	5,821,965	5,124,635	4,975,014	908,263
Kansas	63	19	9,810	15,111	6,797,975	4,675,216	1,582,090	348,377
Kentucky	343,906	241,503	83,604	79,643	2,659,045	2,403,094	675,216	252,959
Louisiana	55,780	30,368	(1)	(1)	5,788,098	6,660,994	217,021	75,530
Maine	115,014	64,541	12,207	4,028	666,834	504,740	6,411,244	1,682,791
Maryland	---------	---------	(1)	(1)	6,452,373	8,077,417	504,267	59,280
Massachusetts	7,411	549	129,253	74,712	6,313,547	5,230,641	1,332,181	898,103
Michigan	485,104	409,833	63,131	36,221	23,187,123	19,788,221	6,006,640	2,612,658
Minnesota	922,732	387,122	270,987	62,382	7,441,456	5,666,409	12,383,701	1,142,354
Mississippi	152,533	60,118	1,480	1,096	1,845,864	1,482,581	450,713	350,725
Missouri	175,257	115,161	(1)	(1)	5,695,296	5,417,628	1,095,126	704,567
Montana	374,214	256,381	202,467	58,772	1,873,167	1,428,970	4,892,788	2,150,962
Nebraska	8	21	(1)	(1)	4,892,286	3,542,839	544,254	331,267
Nevada	2,565	281	719	359	570,104	1,528,284	1,528,107	852,135
New Hampshire	(1)	(1)	3,497	1,295	647,008	492,901	2,553,224	508,690
New Jersey	18,000	24,000	66.842	127,293	7,024,914	9,469,530	35,160	3,898
New Mexico	42,645	29,464	---------	---------	389,842	402,449	107,079	97,140
New York	(1)	(1)	361,647	211,363	18,137,789	17,723,975	2,132,269	563,648
North Carolina	(1)	(1)	(1)	(1)	4,524,724	4,173,758	4,200,024	1,491,411
North Dakota	467,316	263,769	192,407	81,296	1,866,524	1,464,867	4,690,545	376,349
Ohio	710,247	537,491	1,644,002	2,214,738	20,351,586	22,821,839	399,907	247,619
Oklahoma	---------	---------	(1)	(1)	2,353,559	2,209,098	1,416,104	702,747
Oregon	220,243	162,565	106,759	52,482	5,325,132	5,200,630	6,894,354	3,355,588
Pennsylvania	67,627	45,245	64,511	107,612	14,282,828	19,853,236	413,278	66,767
Puerto Rico	---------	---------	---------	---------	14,573	36,433	108,157	127,733
Rhode Island	---------	---------	---------	---------	472,478	493,868	116,973	63,528
South Carolina	---------	---------	---------	---------	939,388	831,503	108,711	60,809
South Dakota	76,995	39,099	1,941	920	2,294,418	1,431,044	3,551,722	1,047,270
Tennessee	(1)	(1)	7,250	5,438	3,834,313	4,797,361	1,339,088	505,960
Texas	1,556,650	957,903	63,508	77,701	15,998,314	16,602,593	2,663,089	672,662
Utah	172,703	66,291	53,359	27,158	1,644,496	1,127,921	1,615,548	1,222,491
Vermont	4,100	1,882	---------	---------	286,197	271,278	978,293	478,557
Virginia	(1)	(1)	---------	---------	5,193,261	5,249,055	1,942,851	307,898
Washington	366,283	216,247	752,348	423,592	6,895,285	5,100,795	6,426,994	4,321,322
West Virginia	(1)	(1)	---------	---------	3,935,001	7,147,155	185,104	128,215
Wisconsin	990,919	375,774	194,457	56,658	12,250,771	9,274,989	12,645,176	7,663,239
Wyoming	201,768	52,937	2,000	1,300	866,039	585,327	1,560,960	1,153,221
Undistributed [1]	729,479	618,905	202,612	360,349	---------	---------	---------	---------
Total	10,669,141	6,487,822	5,637,498	4,930,002	301,728,494	295,139,306	133,782,739	58,244,909

[1] Figures that may not be shown separately are combined as "Undistributed."
[5] Includes 4,867,003 tons of ballast gravel valued at $2,214,808, produced by railroads for their own use.
[6] Includes 1,623,165 tons of gravel valued at $794,405, used by railroads for fills and similar purposes.

Government-and-Contractor Production.—Figure 2 and tables 5 and 6 indicate the volume and the relative importance of Government-and-contractor production. Such noncommercial operations comprised 31 percent of total output in 1952 compared with 29 percent in 1951, and 30 percent in 1950. The value of this output was 16 percent of total value of all production, the same percentage as in 1951.

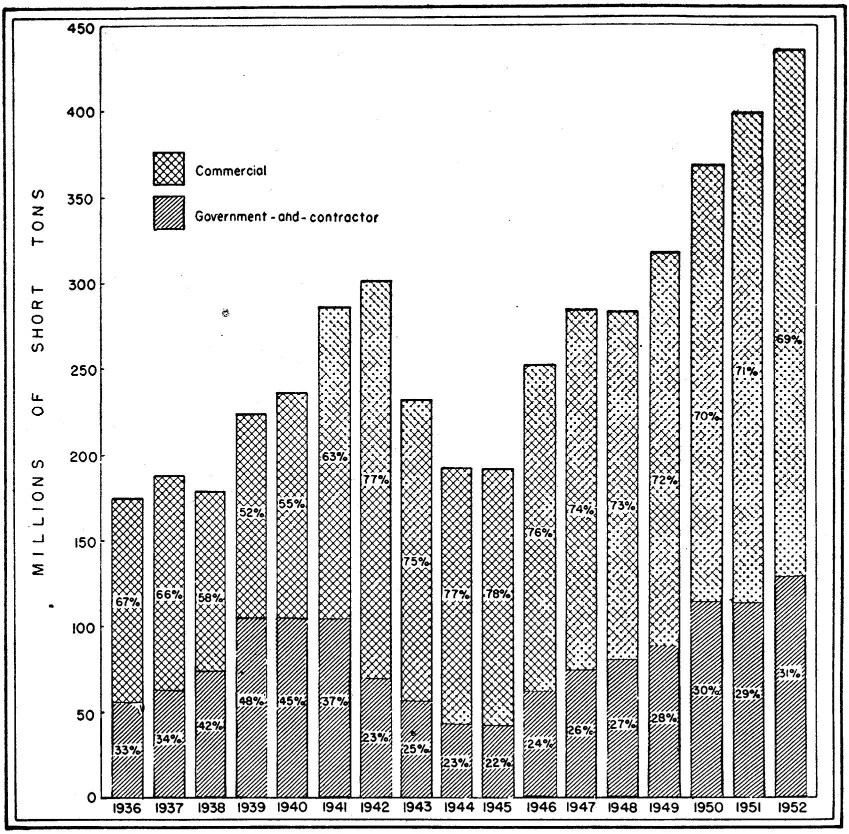

FIGURE 2.—Sand and gravel sold or used in the United States by producers, 1936–52.

TABLE 5.—Sand and gravel sold or used by Government-and-contractor producers in the United States,[1] 1943–47 (average) and 1948–52, by uses

Year	Sand				Gravel				Total Government-and-contractor sand and gravel	
	Building		Paving		Building		Paving			
	Quantity (thousand short tons)	Value (thousand dollars)	Quantity (thousand short tons)	Value (thousand dollars)	Quantity (thousand short tons)	Value (thousand dollars)	Quantity (thousand short tons)	Value (thousand dollars)	Quantity (thousand short tons)	Value (thousand dollars)
1943–47 (average)	1,501	738	5,121	1,928	2,775	1,722	47,056	19,104	56,453	23,492
1948	1,529	811	7,336	3,452	5,487	3,405	71,411	33,510	85,763	41,178
1949	1,604	959	7,424	2,820	3,133	2,235	75,738	31,093	87,899	37,107
1950	2,759	1,675	11,159	4,286	5,216	4,510	93,765	43,245	112,899	53,716
1951	[2] 1,869	[2] 2,001	[2] 12,564	[2] 4,776	7,665	6,906	[2] 92,717	[2] 39,854	[2] 114,815	[2] 53,537
1952	1,184	1,140	15,402	6,230	3,562	2,858	113,635	48,017	133,783	58,245

[1] Includes Alaska, Hawaii, and Puerto Rico.
[2] Revised figure.

States reported 52 percent of the total Government-and-contractor output in 1952, counties 29 percent, Federal agencies 18 percent, and municipalities 1. In 1952 contractors furnished 65 percent of the Government-and-contractor tonnage, and construction and maintenance crews 35 percent.

TABLE 6.—Sand and gravel sold or used by Government-and-contractor producers in the United States,[1] 1943–47 (average) and 1948–52, by type of producer

Type of producer	1943–47 (average)		1948		1949	
	Thousand short tons	Average value per ton	Thousand short tons	Average value per ton	Thousand short tons	Average value per ton
Construction and maintenance crews	31,773	$0.32	42,531	$0.34	43,586	$0.31
Contractors	24,680	.54	43,232	.62	44,313	.53
Total	56,453	.42	85,763	.48	87,899	.42
States	24,125	.44	45,166	.55	44,354	.44
Counties	21,003	.30	32,260	.32	33,822	.31
Municipalities	1,309	.38	1,881	.41	2,131	.40
Federal agencies	10,016	.62	6,456	.83	7,592	.82
Total	56,453	.42	85,763	.48	87,899	.42

Type of producer	1950		1951		1952	
	Thousand short tons	Average value per ton	Thousand short tons	Average value per ton	Thousand short tons	Average value per ton
Construction and maintenance crews	48,742	$0.33	[2] 41,637	[2] $0.36	46,901	$0.35
Contractors	64,157	.59	[2] 73,178	.53	86,882	.48
Total	112,899	.48	[2] 114,815	[2] .47	133,783	.44
States	61,798	.50	[2] 60,387	[2] .43	68,928	.44
Counties	37,841	.30	34,249	.37	39,107	.37
Municipalities	2,109	.54	2,159	.47	2,068	.52
Federal agencies	11,151	.89	18,020	.77	23,680	.53
Total	112,899	.48	[2] 114,815	[2] .47	133,783	.44

[1] Includes Alaska, Hawaii, and Puerto Rico.
[2] Revised figure.

Degree of Preparation.—Almost three-quarters of the sand and gravel sold or used in the United States in 1952 was washed, screened or otherwise prepared. About one-quarter was a bank-run product used chiefly as a base for secondary roads. Of the quantity so used, 83 percent was supplied by Government-and-contractor sources. Table 7 shows the relationship between prepared and unprepared production for 1951–52.

Size of Plants.—The average annual plant output of commercial operating units (except railroads) in 1952 dropped to 118,000 short tons compared with 120,000 in 1951. Compared with 1951, the number of small to medium-size plants increased consistently; there was also a substantial increase in the number of plants producing 600,000 to 800,000 tons each a year. The number of plants with an annual output exceeding 1 million tons was the same as in 1951. It appears, therefore, that an increase in the number of relatively large producing units was confined to the 600,000- to 800,000-ton groups.

TABLE 7.—Sand and gravel sold or used by producers in the United States,[1] 1951–52, by class of operation and degree of preparation

	1951			1952		
	Quantity		Average value per ton	Quantity		Average value per ton
	Short tons	Percent		Short tons	Percent	
Commercial operations:						
Prepared	255, 411, 451	89	$1. 03	272, 225, 449	90	$1. 03
Unprepared	30, 408, 053	11	. 53	29, 503, 045	10	. 53
Total	285, 819, 504	100	. 98	301, 728, 494	100	. 98
Government-and-contractor operations:						
Prepared	[2] 45, 487, 462	[2] 40	. 80	47, 158, 666	35	. 84
Unprepared	[2] 69, 327, 487	[2] 60	[2] . 25	86, 624, 073	65	. 21
Total	[2] 114, 814, 949	100	[2] . 47	133, 782, 739	100	. 44
Grand total	[2] 400, 634, 453		. 83	435, 511, 233		. 81

[1] Includes Alaska, Hawaii, and Puerto Rico.
[2] Revised figure.

TABLE 8.—Comparison of number and production of commercial sand and gravel plants in the United States, 1951–52, by size group [1]

Size group, in short tons	1951				1952			
	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	759	32. 5	7, 604	2. 7	824	32. 9	8, 356	2. 8
25,000 to less than 50,000	381	16. 3	13, 734	4. 9	429	17. 1	15, 644	5. 3
50,000 to less than 100,000	435	18. 6	31, 006	11. 1	438	17. 5	31, 188	10. 6
100,000 to less than 200,000	394	16. 8	56, 318	20. 1	405	16. 2	56, 760	19. 3
200,000 to less than 300,000	146	6. 2	35, 538	12. 7	179	7. 1	43, 562	14. 8
300,000 to less than 400,000	81	3. 5	27, 694	9. 9	82	3. 3	27, 656	9. 4
400,000 to less than 500,000	49	2. 1	21, 528	7. 7	40	1. 6	17, 799	6. 0
500,000 to less than 600,000	30	1. 3	16, 423	5. 8	29	1. 2	15, 594	5. 3
600,000 to less than 700,000	17	. 7	11, 016	3. 9	24	1. 0	15, 668	5. 3
700,000 to less than 800,000	10	. 4	7, 374	2. 6	17	. 7	12, 652	4. 3
800,000 to less than 900,000	5	. 2	4, 291	1. 5	5	. 2	4, 233	1. 4
900,000 to less than 1,000,000	4	. 2	3, 836	1. 4	2	. 1	1, 921	. 7
1,000,000 and over	27	1. 2	43, 953	15. 7	27	1. 1	43, 688	14. 8
Total	2, 338	100. 0	280, 315	100. 0	2, 501	100. 0	294, 721	100. 0

[1] Excludes operations by or for States, counties, municipalities, and Federal Government agencies as follows—1951: 750 operations with an output of 115,801,000 tons of sand and gravel; 1952: 806 operations, 134,-788,739 tons. Excludes operations by or for railroads as follows—1951: 131 operations with an output of 5,504,000 tons of sand and gravel; 1952: 176 operations, 7,007,033 tons. Includes Alaska.
[2] Includes a few companies operating more than 1 plant but not submitting separate returns for individua plants.

Methods of Transportation.—There was a continuation of the trend begun in 1946 toward greater use of trucks in the domestic transportation of sand and gravel and a decrease in the use of rail transportation. Details of the tonnage and percentage carried by various methods during 1950–52 are shown in table 9.

TABLE 9.—Sand and gravel sold or used in the United States,[1] 1950–52, by method of transportation

	1950		1951		1952	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Commercial:						
Truck	150,892	41	166,992	41	187,267	43
Rail	72,489	20	80,062	20	83,381	19
Waterway	22,618	6	23,617	6	25,891	6
Unspecified	11,557	3	15,148	4	5,189	1
Total commercial	257,556	70	285,819	71	301,728	69
Government-and-contractor: Truck [2]	112,899	30	[3] 114,815	29	133,783	31
Grand total	370,455	100	[3] 400,634	100	435,511	100

[1] Includes Alaska, Hawaii, and Puerto Rico.
[2] Entire output of Government-and-contractor operations assumed to be moved by truck.
[3] Revised figure.

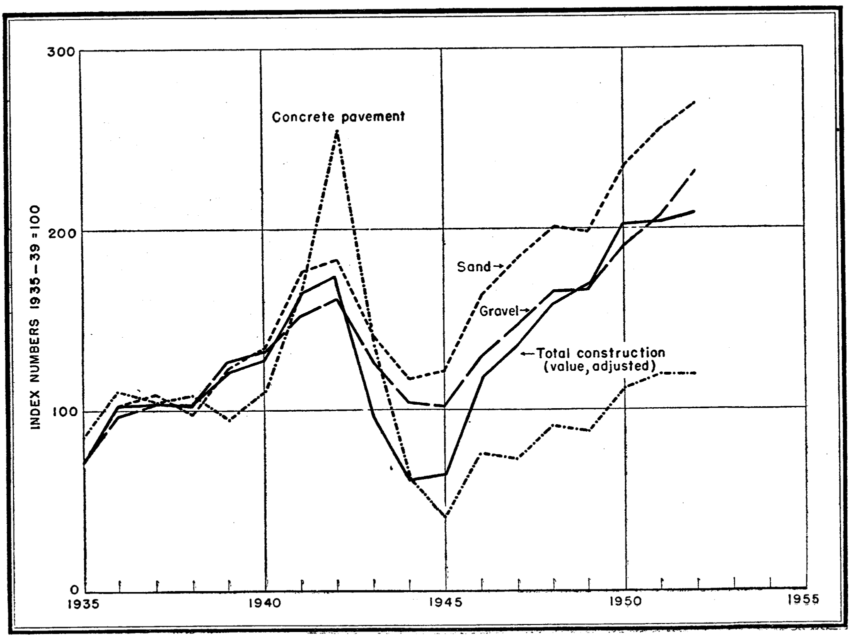

FIGURE 3.—Quantity of sand and gravel produced compared with total construction, value (adjusted to 1947–49 prices), and concrete pavements (contract awards, square yards) in the United States, 1935–52. Data on construction from Statistical Abstracts of the United States and on pavements from Survey of Current Business.

CONSUMPTION

Sand and Gravel for Construction.—The demand for sand and gravel by the construction industry in 1952, as indicated by shipments from commercial plants, continued the upward trend that has characterized recent years. Compared with 1951, the output of building sand increased 3 percent; paving sand, 7 percent; building gravel, 3 percent; and paving gravel, 13 percent. These increases reflect sustained activity in the construction field.

Industrial Sands.—Consumption of sand for industrial uses declined moderately compared with 1951. Use of molding sand decreased 9 percent; glass sand, 5 percent; grinding and polishing sand, 17 percent; fire and furnace sand, 12 percent; and engine sand, 14 percent. Filter sand sales, however, increased 42 percent.

Employment and Productivity.—The number of men employed in the commercial sand and gravel industry in the United States during 1952 was about 28,000, compared with 27,000 in 1951. The average number of days worked dropped from 241 to 239. The average number of hours per man per day (8.7) was the same in 1952 as in 1951, but the output per man per shift increased from 43.9 to 45.7 short tons. The highest production per man per shift was in New York, followed, in order, by Michigan-Wisconsin, California-Nevada, and the North Dakota-South Dakota-Minnesota areas. Table 10 presents a breakdown of employment and production in the commercial sand and gravel industry, by regions.

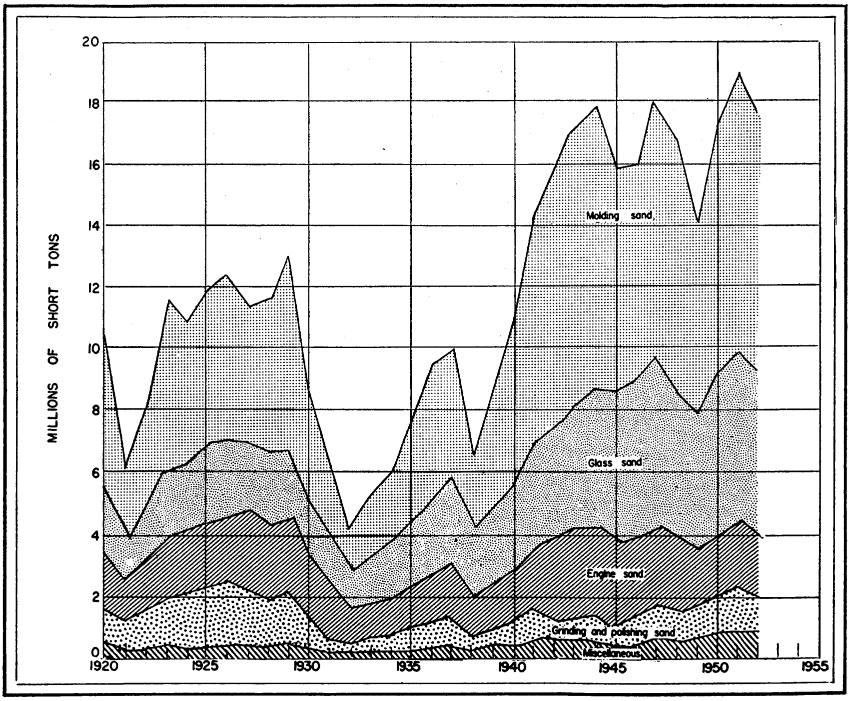

FIGURE 4.—Production of industrial sands in the United States 1920–52.

TABLE 10.—Employment in the commercial sand and gravel industry and average output per man in the United States, 1943–47 (average) and 1948–52, by regions [1]

	Employment					Production (short tons)			Percent of commercial industry represented
	Average number of men	Time employed				Commercial sand and gravel	Average per man		
		Average number of days	Total man shifts	Man-hours			Per shift	Per hour	
				Average man per day	Total				
1943–47 (average)	18,851	236	4,456,625	8.8	39,349,910	142,916,391	32.1	3.6	80.8
1948	21,895	246	5,389,167	8.6	46,103,345	200,706,763	37.2	4.4	86.0
1949	22,964	232	5,336,711	8.7	46,286,039	199,655,709	37.4	4.3	86.4
1950	24,276	238	5,771,740	8.7	50,250,732	236,420,288	41.0	4.7	91.8
1951									
Maine, N. H., Vt., R. I., Mass., and Conn.	839	222	186,173	8.7	1,611,343	9,126,864	49.0	5.7	94.7
N. Y.	1,173	238	279,668	8.4	2,347,443	15,512,790	55.5	6.6	80.3
Pa., N. J., and Del.	2,511	267	670,201	8.7	5,824,485	21,729,144	32.4	3.7	97.8
W. Va., Va., and Md.	1,623	264	428,898	8.9	3,800,624	11,634,653	27.1	3.1	73.5
S. C., Ga., Ala., Fla., and Miss.	1,068	277	296,171	9.1	2,705,217	11,246,126	38.0	4.2	99.2
N. C., Ky., and Tenn.	1,029	262	269,545	9.5	2,552,450	9,538,040	35.4	3.7	97.7
Ark., La., and Tex.	2,215	263	581,552	9.1	5,296,383	20,029,109	34.4	3.8	86.4
Ohio	1,928	255	491,316	8.7	4,285,695	18,069,315	36.8	4.2	94.7
Ill. and Ind.	2,200	250	549,788	8.5	4,649,775	28,846,950	52.5	6.2	95.1
Mich. and Wis.	2,266	213	481,550	8.9	4,274,990	29,522,258	61.3	6.9	91.6
N. Dak., S. Dak., and Minn.	890	163	145,116	9.2	1,329,020	7,760,005	53.5	5.8	75.3
Nebr. and Iowa	684	217	148,619	9.5	1,410,108	7,762,284	52.2	5.5	80.7
Kans., Mo., and Okla.	1,275	231	295,139	8.3	2,463,123	12,541,559	42.5	5.1	87.3
Wyo., Colo., N. Mex., Utah, and Ariz.	583	200	116,635	8.3	966,856	4,940,508	42.4	5.1	88.7
Calif. and Nev.	2,801	249	697,787	8.3	5,819,250	38,012,759	54.5	6.5	99.0
Mont., Wash., Oreg., and Idaho	1,290	190	245,449	8.3	2,031,167	12,063,618	49.1	5.9	82.6
Total	24,375	241	5,883,607	8.7	51,367,929	258,335,982	43.9	5.0	90.4
1952									
Maine, N. H., Vt., R. I., Mass., and Conn.	957	214	204,831	8.7	1,774,548	9,983,365	48.7	5.6	93.3
N. Y.	1,229	226	277,241	8.4	2,318,015	16,703,526	60.2	7.2	92.1
Pa., N. J., and Del.	2,491	260	647,499	8.6	5,563,218	21,140,635	32.6	3.8	97.2
W. Va., Va., and Md.	1,574	269	423,251	8.9	3,774,758	13,556,695	32.0	3.6	87.0
S. C., Ga., Ala., Fla., and Miss.	1,163	264	306,624	8.9	2,739,062	12,058,060	39.3	4.4	96.8
N. C., Ky., and Tenn.	1,155	251	289,430	9.3	2,689,182	10,858,391	37.5	4.0	98.6
Ark., La., and Tex.	2,325	264	613,288	9.1	5,571,623	22,206,319	36.2	4.0	91.6
Ohio	1,917	240	460,219	8.6	3,972,552	19,414,708	42.2	4.9	95.4
Ill. and Ind.	2,190	250	547,243	8.4	4,620,973	28,352,292	51.8	6.1	93.7
Mich. and Wis.	2,646	212	561,872	9.0	5,065,519	32,403,272	57.7	6.4	91.4
N. Dak., S. Dak., and Minn.	984	174	171,192	9.2	1,574,322	9,536,018	55.7	6.1	82.2
Nebr. and Iowa	862	217	187,047	9.6	1,794,610	10,019,944	53.6	5.6	93.5
Kans., Mo., and Okla.	1,375	240	329,326	8.7	2,859,281	14,359,030	43.6	5.0	96.7
Wyo., Colo., N. Mex., Utah, and Ariz.	640	209	133,757	8.4	1,116,901	5,880,755	44.0	5.3	91.7
Calif. and Nev.	2,840	251	712,490	8.3	5,935,574	40,955,781	57.5	6.9	97.4
Mont., Wash., Oreg., and Idaho	1,349	201	271,539	8.1	2,212,373	12,695,494	46.8	5.7	82.2
Alaska	58	131	7,572	8.4	63,316	382,446	50.5	6.0	49.7
Total	25,755	239	6,144,421	8.7	53,645,827	280,506,731	45.7	5.2	93.0

[1] Excludes plants operated by or directly for States, counties, municipalities, and Federal Government agencies.

STOCKS

Stocks of sand and gravel are relatively small and virtually constant from year to year. For this reason, the terms "production" and "sales" are employed interchangeably in this chapter.

PRICES

The average per ton value of sand used for molding, grinding, polishing, furnaces, and as a constituent of glass increased; however, all other sand categories, including the large tonnage used for building and paving, declined in average value, resulting in an overall average decrease of 2 percent in value for all sand. The average value of all gravel production declined 3 percent. The percent change in value for each class of sand and gravel is shown in table 1.

FOREIGN TRADE [4]

Imports of gravel and sand of all categories declined in 1952 as compared with 1951, the total decline in tonnage being 14 percent. Belgium supplied all the 1952 glass sand imports. Sand "not specifically provided for (n. s. p. f.)" in the import classification came principally from Canada, which was also the source of all imported gravel in 1952. Table 11 shows domestic sand and gravel imports for 1943–52, as reported by the United States Department of Commerce.

TABLE 11.—Sand and gravel imported for consumption in the United States, 1943–52, by classes

[U. S. Department of Commerce]

Year	Sand				Gravel		Total	
	Glass sand		Other sand [2]					
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1943	18	$363	296,262	$206,145	86,924	$63,381	383,204	$269,889
1944	15	181	209,255	129,632	67,929	31,208	277,199	161,021
1945	(3)	148	200,280	126,102	80,861	43,976	281,141	170,226
1946	5,006	9,102	262,484	194,820	83,860	25,847	351,350	229,769
1947	7,804	12,532	297,481	283,884	177,244	100,665	482,529	397,081
1948	16,914	24,134	336,898	302,117	89,174	30,411	442,986	356,662
1949	11,491	20,152	287,452	277,564	135,227	19,194	434,170	316,910
1950	9,191	25,481	290,025	266,065	146,079	29,011	445,295	320,557
1951	[4] [5] 6,260	[4] 91,424	319,584	317,205	149,766	31,189	[5] 475,610	439,818
1952	[4] 4,016	[4] 23,998	300,182	344,674	104,332	13,771	408,530	382,443

[1] Classification reads: "Sand containing 95 percent or more silica and not more than 0.6 percent oxide of iron and suitable for manufacture of glass."
[2] Classification reads: 1943–47: "Sand, n. s. p. f."; 1948–52: "Sand, n. s. p. f., crude or manufactured."
[3] Less than 1 ton.
[4] Includes [5] 53 short tons valued at $80,847 in 1951; and 11 short tons valued at $18,603 in 1952 imported from West Germany, consisting of synthetically prepared silica and not actually a glass sand.
[5] Revised figure.

TECHNOLOGY

Research.—The National Sand and Gravel Association conducts research in cooperation with the Engineering Department of the University of Maryland at College Park, Md. An important problem now in progress is research on the effect in concrete of undesirable materials in sand and gravel. A serious problem, particularly in some western sands and gravels used as concrete aggregate, is the presence of hydrous or glassy silicates that react harmfully with soluble alkalies in the cement.

[4] Figures on imports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

Beneficiation.—Froth flotation is attaining increasing importance in glass-sand preparation. Sand is a low-priced product that will not bear heavy transportation expense. To avoid haulage of high-quality glass sands from distant sources, abundant nearby deposits of beach and river sands may, at times, be treated by froth-flotation processes to produce suitable glass sands. In some instances, by-product feldspar, and other minerals may be recoverable. European progress in beneficiating glass sands by flotation has been described in some detail. Russian investigators are reported to have made marked progress in this field.[5]

At one sand plant in California where flotation is used, the material is first passed through an attrition machine equipped with rubber-covered paddle arms. The purpose is to scour and scrub the individual grains to make them more amenable to froth-flotation treatment. The beach sands treated consist of about 50 percent quartz and the remainder chiefly high-alumina minerals. A small percentage of "heavies" consists of ilmenite, garnet, monazite, and zircon. The flotation process separates a purified quartz and a high-alumina mineral concentrate for use in the ceramic industry.[6]

A type of equipment new to the sand and gravel industry has been installed by a New Jersey company to recover sand in minus-100- and minus-200-mesh ranges. The machine, known as the Dorr Clone, operates on the centrifugal principle. The pulp is pumped tangentially into a cone-shaped unit, and the resulting centrifugal force causes the heavier particles to move to the periphery. They gradually work downward and are discharged at the bottom. The lighter materials move upward and are discharged at the top of the unit. The water content of the underflow can be controlled. This equipment has been used successfully in the Florida phosphate fields, and it may find wider use in sand and gravel plants.[7]

At one sand and gravel deposit in Arizona, many plus-5-inch diameter cobbles occur, and their separation by means of an ordinary grizzly resulted in much lost time in removing boulders that blinded the openings. This difficulty was overcome by using a 25- by 18-foot platform railroad-rail grizzly. As soon as a truckload of gravel is dumped upon it, hydraulic hoists raise one side of the grizzly until it tilts to a 55° slope, at which point the undesired oversize cobbles roll off to a waste hopper, while the undersize product drops through to the primary crusher.[8]

Portable Plants.—Portable plants have been common in the sand and gravel industry for many years, and during that time they have experienced revolutionary changes in consonance with the trends in progress of the industry as a whole. Single units have grown into sectionalized plants, each unit of which is a portable rubber-mounted machine. The units may consist of shovels, compressors, screens, washers, scrubbers, and crushers. Their size is limited by permissible

---

[5] Pearson, B. M., European Developments in Use and Processing of Glass Sands: Rock Products, vol. 55, No. 9, September 1952, pp. 81–87, 112.

[6] Lenhart, Walter B., Flotation Process Applied to Silica: Rock Products, vol. 55, No. 2, February 1952, pp. 100–103.

[7] Rock Products, Meeting Fine-Sand Specifications: Vol. 55, No. 12, December 1952, pp. 116–117, 124–126.

[8] Utley, Harry F., Hydraulic-Powered Tilting Grizzly Speeds Boulder Rejects at Hopper: Pit and Quarry, vol. 45, No. 5, November 1952, p. 120.

highway and bridge loads. Portable plants are employed at times as supplementary units of permanent plants.[9]

A portable plant may be used also for preliminary preparation at the pit, with subsequent processing at the fixed plant. For instance, a portable plant is used at one North Carolina plant simply to scalp out excessive fines, which are returned to the worked-out pit. A similar two-stage operation is in use at a South Carolina plant.[10]

Under-Water Operations.—An ocean-floor deposit of sand and gravel in a small cove several miles south of the Golden Gate on the California coast provides satisfactory commercial products. A dragline excavator has been established on the shore with a slackline anchored across the cove. The processing plant classifies the product into 1 grade of sand and 3 grades of gravel. This unique operation has recently been described.[11]

Lake-bottom areas suitable for sand and gravel dredging in navigable water are difficult to find in fogs and periods of low visibility. One company operating on Lake Erie has marked its dredging areas with anchored buoys carrying radar reflectors which can be detected with the dredging vessel's radar equipment.[12]

Prospecting.—A special type of rotary drill using an 8-inch casing and capable of drilling to a depth of 1,500 feet is useful for sand and gravel prospecting. The casing is divided into 5-foot sections, with heavy thread connections. The lower section, which is replaceable, is provided with a sawtooth cutting edge. The bailer consists of a 9-foot length of 6-inch pipe having a flap valve at the lower end. The cutter edge is kept 2 to 5 feet ahead of the bailer. Frequent raising and dropping of the bailer tend to create a suction that draws the sand and gravel into it. Pieces of gravel almost as large as the bailer may be included. A 70-foot hole can be sunk in 3½ to 4 hours. One Texas company sinks prospect holes with this equipment on a 210-foot grid and plots on a map the depths of top soil, good gravel, fair gravel, sand, low grade gravel, and very low grade gravel. Areas for portable plant operation are thus delineated.[13]

Reclamation of Worked-Out Areas.—The leveling of dumps and filling of worked-out sand and gravel pits are important conservation activities in many localities. Attractive landscapes, including tillable or pasture land, may replace worked-out areas. At one sand and gravel operation in Michigan the topsoil is first stripped and stored, and the lower overburden is piled elsewhere. The worked-out areas are later filled in, using earth-moving equipment and the topsoil redeposited on the surface.[14]

---

[9] Lenhart, Walter B., Portable Plant's Role in Aggregate Production: Rock Products, vol. 55, No. 1, January 1952, pp. 161–163, 199–200.

[10] Lenhart, Walter B., Portable Plant in Pit to Remove Fines: Rock Products, vol. 55, No. 6, June 1952, pp. 104–106. Two-Stage Sand and Gravel Plant: Rock Products, vol. 55, No. 9, September 1952, pp. 54–66, 108.

[11] Pit and Quarry, California Open-Pit Operation Takes to the Water: Vol. 45, No. 3, September 1952, pp. 106–108.

[12] Pit and Quarry, Erie Sand and Gravel Co. Vessel Uses Radar to Find Dredging Areas: Vol. 44, No. 10, April 1952, p. 82.

[13] Lenhart, Walter B., Prospecting for Sand and Gravel: Rock Products, vol. 55, No. 8, August 1952, p. 174.

[14] Pit and Quarry, Michigan Sand and Gravel Producer Reclaims "Lost" Land From Pits: Vol. 45, No. 2, August 1952, pp. 117–118, 120.

History.—An illustrated description of the evolution in equipment and methods used in excavating and preparing sand and gravel has recently appeared.[15] The historical record which pertains primarily to developments in the British industry begins with the use of gravel on roads about 1737. Primitive hand methods were used in early days for stripping, excavating and even for dredging river gravels, but these were gradually replaced by mechanical means, the details of which are discussed. The history of production methods and equipment extends to 1930.

[15] Webb, D. A., Early Methods of Sand and Gravel Production: Cement, Lime and Gravel (London), vol. 27, No. 5, November 1952, pp. 204–219.

Secondary Metals—Nonferrous

By Archie J. McDermid[1] [2]

MOST NONFERROUS METALS, both primary and secondary, as well as scrap, were in restricted supply early in 1952. Demand for some metals slackened during the year, and their supply-demand relationships improved; as regards lead and zinc, increased supplies of primary metal and scrap by midyear caused declines of several cents a pound in the prices of both. The scarcity that began in 1950 and continued in 1951 had been relieved to some extent, in respect to aluminum and magnesium, by increased primary supply and, in respect to lead and zinc, by lower demand as well as increased total supply. Supplies of refined copper were inadequate throughout 1952, but demand for copper-alloy scrap for use in brass-ingot manufacture slackened slightly after the first quarter. In 1952 recoveries of all nonferrous secondary metals declined slightly except for aluminum, which increased slightly over 1951. Government control of metals, including ceiling price restrictions, continued in effect throughout 1952.

Consumption of primary aluminum and magnesium and of refined copper and nickel rose in 1952, but consumption of copper, magnesium, and nickel scrap dropped; that of aluminum scrap increased 5 percent compared with a 10-percent increase in use of primary aluminum. Consumption of refined lead and slab zinc decreased 3 and 9 percent, respectively, and use of lead and zinc scrap 10 and 12 percent.

The reasons for the reduced consumption of scrap compared with that of refined metal would be difficult to determine from available information. Output, consumption, and stocks of primary metal are precisely reported and published, providing a sound basis for determining the metal available, but there is no adequate record of the generation of scrap. Receipt and use of purchased scrap were restricted in 1952 by Government control regulations, but plants were allowed to use their home-generated scrap; moreover, nothing in the regulations prevented a generator of scrap from expanding his use of home scrap to include material that he might ordinarily sell to a dealer or smelter, or from installing and beginning to use scrap-melting equipment. The Government required consumers of scrap and the larger dealers in copper and lead scrap to file monthly reports, which provided a check on their operations, but there was no continuing

[1] Commodity-industry analyst.
[2] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page of the Bureau of Mines from records of the U. S. Department of Commerce.

record of the stocks and transactions of generators or the smaller scrap-metal dealers. It was therefore difficult to determine whether purchased scrap was scarce (1) because it was not being generated in adequate volume, (2) because it was being accumulated by generators or others, or (3) because it was consumed as home scrap.

TABLE 1.—Salient statistics of nonferrous secondary metals recovered from scrap processed in continental United States, 1951–52

Metal	From new scrap		From old scrap		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1951						
Aluminum	216,017	$78,759,798	76,591	$27,925,079	292,608	$106,684,877
Antimony	4,007	3,539,784	19,936	17,611,462	23,943	21,151,246
Copper	474,158	229,492,472	458,124	221,732,016	932,282	451,224,488
Lead	76,452	26,452,392	441,658	152,813,668	518,110	179,266,060
Magnesium	5,366	2,629,340	6,160	3,018,400	11,526	5,647,740
Nickel	3,788	4,297,865	4,814	5,461,964	8,602	9,759,829
Tin	11,476	29,449,252	22,958	58,913,901	34,434	88,363,153
Zinc	246,203	89,617,892	68,174	24,815,336	314,377	114,433,228
Total		464,238,795		512,291,826		976,530,621
1952						
Aluminum	233,258	85,698,989	71,264	26,182,394	304,522	111,881,383
Antimony	3,471	3,055,868	19,618	17,271,688	23,089	20,327,556
Copper	488,562	236,464,008	414,635	200,683,340	903,197	437,147,348
Lead	59,463	19,147,086	411,831	132,609,582	471,294	151,756,668
Magnesium	4,240	2,077,600	7,237	3,546,130	11,477	5,623,730
Nickel	3,220	3,788,652	4,259	5,011,139	7,479	8,799,791
Tin	9,328	22,469,286	22,933	55,241,010	32,261	77,710,296
Zinc	235,758	78,271,656	74,665	24,788,780	310,423	103,060,436
Total		450,973,145		465,334,063		916,307,208

TABLE 2.—Secondary metals recovered as unalloyed metal, in alloys, and in chemical compounds in the United States, 1943–47 (average) and 1948–52, in short tons

Metal	1943–47 (average)	1948	1949	1950	1951	1952
Aluminum	312,181	286,777	180,762	243,666	292,608	304,522
Antimony	18,123	21,592	18,061	21,862	23,943	23,089
Copper	961,758	972,788	713,143	977,239	932,282	903,197
Lead	388,261	500,071	412,183	482,275	518,110	471,294
Magnesium	9,891	7,553	5,962	9,476	11,526	11,477
Nickel	7,102	8,850	5,680	8,795	8,602	7,479
Tin	32,653	30,124	24,901	35,481	34,434	32,261
Zinc	337,175	324,639	237,813	326,030	314,377	310,423

Consumption of scrap of the four principal metals decreased for several months preceding termination of the steel strike early in July and increased thereafter to about the level of activity of the first half of the year. Total consumers' stocks of aluminum and copper scrap were higher at the end of 1952 than at the beginning, indicating that supply had become more abundant in relation to demand. Total stocks of zinc scrap in the hands of consumers also rose, and those of lead scrap remained about the same as at the end of 1951; both materials were in plentiful supply in the later months of the year.

SCOPE OF REPORT

Table 3 classifies the plants canvassed in nonferrous secondary metal surveys by type of operation and kind of material consumed. Plants have been recorded in over one column if they used scrap items of more than one base; some smelters are listed as lead smelters, aluminum smelters, and copper smelters because they consumed lead-, aluminum-, and copper-base scrap. In the same way, some foundries have been counted as both aluminum and brass foundries. The tabulation of plants in some categories is subject to limitations. The large number of foundries and the small size of many of them make it impossible to obtain reports from all units. Also, a few large corporations operating two or more plants prefer to file consolidated reports, in which the number and location of plants are not given. As a rule, response by the larger plants is excellent, so that coverage of quantities of metals consumed is better than coverage according to the number of plants.

The reports from industry, on which data in this chapter are based, are received monthly from smelters, brass and aluminum rolling mills, wire mills, primary producers, and some foundries and manufacturers. All brass foundries, some manufacturers, and a number of the smaller aluminum foundries were canvassed on an annual basis.

TABLE 3.—Number and classification of plants in the United States consuming nonferrous scrap metals, refined copper, and copper-alloy ingots in 1952

Kind of plant	Type of materials used				
	Aluminum	Copper	Lead and tin	Zinc	All nonferrous types
Primary plants	[1] 66	[2] 12	6		
Secondary smelters	[3] 165	[4] 116	269	149	
Distillers				[5] 24	
Chemical plants	23	54		28	
Brass mills		61			
Wire mills		[6] 15			
Foundries and miscellaneous manufacturers	[7] 1,040	[8] 1,784	30	[9] 71	[10] 1,000

[1] Includes 15 aluminum-reduction plants and 51 rolling mills and extrusion plants having melting facilities, which consumed aluminum scrap or ingot.
[2] Primary refineries that consumed copper-base scrap.
[3] Includes 159 aluminum-alloy ingot makers and 6 military aluminum smelters.
[4] Includes 79 secondary copper smelters and 37 smelters using copper scrap in other than copper alloys.
[5] Includes 15 secondary plants and 9 primary producers that used scrap in addition to ore. Includes producers of zinc dust and redistilled slab.
[6] Refers to companies operating wire mills. Some companies operate over 1 plant.
[7] Includes foundries using either aluminum scrap or ingot.
[8] Brass foundries.
[9] Includes galvanizers, die casters, and zinc rolling mills.
[10] Iron foundries, steel plants, and miscellaneous manufacturers. Any or all types of nonferrous scrap were used by these consumers as well as by the aluminum and brass foundries.

Detailed information on primary metals may be found in the chapters devoted to those metals.

Definitions of terms used in this chapter follow:

Secondary metals are metals or alloys recovered from scrap and residues. The term "secondary" applies only to the source of the metal and has no relation to the type of product recovered as to quality, degree of purity, or physical characteristics.

Scrap metals are divided into three main categories—old scrap, new scrap, and home scrap.

Old scrap consists of metal articles that have been discarded because of wear, damage, or obsolescence, usually after serving a useful purpose. Typical examples of old scrap are discarded trolley wire, battery plates, railroad-car boxes, fire-cartridge cases, automobile crankcases, used pipe, plumbing fixtures from building demolition, lithographers' plates, and obsolete military equipment (frequently unused).

New scrap consists of process or plant scrap generated in the manufacture of articles from primary or refined metal and consumed at a plant of different location from the plant of generation. New scrap also includes defective finished or semifinished articles returned by purchasers to be reworked.

Home scrap or *runaround scrap* is process scrap consumed in the plant where generated. In this chapter consumption of new and old scrap only is tabulated, no record being kept, in nonferrous metal canvasses, of home scrap. Scrap generated in a machine shop and consumed in a foundry at the same plant location is considered home scrap, and its consumption is not tabulated. Consumption of scrap is always measured at the point where it loses its identity as scrap and becomes secondary metal.

Toll scrap is scrap treated for a toll or conversion charge and is reported by the plant at which the scrap is consumed, not by the plant owning the material.

Borings and turnings and other items of process scrap, when consumed outside the plant where generated, are new scrap, whether clean, rusty, or oily and whether generated recently or long before reclamation. Residues are new scrap if generated in processing scrap or refined metal. For example, flue dust from smelting brass scrap is new scrap. Zinc-chemical residues resulting from the consumption of zinc dust in the manufacture of sodium hydrosulfite are also new scrap. On the other hand, residues generated in processing ore or concentrates are not scrap but "primary residue." Old mine tailings are primary residue because generated in processing ore. Aircraft plants melt zinc-die alloys and antimonial lead to make dies and remelt the dies to make new ones whenever necessary. The same material may be remelted several times during a year. In such cases the dies are not considered to be scrap. If, however, they are sold to a smelter for redistillation or remelting, they are considered to be old scrap.

Purchased scrap is a term used in nonferrous-scrap-metal questionnaires to cover all scrap that should be reported. It includes new scrap, old scrap, and toll scrap, all of which have passed through commercial transactions. It also includes scrap generated at one plant and transferred to another plant of the same company for processing, which usually involves transportation charges. The term also includes scrap reclaimed in shipyard repair work and from line operations at railroad foundries, although no definite financial transaction may have resulted.

The recovery tables that appear near the beginning of each of the sections on metals in this chapter are double. The figures on the left side represent the recoverable metal in the scrap processed. They are obtained by multiplying the reported gross weights of scrap consumed during the year by percentage recovery factors to obtain the metallic recovery (weight after melting loss), then multiplying the metallic recovery by composition percentages of the products to obtain the quantities of aluminum, copper, lead, zinc, etc., recoverable. The recoverable zinc from zinc die-cast scrap is part of the zinc from zinc-base scrap, as shown in the zinc-recovery table in the Secondary Zinc section of this chapter, the recoverable copper is credited to zinc-base scrap in the copper-recovery table and the recoverable aluminum to the zinc-base scrap in the aluminum-recovery table.

Tonnages of metal recovered are listed in the right side of the recovery table, by products, as the companies report them to the Bureau of Mines. The totals so derived for each side of the table do not agree because the actual weight of metal produced from melting or otherwise consuming scrap is seldom precisely the same as the calculated recoverable weight. As presented in the tables, however, the items have been adjusted to give the exact balance theoretically expected. The word "recovery" may therefore be applied to both sides of the table.

SECONDARY ALUMINUM

Recovery of secondary aluminum from purchased and toll-treated scrap consumed in 1952 totaled 305,000 short tons, with a calculated value of $111,881,000. This represented an increase of about 4 percent compared with 293,000 tons recovered in 1951. Values were computed on the basis of the average price received by primary producers for virgin pig aluminum. The average price of primary pig increased from 18.23 cents per pound in 1951 to 18.37 cents in 1952. Aluminum recovered from secondary sources in 1952 was the largest quantity since 1947, when 345,000 tons was reclaimed.

TABLE 4.—Aluminum recovered from scrap processed in the United States, 1951–52, in short tons

Recoverable aluminum-alloy content of scrap processed			Aluminum recovered [1] from scrap processed		
Kind of scrap	1951	1952	Form of recovery	1951	1952
New scrap:			As metal	5,341	4,897
Aluminum-base [2]	215,753	232,833	Aluminum alloys	283,938	294,582
Copper-base	84	191	In brass and bronze	385	387
Zinc-base	122	88	In zinc-base alloys	1,204	898
Magnesium-base	58	146	In magnesium alloys	346	465
			In chemical compounds	1,394	3,293
Total	216,017	233,258	Grand total	292,608	304,522
Old scrap:					
Aluminum-base [3]	75,942	70,301			
Copper-base	129	123			
Zinc-base	238	318			
Magnesium-base	282	522			
Total	76,591	71,264			
Grand total	292,608	304,522			

[1] In accordance with common usage, the term "aluminum" covers aluminum alloys, and the figures include all constituents of the alloys recovered from aluminum-base scrap.
[2] Recoverable aluminum content of new aluminum-base scrap was 201,563 tons in 1951 and 216,314 tons in 1952.
[3] Recoverable aluminum content of old aluminum-base scrap was 70,713 tons in 1951 and 65,139 tons in 1952.

342070—55——57

Production of secondary aluminum-base ingot by nonintegrated secondary smelters as reported to the Bureau of Mines totaled 233,000 tons in 1952, a 16-percent increase compared with 1951. Production of the deoxidizing grades of ingot increased approximately 3,000 tons, or to 43,000, despite a slowdown during midyear, resulting from a labor strike in the steel mills. The three largest outputs of alloy ingot were 62,000 tons of AXS 679 and variations, 37,000 of No. 319 and variations, and 21,000 of No. 12 and variations—a total of 120,000 tons or 51 percent of the total aluminum-base ingot produced by independent secondary smelters in 1952.

TABLE 5.—Production of secondary aluminum and aluminum-alloy products in the United States, 1950–52, gross weight in short tons

Product	1950	1951 [1]		1952
		January–July	August–December	
Secondary aluminum ingot: [2]				
Silicon (Cu, max. 1 percent)	10,393	10,930		
Silicon (Cu, 1 to 2.5 percent)	5,395	3,678		
Other copper (Si max. 2.5 percent) alloys	[3] 6,043	[3] 2,594		
Copper-silicon (each over 2.5 percent) alloys	90,639	62,177		
Aluminum-magnesium and aluminum-zinc alloys	4,907	3,292		
Pure aluminum (98.5 percent)	2,105	2,422	2,916	4,893
Aluminum-silicon (Cu max. 0.6 percent) alloys			5,048	15,372
Aluminum-silicon (Cu, 0.6 to 2 percent) alloys			3,028	7,092
No. 12 alloy and variations	18,063	9,263	6,534	20,665
Aluminum-copper (Si max. 1.5 percent) alloys			[3] 2,225	[3] 6,240
No. 319 alloy and variations			13,838	37,055
AXS 679 alloy and variations			13,226	61,839
Aluminum-silicon-copper-nickel alloys	7,466	7,433	3,062	15,474
Deoxidizing and other dissipative uses	39,886	24,708	15,801	43,398
Aluminum-base hardeners	4,697	3,399	2,253	6,485
Aluminum-magnesium alloys			331	1,019
Aluminum-zinc alloys			1,342	3,181
Miscellaneous	[4] —10,347	1,288	881	10,307
Total	179,247	131,184	70,485	233,020
Secondary aluminum recovered by various producers [5]	64,667	77,377		73,392
Aluminum powder [6]	35			
Aluminum-alloy castings	11,439	15,394		7,811
Aluminum in chemicals	331	1,394		3,293

[1] Classification of ingot for reporting to the Bureau of Mines was changed Aug. 1, 1951.
[2] Gross weight, including copper, silicon, and other alloying elements at independent secondary smelters; total secondary aluminum and aluminum-alloy ingot contained 5,339 tons of primary aluminum in 1950, 12,353 tons in 1951, and 20,509 tons in 1952.
[3] Of the total, 1,810 tons was produced in 1950,1,438 tons was produced in 1951 and 1,031 tons in 1952 at Naval Air Stations and United States Air Force Bases.
[4] Negative production indicates consumption of this material at smelters greater than production.
[5] Secondary aluminum recovered by primary producers and independent fabricators.
[6] Does not include production measured as ingot for graining, powder, atomizing, or chemical purposes.

During 1946 and 1947 obsolete and wrecked aircraft-scrap consumption exceeded that of any other type of aluminum-base scrap and reached a peak (149,000 tons) in 1947. Since then consumption of old aluminum scrap, including aircraft scrap, has trended downward, totaling 89,000 tons in 1951 and 82,000 in 1952. Since 1949 the consumption of new scrap has increased rapidly owing to increased consumption of primary aluminum. Apparent consumption of primary aluminum increased from 636,000 tons in 1949 to 1,073,000 tons in 1952. The total quantity of purchased aluminum-base scrap consumed during 1952 was 348,000 short tons compared with 332,000 tons in 1951 and 199,000 in 1949. Consumption of new scrap increased 22,200 tons and that of old scrap decreased 6,800 tons compared with 1951. Alloy sheet consumed in 1952 increased 2,900 tons, borings and turnings 16,700 tons, and 2S and 3S sheet and utensils 1,500 tons. Total aircraft scrap consumed in 1952 was 12,000 tons, representing a decrease of 2,600 tons compared with 1951, and was the smallest quantity used since 1949. Nonintegrated secondary smelters consumed 73 percent of the total purchased aluminum-base scrap used in 1952; primary producers and fabricators 23 percent and foundries, chemical producers, and others the remaining 4 percent.

TABLE 6.—Stocks and consumption of new and old aluminum scrap in the United States in 1952, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Secondary smelters: [1]						
2S and 3S sheet and utensils	1,563	24,212	15,860	8,730	24,590	1,185
Castings and forgings	410	27,519	5,491	21,365	26,856	1,073
Alloy sheet	1,035	59,692	48,531	9,889	58,420	2,307
Borings and turnings	1,024	68,262	66,351		66,351	2,935
Grindings and sawings	91	1,205	915		915	381
Dross and skimmings	1,195	30,799	30,227		30,227	1,767
Foil and wire	303	4,355	343	3,933	4,276	382
Aircraft	567	12,113		12,006	12,006	674
Pistons	77	3,379		3,291	3,291	165
Irony aluminum	260	10,315		9,879	9,879	696
Miscellaneous	1,047	18,029	9,825	8,447	18,272	804
Total	7,572	259,880	177,543	77,540	255,083	12,369
Primary producers and fabricators:						
2S and 3S sheet and utensils	576	14,259	14,324	57	14,381	454
Castings and forgings	16	618	388	166	554	80
Alloy sheet	1,244	39,129	38,251	307	38,558	1,815
Borings and turnings	370	13,277	12,815		12,815	832
Dross and skimmings	30	89	84		84	35
Foil and wire	32	953	378	415	793	192
Aircraft	143	69		115	115	97
Miscellaneous	327	11,221	9,320	1,319	10,639	909
Total	2,738	79,615	75,560	2,379	77,939	4,414
Foundries and miscellaneous manufacturers:						
2S and 3S sheet and utensils	151	909	733	219	952	108
Castings and forgings	123	3,396	1,770	1,621	3,391	128
Alloy sheet	61	1,318	1,249	117	1,366	13
Borings and turnings	55	3,719	3,420		3,420	354
Dross and skimmings	1,430	4,660	4,875		4,875	1,215
Foil and wire	243	[2] −170	35	35	70	3
Aircraft	9	21		29	29	1
Pistons	9	91		89	89	11
Miscellaneous	167	453	303	213	516	104
Total	2,248	14,397	12,385	2,323	14,708	1,937
Grand total:						
2S and 3S sheet and utensils	2,290	39,380	30,917	9,006	39,923	1,747
Castings and forgings	549	31,533	7,649	23,152	30,801	1,281
Alloy sheet	2,340	100,139	88,031	10,313	98,344	4,135
Borings and turnings	1,449	85,258	82,586		82,586	4,121
Grindings and sawings	91	1,205	915		915	381
Dross and skimmings	2,655	35,548	35,186		35,186	3,017
Foil and wire	578	5,138	756	4,383	5,139	577
Aircraft	719	12,203		12,150	12,150	772
Pistons	86	3,470		3,380	3,380	176
Irony aluminum	260	10,315		9,879	9,879	696
Miscellaneous	1,541	29,763	19,448	9,979	29,427	1,817
Total	12,558	353,892	265,488	82,242	347,730	18,720

[1] Excludes secondary smelters owned by primary aluminum companies.
[2] Negative figure indicates shipments greater than receipts.

Stocks of secondary aluminum-base ingot held by independent secondary smelters at the end of 1952 totaled 11,100 short tons, an increase of 7,200 tons compared with December 31, 1951. Stocks of purchased aluminum-base scrap held by all consumers, including smelters, primary producers, fabricators, and others with melting facilities, increased 6,100 tons and represented about 15 days' supply. These stock increases were accumulated during a slowdown period caused by the steel strike in midyear. Shipments of the deoxidizing grades of ingot, for example, during July were 900 tons; the monthly average during 1952 was 3,300 tons.

Aluminum-scrap and secondary-aluminum-ingot prices were controlled throughout 1952 by Office of Price Stabilization Ceiling Price Regulation 54. Revision 1 to this regulation, effective January 16, raised the ceilings on selected types of scrap and secondary ingot and directed that ceiling prices for aircraft scrap and irony aluminum should be established on a delivered basis. To offset freight-rate increases on secondary ingot, Amendment 1 to Ceiling Price Regulation 54, Revision 1, effective December 3, 1952, was necessary. It revised ceiling prices from a delivered to a shipping-point basis. An allowance was made for transportation charges above 75 cents per 100 pounds. The average monthly price of secondary aluminum ingot (No. 12 alloy at New York, as quoted by the American Metal Market) was 19.50 cents a pound in all months of 1952 except July, when it was 18.81 cents, and August, when it was 19.40 cents. The average for the year was 19.43 cents.

Aluminum-base scrap was imported from 17 countries in 1952 and totaled 7,000 short tons valued at $2,592,000. The average value was 18.52 cents per pound. Canada supplied 3,800 tons, West Germany, 800 tons, The Netherlands, 690 tons, Japan, 565 tons, and the remaining 1,100 tons came from 13 other countries. Exports of aluminum-base scrap totaled 1,000 tons, having a total value of $164,000. The average value was 7.98 cents per pound. Exports consisted almost entirely of drosses, skimmings and other low grades of scrap.

SECONDARY ANTIMONY

Recovery of secondary antimony in 1952 totaled 23,000 short tons valued at $20,328,000, a decrease of 4 percent in quantity and value from the 24,000 tons valued at $21,151,000 reclaimed in 1951. The values are computed at 44.02 cents per pound in 1952 and 44.17 cents in 1951, the average New York selling price in each year.

Secondary copper and lead smelters recovered 85 percent of the total (20,000 tons), manufacturers 8 percent (1,773 tons), and primary lead smelters, 7 percent (1,615 tons). Antimony recovered in antimonial lead declined 8 percent but increased 6 percent in other lead-base alloys and 12 percent in tin-base alloys.

Consumption of battery-lead plate scrap fell 8 percent below 1951 or to 383,000 tons but yielded 55 percent of all antimony reclaimed. Antimony recovered from tin scrap came chiefly from tin babbitt scrap; that recovered from lead scrap (23,000 tons) was reclaimed chiefly from old battery plates and in smaller quantities from other scrap, including type metals, common babbitt, dross, etc.

TABLE 7.—Antimony recovered from scrap processed in the United States, 1951–52, in short tons

Recoverable antimony content of scrap processed			Antimony recovered from scrap processed		
Kind of scrap	1951	1952	Form of recovery	1951	1952
New scrap:			In antimonial lead	16,747	15,462
Lead-base	4,006	3,471	In other lead alloys	7,033	7,445
Tin-base	1		In tin-base alloys	163	182
Total	4,007	3,471	Grand total	23,943	23,089
Old scrap:					
Lead-base	19,768	19,451			
Tin-base	168	167			
Total	19,936	19,618			
Grand total	23,943	23,089			

All secondary antimony in 1952 was recovered from lead- and tin-base scrap in, so far as can be determined, lead- and tin-base alloy products. All metallic antimony and antimony oxide produced came from ore. The Secondary Metals Recovery Section of the Bureau of Mines, at the College Park, Md., field station carries on experiments for recovering nonferrous metals from scrap and has initiated a project in which selective oxidation is used. Since lead alloys form relatively simple, low-melting systems, they have been selected as the first to be investigated in this project. This work may develop a method of recovering secondary metallic antimony or antimony oxide.

The recoverable antimony content of the lead and tin scrap used in 1952 was 23,000 tons. The lead and tin products in which antimony was used required 29,000 tons of this metal, of which 6,000 tons was primary metal. Most antimony so used could be recovered sooner or later, but none of the 8,000 tons used in nonmetal products was salvageable, all being used destructively in such products as fireworks or in such products as flameproofed textiles from which it could not be separated, reclaimed by remelting as in lead and tin scrap, or recovered by any other method yet developed.

National Production Authority Order M–39, controlling use and distribution of antimony, was revoked on May 15 because industry appeared to be able to meet all necessary requirements. Mandatory reporting on stocks, consumption, etc., was continued.

Data on consumption of scrap from which antimony was recovered may be found in the tables on consumption of lead- and tin-base scrap in the sections of this chapter devoted to those metals. Products in which antimony was recovered are included in the lead- and tin-products table of this chapter under the heading Secondary Lead.

SECONDARY COPPER AND BRASS

The recovery of secondary copper from all classes of nonferrous scrap totaled 903,000 short tons valued at $437,147,000 in 1952, a 3-percent decrease in quantity and value from the 932,000 tons valued at $451,224,000 recovered in 1951. These values are computed at 24.2 cents per pound, the average weighted price for all grades of refined copper sold by producers in both years.

TABLE 8.—Copper recovered from scrap processed in the United States, 1951–52, in short tons

Recoverable copper content of scrap processed: Kind of scrap	1951	1952
New scrap:		
Copper-base	464,226	477,853
Aluminum-base	9,595	10,442
Nickel-base	331	261
Lead-base		
Zinc-base	6	6
Total	474,158	488,562
Old scrap:		
Copper-base	454,447	411,296
Aluminum-base	2,693	2,553
Nickel-base	853	657
Lead-base	32	31
Tin-base	97	97
Zinc-base	2	1
Total	458,124	414,635
Grand total	932,282	903,197

Copper recovered from scrap processed: Form of recovery	1951	1952
As unalloyed copper:		
At primary plants	135,023	122,376
At other plants	51,439	51,528
Total	186,462	173,904
In brass and bronze	702,416	686,382
In alloy iron and steel	3,066	2,290
In aluminum alloys	17,230	24,606
In other alloys	203	627
In chemical compounds	22,905	15,388
Total	745,820	729,293
Grand total	932,282	903,197

The reduction in secondary copper output was caused to a large extent by factors other than lack of demand; the market was good throughout the year, although better for some secondary copper producers than others. The existence of ceiling prices on domestic copper and scrap, contrasted with the higher prices in the world market in the first half of 1952, held back supplies of scrap from the domestic market as they had in 1951. The price of foreign copper sold in the United States advanced sharply after May 1952 when the Government authorized importers to pay higher prices for foreign copper and to pass on to consumers 80 percent of the increased costs. The hope that domestic prices would advance to the levels of foreign copper sold in the United States restricted the flow of scrap and its consumption after this advance. The scarcity of scrap was reflected in consumption data. Use of refined copper increased 63,000 tons (4 percent) in 1952, whereas consumption of copper scrap decreased 33,000 tons or 2 percent. Stocks of copper-base scrap held by all consumers were substantially greater at the end of 1952 (107,000 tons) than at the beginning (66,000 tons). Scrap stocks held by smelters at the end of June exceeded scrap consumption for the current month for the first time since September 1950. Prices paid for unalloyed scrap by primary producers and for brass-mill scrap by brass mills remained at ceilings throughout the year, but prices paid by ingotmakers for alloy scrap declined slightly in the latter half of the year. Many consumers probably were accumulating scrap in 1952, allowable but limited in the regulations, in the hope of higher prices later for either the scrap or their products. It is also probable that foundries and brass mills used home scrap that, in previous years, would have been sold to smelters or began to operate equipment to remove metallics from scrap that otherwise would have been sold without treatment.

The accumulation of scrap due to restricted consumption and flow was not entirely evident in recorded data but apparently existed to some extent in the stocks of generators, of scrap speculators, and of dealers whose small size excused them from reporting. These stocks were subject to inspection but were not regularly reported.

TABLE 9.—Copper recovered as refined copper, in alloys and in other forms, from copper-base scrap processed in the United States, 1951–52, in short tons

	From new scrap		From old scrap		Total	
	1951	1952	1951	1952	1951	1952
By secondary copper smelters	77,844	53,871	247,172	229,876	325,016	283,747
By primary copper producers	86,345	87,715	57,491	41,547	143,836	129,262
By brass mills	275,002	316,037	39,848	48,570	314,850	364,607
By foundries	23,878	18,305	99,331	85,827	123,209	104,132
By chemical plants	1,157	1,925	10,605	5,482	11,762	7,407
Total	464,226	477,853	454,447	411,302	918,673	889,155

Secondary copper is recovered in refined form by refining unalloyed scrap and by separation and refining from alloyed scrap. It is also recovered in brass and bronze or other alloys from copper, brass, and other alloyed scrap by remelting without separation. Copper recovered by refining from or remelting new copper and brass scrap increased about 3 percent owing to increased operations at brass mills, the only group among the plants using copper-base scrap to recover more secondary copper in 1952 than in 1951. Recovery of copper from new aluminum scrap was about 1,000 tons higher in 1952 than in the previous year. Copper recovered from both old and new scrap by secondary copper smelters declined 13 percent or to 284,000 tons in 1952 and that by primary copper producers 10 percent or to 129,000 tons. However, the primary producer's output of refined copper in the final quarter of 1952 increased to 38,000 tons, higher than in any other quarter of the year or in any quarter of 1951, except the second when it was 46,000 tons. Recovery by the brass mills rose 16 percent or to 365,000 tons. The data in table 9 will not agree with those in the footnotes in table 11 of this report because the former are obtained by applying recovery factors to quantities of scrap consumed, whereas the latter represent production as reported on the questionnaires.

Copper-base-scrap consumption in 1952 decreased in proportion to the decline in secondary output and totaled 1,289,000 tons compared with 1,322,000 in 1951. Secondary smelters used 458,000 tons of scrap (10,000 more than the brass mills) in 1951 and 400,000 (116,000 less than the brass mills) in 1952. The brass mills' use of cartridge cases, unalloyed scrap and yellow brass increased 53, 27, and 12 percent, respectively, whereas the secondary smelters consumed 18 percent less yellow brass scrap and 10 percent less unalloyed scrap in 1952 than in 1951, and their use of cartridge cases in both years was minor. Primary producers raised their consumption of new scrap from 128,000 tons in 1951 to 138,000 in 1952, but their total scrap consumption declined 9 percent or to 220,000 tons. Consumption of copper-base scrap by the foundries decreased 12 percent or to 143,000 tons in 1952, and their reported use of brass ingot declined 17 percent or to 269,000 tons.

TABLE 10.—Stocks and consumption of new and old copper scrap in the United States in 1952, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Secondary smelters:						
No. 1 wire and heavy	1,242	34,216	1,814	31,572	33,386	2,072
No. 2 wire, mixed heavy, and light	2,007	62,242	2,424	57,593	60,017	4,232
Composition or red brass	2,305	94,396	37,636	52,864	90,500	6,201
Railroad-car boxes	69	360	2	302	304	125
Yellow brass	3,381	70,520	11,490	56,171	67,661	6,240
Cartridge cases	121	1,952	4	1,834	1,838	235
Auto radiators (unsweated)	1,405	54,309	----------	51,431	51,431	4,283
Bronze	985	35,025	2,957	29,950	32,907	3,103
Nickel silver	484	2,966	348	2,641	2,989	461
Low brass	113	2,792	2,395	281	2,676	229
Aluminum bronze	207	735	18	733	751	191
Low-grade scrap and residues	6,363	56,896	30,598	25,381	55,979	7,280
Total	18,682	416,409	89,686	310,753	400,439	34,652
Primary producers:						
No. 1 wire and heavy	1,018	29,186	24,320	4,904	29,224	980
No. 2 wire, mixed heavy, and light	1,440	47,439	37,354	9,486	46,840	2,039
Refinery brass	6,380	31,405	11,223	20,816	32,039	5,746
Low-grade scrap and residues	9,432	126,036	65,279	47,073	112,352	23,116
Total	18,270	234,066	138,176	82,279	220,455	31,881
Brass mills:						
No. 1 wire and heavy	1,185	50,292	43,737	5,360	49,097	2,380
No. 2 wire, mixed heavy, and light	601	36,964	31,571	5,490	37,061	504
Yellow brass	8,331	358,196	350,272	45	350,317	16,210
Cartridge cases	3,816	52,055	----------	54,602	54,602	1,269
Bronze	138	2,589	2,492	----------	2,492	235
Nickel silver	885	8,141	8,225	----------	8,225	801
Low brass	384	13,838	13,621	16	13,637	585
Aluminum bronze	67	1,395	1,380	----------	1,380	82
Total	15,407	523,470	451,298	65,513	516,811	22,066
Foundries, chemical plants, and other manufacturers:						
No. 1 wire and heavy	1,630	19,616	5,210	13,652	18,862	2,384
No. 2 wire, mixed heavy, and light	1,612	10,013	3,548	6,220	9,768	1,857
Composition or red brass	2,758	27,016	8,926	17,068	25,994	3,780
Railroad-car boxes	2,840	68,329	----------	65,690	65,690	5,479
Yellow brass	1,974	14,065	4,547	9,643	14,190	1,849
Cartridge cases	9	227	----------	236	236	----------
Auto radiators (unsweated)	6	700	----------	670	670	36
Bronze	1,857	10,608	569	10,117	10,686	1,779
Nickel silver	12	81	60	14	74	19
Low brass	243	2,487	177	2,322	2,499	231
Aluminum bronze	422	749	498	372	870	301
Low-grade scrap and residues	243	2,208	1,051	1,009	2,060	391
Total	13,606	156,099	[1] 24,586	[1] 127,013	[1] 151,599	18,106
Grand total:						
No. 1 wire and heavy	5,075	133,310	75,081	55,488	130,569	7,816
No. 2 wire, mixed heavy, and light	5,660	156,658	74,897	78,789	153,686	8,632
Composition or red brass	5,063	121,412	46,562	69,932	116,494	9,981
Railroad-car boxes	2,909	68,689	2	65,992	65,994	5,604
Yellow brass	13,686	442,781	366,309	65,859	432,168	24,299
Cartridge cases	3,946	54,234	4	56,672	56,676	1,504
Auto radiators (unsweated)	1,411	55,009	----------	52,101	52,101	4,319
Bronze	2,980	48,222	6,018	40,067	46,085	5,117
Nickel silver	1,381	11,188	8,633	2,655	11,288	1,281
Low brass	740	19,117	16,193	2,619	18,812	1,045
Aluminum bronze	696	2,879	1,896	1,105	3,001	574
Low-grade scrap and residues [2]	22,418	216,545	108,151	94,279	202,430	36,533
Total	65,965	1,330,044	[1] 703,746	[1] 585,558	[1] 1,289,304	106,705

[1] Of the totals shown, chemical plants reported the following: Unalloyed copper scrap, 1,026 tons of new and 5,519 tons of old; copper-base alloy scrap 976 tons of new and 920 tons of old.
[2] Includes refinery brass.

When railroad-car journal bearings become worn out from use they are sent to foundries to be reworked. These bearings consist of a bronze back (composition 75 percent copper, 5 percent tin, 17.5 percent lead, and 2.5 percent zinc) in the form of a half cylinder, the bearing surface of which is lined with babbitt (composition 85 to 88 percent lead, 8 to 10 percent antimony, and 3 to 5 percent tin). Some worn bearings can be repaired by sweating off the babbitt and relining, but many are so cracked or damaged that remelting of the entire part is necessary. The sweating is done in a sweating furnace in which the babbitt drains off as melted, or in a bath of molten babbitt from which the brass backs are removed after the babbitt has melted off. Some plants remelt all the backs after the babbitt has been removed, and some sort out the sound backs for relining. Most scrapped bear-

TABLE 11.—Analysis and production of secondary copper and copper-alloy products in the United States, 1951–52

Item produced from scrap	Approximate analysis (percent)						Gross weight produced (short tons)	
	Cu	Sn	Pb	Zn	Ni	Al	1951	1952
Unalloyed copper products:								
Refined copper, electrolytic grade (99.9 Cu + Ag)	100						143,520	128,260
Refined copper (under 99.9 Cu + Ag)	99						12,012	14,503
Copper sheet, rod, tubing, etc	99						23,576	23,522
Copper powder	98						3,680	3,851
Copper castings	98						3,674	3,768
Total							186,462	173,904
Brass and bronze ingots:								
Tin bronze	88	10		2			23,534	23,894
Leaded-tin bronze	88	6	1.5	4.5			25,901	23,023
Leaded red brass	85	5	5	5			123,544	106,760
Leaded semired brass	81	3	7	9			67,457	52,268
High-leaded-tin bronze	80	10	10				29,061	20,941
Do	84	6	8	2			14,367	13,500
Do	75	5	20				9,816	8,599
Leaded yellow brass	66	1	3	30			25,330	23,596
Manganese bronze	62			27		5	19,835	20,440
Aluminum bronze	89					10	5,996	5,629
Nickel silver	58	2	17	18	14		3,470	2,955
Do	65	4	3	5	22			
Low brass	80			20			1,761	2,201
Silicon bronze	92			4			3,392	4,212
Conductor bronze	94	2	2	2			814	669
Hardeners and special alloys	81						11,476	11,160
Total [1]							365,754	319,847
Brass-mill billets made by ingot makers							5,786	7,702
Brass and bronze sheet, rod, tubing, etc.[2]							424,077	491,590
Brass and bronze castings [3]							137,895	119,112
Brass powder							1,171	926
Copper in chemical products (content)							22,905	15,388

[1] Gross weight of brass and bronze ingot. Includes 285,480 tons of copper, 10,202 tons of tin, 12,159 tons of lead, 38,655 tons of zinc, 575 tons of nickel, 121 tons of aluminum, and 18,562 tons of other alloying ingredients in 1951; and 228,988 tons of copper, 8,633 tons of tin, 9,854 tons of lead, 31,186 tons of zinc, 405 tons of nickel, 96 tons of aluminum, and 40,685 tons of other alloying ingredients in 1952.

[2] Gross weight of secondary brass and bronze in commercial shapes. Includes 298,014 tons of copper, 415 tons of tin, 5,060 tons of lead, 118,203 tons of zinc, 2,340 tons of nickel, and 45 tons of aluminum in 1951; and 350,700 tons of copper, 268 tons of tin, 5,680 tons of lead, 133,650 tons of zinc, 1,180 tons of nickel, and 112 tons of aluminum in 1952.

[3] Gross weight of secondary metal in brass and bronze castings. Includes 108,617 tons of copper, 5,525 tons of tin, 15,146 tons of lead, 8,545 tons of zinc, 15 tons of nickel, and 47 tons of aluminum in 1951; and 92,696 tons of copper, 5,212 tons of tin, 14,595 tons of lead, 6,484 tons of zinc, 58 tons of nickel, and 67 tons of aluminum in 1952.

ings are remade into new car journals. All of the antimony in the bearing metal cannot be removed by sweating because some of it diffuses into the brass. Antimony content up to 1 percent is allowable in the brass used for the backs of the bearings but is an impurity in most copper alloys. The new bearing surfaces are given a thin coating of tin. Babbitt is then poured on to a depth of ½ inch, then machined to ¼ inch. The chief cause of failure of the bearing is separation of the babbitt from the brass.

TABLE 12.—Consumption of copper and brass materials, in the United States, 1951–52, by principal consuming groups, in short tons

Item consumed	Primary producers	Brass mills	Wire mills	Foundries and miscellaneous [1]	Secondary smelters
1951					
Copper-base scrap	241,514	448,501		160,660	458,306
Primary material	[2] 1,206,988				
Refined copper [3]		650,967	710,199	38,732	13,744
Brass ingot		7,815	842	355,020	
Slab zinc		129,798			
Miscellaneous		559		[4] 309	20,744
1952					
Copper-base scrap	220,455	516,811		143,158	400,439
Primary material	[2] 1,177,696				
Refined copper [3]		675,073	739,487	38,535	22,918
Brass ingot		12,546	262	292,817	
Slab zinc		155,608			
Miscellaneous		887		408	18,408

[1] Excludes chemical plants.
[2] Recoverable copper content; gross weight not available.
[3] Detailed information on consumption of refined copper will be found in the Copper chapter of this volume.
[4] Revised figure.

Consumption of brass ingot reported by foundries was 18 percent less in 1952 than in 1951 and totaled 269,000 short tons compared with 326,000. In addition to the 269,000 tons reported by the foundries, 16,000 tons was consumed by brass and wire mills, so that the total reported consumption in 1952 was 285,000 tons. Exports totaled 2,400 tons. Data on imports of brass ingot are not readily available. Brass ingotmakers shipped 308,000 tons of brass ingot in 1952 and 370,000 tons in 1951. On the assumption that shipments equal domestic consumption plus exports, this consumption survey achieved 93 percent coverage in 1952 compared with 91 percent in 1951. Although 3,000 plants were canvassed in 1952, only 1,447 were tabulated. The other plants, many of whose names were obtained from industrial directories and other sources, were found not to belong in Bureau of Mines classifications; these consumed none or negligible quantities of metal in 1952 or failed to report.

In table 13 the ingot consumption has been classified under 9 general types and by States, combined in 9 groups, according to Minerals Yearbook practice. As in 1951, the geographic division containing Ohio and Illinois consumed more than any other group (120,000 tons) and Ohio more than any other State (49,000 tons).

TABLE 13.—Foundry consumption of brass ingot, in the United States in 1952, by geographic division and States, in short tons

Geographic division and State	Tin bronze	Leaded tin bronze	Leaded red brass	High leaded tin bronze	Leaded yellow brass	Manganese bronze	Hardeners	Nickel silver	Low brass	Total
New England:										
Connecticut	377	2,746	4,224	397	1,810	232	8	45	390	10,229
Maine	27	16	215	99	3	290	45	-------	15	710
Massachusetts	919	2,557	4,860	273	389	872	50	149	124	10,193
New Hampshire	10	33	722	-------	598	121	-------	23	53	1,560
Rhode Island and Vermont	65	352	1,174	64	29	2	8	-------	44	1,738
Total	1,398	5,704	11,195	833	2,829	1,517	111	217	626	24,430
Middle Atlantic:										
New Jersey	1,826	768	5,048	817	436	794	31	11	126	9,857
New York	3,295	2,923	12,330	1,037	1,705	2,732	246	253	632	25,153
Pennsylvania	2,705	3,198	17,131	2,717	1,205	6,186	1,152	662	1,547	36,503
Total	7,826	6,889	34,509	4,571	3,346	9,712	1,429	926	2,305	71,513
East North Central:										
Illinois	1,924	3,056	19,018	1,395	275	953	54	349	1,339	28,363
Indiana	268	364	7,971	821	106	169	205	16	59	9,979
Michigan	459	3,871	11,080	719	770	1,641	58	14	172	18,784
Ohio	2,876	6,600	28,536	7,799	652	1,078	243	768	499	49,051
Wisconsin	1,365	1,225	5,136	2,242	1,970	498	14	961	187	13,598
Total	6,892	15,116	71,741	12,976	3,773	4,339	574	2,108	2,256	119,775
West North Central:										
Iowa	19	50	2,068	91	28	83	-------	20	1	2,360
Kansas	23	68	105	-------	121	4	-------	-------	1	322
Minnesota	414	658	1,690	687	24	82	8	-------	10	3,573
Missouri	219	402	2,035	258	838	101	46	2	320	4,221
Nebraska and South Dakota	66	12	395	14	-------	31	-------	-------	-------	518
Total	741	1,190	6,293	1,050	1,011	301	54	22	332	10,994
South Atlantic:										
Delaware	29	12	371	35	28	23	-------	-------	3	501
Florida	6	-------	53	13	-------	61	-------	-------	150	283
Georgia	4	373	125	-------	5	-------	-------	-------	3	510
Maryland and District of Columbia	39	244	532	103	-------	67	8	96	66	1,155
North and South Carolina	-------	64	40	1	128	1	1	-------	-------	235
Virginia	641	284	111	230	99	96	12	-------	-------	1,473
West Virginia	3	130	2,871	31	328	12	-------	-------	8	3,383
Total	722	1,107	4,103	413	588	260	21	96	230	7,540
East South Central:										
Alabama	61	1,430	3,889	167	620	533	5	1	185	6,891
Kentucky	1	40	393	100	4,293	9	22	-------	-------	4,858
Mississippi	3	-------	9	4	-------	-------	-------	-------	-------	16
Tennessee	48	259	595	650	92	90	3	-------	4	1,741
Total	113	1,729	4,886	921	5,005	632	30	1	189	13,506
West South Central:										
Arkansas and Louisiana	19	23	93	7	-------	21	-------	-------	2	165
Oklahoma	363	510	97	82	1	15	1	-------	10	1,079
Texas	109	290	1,652	46	8	268	6	3	82	2,464
Total	491	823	1,842	135	9	304	7	3	94	3,708
Mountain:										
Colorado and New Mexico	119	128	144	9	2	12	1	-------	17	432
Idaho, Montana, and Utah	3	9	5	-------	-------	-------	4	-------	-------	21
Total	122	137	149	9	2	12	5	-------	17	453
Pacific:										
California	952	687	11,539	840	1,365	509	21	29	230	16,172
Oregon	1	102	36	17	-------	11	-------	-------	-------	167
Washington	17	68	148	13	-------	135	10	-------	2	393
Total	970	857	11,723	870	1,365	655	31	29	232	16,732
Grand total	19,275	33,552	146,441	21,778	17,928	17,732	2,262	3,402	6,281	268,651

The division using the next largest total (72,000 tons) was the Middle Atlantic, in which the New York metropolitan area lies. These two regions together consumed 71 percent of the total quantity used by foundries. Of the 320,000 tons of copper-alloy ingot produced in 1952, about 55 percent was made in the Chicago metropolitan area, 20 percent in the New York City area, and 5 percent in Ohio. Consumption of composition ingot—the largest item—amounted to 146,000 tons (55 percent of the total).

In table 14 the consumption of the different types of ingot is compared, in percent, for the 5 years in which the survey has been conducted.

Dealers' buying prices for No. 1 composition scrap remained at the ceiling price (18.25 cents) through the first 4 months of the year, then declined gradually to 17.75 cents, which was the average of prices quoted at the end of the year. The price of No. 1 Heavy copper scrap was 19.00 cents—the ceiling price—throughout 1952. Prices for copper-alloy ingot were at ceilings from March 3, 1952, when they were established, for the remainder of the year.

TABLE 14.—Foundry consumption of brass ingot in the United States, percent by type of ingot, 1948–52

[Percent of total]

Type of ingot	Tin bronze	Leaded tin bronze	Leaded red brass	High-leaded tin bronze	Leaded yellow brass	Manganese bronze	Hardeners	Nickel silver	Low brass	Total tons consumed
1948	5.7	17.4	54.8	7.5	6.3	4.2	1.1	1.1	1.9	225,298
1949	5.6	15.2	57.9	6.1	7.2	4.3	1.0	.7	2.0	162,188
1950	4.4	15.0	61.8	4.6	6.9	3.7	1.3	.6	1.7	273,433
1951	6.1	15.8	54.2	7.5	7.5	4.9	1.2	.6	2.2	325,786
1952	7.2	12.5	54.5	8.1	6.7	6.6	.8	1.3	2.3	268,651

TABLE 15.—Brass and copper scrap imported into and exported from the United States, 1943–47 (average) and 1948–52, in short tons

	1943–47 (average)	1948	1949	1950	1951	1952
Imports for consumption:						
Brass scrap	31,891	59,984	23,486	37,537	6,523	10,321
Scrap copper	2,478	9,334	6,765	34,242	6,792	5,125
Exports:						
Brass scrap	961	6,584	13,963	9,054	4,857	[1] 6,261
Scrap copper	422	2,266	8,284	9,445	7,701	8,941

[1] Copper-base alloy scrap, including nickel silver; not strictly comparable with earlier years.

SECONDARY LEAD

The quantity of secondary lead recovered in 1952 dropped 9 percent to 471,000 short tons valued at $151,757,000 compared with 518,000 tons valued at $179,266,000 in 1951. Value of lead recovered has been computed for both years on the basis of the yearly average weighted prices of all grades of refined lead sold by producers or 16.1 cents a pound in 1952 and 17.3 cents in 1951. The quantity of lead recovered was greater than domestic mine production for the seventh consecutive year.

TABLE 16.—Lead recovered from scrap processed in the United States, 1951–52, in short tons

Recoverable lead content of scrap processed			Lead recovered from scrap processed		
Kind of scrap	1951	1952	Form of recovery	1951	1952
New scrap:			As metal:		
Lead-base	68,064	51,380	At primary plants	3,893	3,070
Copper-base	8,388	8,083	At other plants	165,023	137,032
Total	76,452	59,463	Total	168,916	140,102
Old scrap:					
Battery lead plates	282,630	254,827	In antimonial lead [1]	229,963	222,951
All other lead-base	135,109	130,302	In other lead alloys	95,516	93,048
Copper-base	23,897	26,679	In copper-base alloys	23,044	14,479
Tin-base	22	23	In tin-base alloys	671	714
Total	441,658	411,831	Total	349,194	331,192
Grand total	518,110	471,294	Grand total	518,110	471,294

[1] Includes 34,303 tons of lead recovered in antimonial lead from secondary sources at primary plants in 1951 and 35,145 tons in 1952.

Shipments (the same as production for all practical purposes) of secondary lead as metal fell from 172,000 tons in 1951 to 143,000 tons in 1952—a decrease of 17 percent. Secondary lead recovered in antimonial lead decreased only 3 percent to 223,000 tons but dropped 17 percent in lead-base babbitt, 5 percent in type metals, and 51 percent in miscellaneous alloys. Lead recovered in solder increased 13 percent to total 39,000 tons. The decrease in total output of the

TABLE 17.—Shipments [1] of secondary lead, tin, and lead- and tin-alloy products in the United States in 1952, gross weight in short tons

Product	Gross weight of products [2]	Secondary metal content			
		Lead	Tin	Antimony	Copper
Refined pig lead	113,216	113,216			
Remelt lead	28,509	26,445			
Lead foil	1,502	441			
Total	143,227	140,102			
Refined pig tin	3,039		3,039		
Remelt tin	354		161		
Tin foil	12		7		
Total	3,405		3,207		
Lead and tin alloys:					
Antimonial lead	251,488	222,951	256	15,462	15
Common babbitt	29,502	21,504	1,834	2,984	40
Genuine babbitt	1,529	166	479	88	34
Other tin babbitts	1,663	548	406	94	31
Solder	72,492	38,889	8,255	576	6
Type metals	40,049	31,725	1,722	3,820	8
Miscellaneous lead-tin alloys	1,929	649	48	55	
Total	398,652	316,432	13,000	23,079	134
Composition foil	509	281	56	10	
Tin content of chemical products	382		382		

[1] Most of the figures herein represent shipments rather than production of the items involved. However, it has been necessary to record actual production figures in some instances where the information is procured from reports on that basis.

[2] Difference between gross weight of products and secondary metal content represents added primary metals or impurity content.

industry amounted to 15 percent. No scrap lead was reported used in chemicals in 1952, whereas 151,000 tons of refined lead was consumed in tetraethyl lead and miscellaneous chemicals. Secondary smelters consumed 103,000 tons of primary metals (1 percent under the 1951 total) with scrap metal and secondary ingot, of which 83,000 tons was soft lead, 6,000 tons antimonial lead, 9,000 tons primary and detinners' brand tin, 4,000 tons antimony in metal and in ore, and 1,000 tons miscellaneous metals such as arsenic and bismuth.

The data for gross weights of products in the first column of table 17 include, in addition to secondary metal and impurity content, primary metal added as an alloying ingredient by secondary smelters. The secondary metal content of production by primary producers is included in the totals, but the primary metal content of output by primary producers is not. If the items for secondary lead in lead and tin products in the right side of table 16 are added and those for secondary lead content of shipments of secondary products are added separately, the two totals will be the same within a few hundred tons.

Primary lead refiners process scrap and recover some secondary metal in conjunction with their primary operations. In 1952 they reclaimed 38,000 tons of secondary lead or 8 percent of the total production. Of this quantity 3,000 tons was refined soft lead and 35,000 tons antimonial lead. Secondary antimony recovered in antimonial lead by these plants was 2,000 tons.

All consumers, including primary refiners, secondary smelters, foundries, and other manufacturers, used 609,000 tons of lead-base scrap and residues—10 percent under the quantity consumed in 1951. Slight gains were reported in use of hard lead scrap and solder scrap, but consumption of soft lead decreased 12 percent, battery-lead plates 8 percent, common babbitt 11 percent, type metals 7 percent, and the drosses 21 percent. Peak operations occurred in October (about 60,000 tons of scrap was treated), and the lowest monthly consumption of the year was recorded in December (40,000 tons). Of the 593,000 tons of lead-base scrap consumed by smelters in 1952, 383,000 was battery-lead plates; of the 16,000 tons consumed by foundries and manufacturers 13,000 tons was mixed common babbitt. The next largest item used by the smelters was drosses (78,000 tons) and the next, soft lead (52,000 tons). Virtually no process scrap is generated in using lead except drosses, which were 13 percent of the total lead-base scrap used in 1952.

The supply of lead was still short in the early months of 1952, but due to greatly increased imports became so plentiful as to cause the National Production Authority to revoke all controls (except mandatory reporting) on lead on May 15. As a result of the excess supplies, the selling price of lead declined from the 19-cent ceiling that prevailed through April 29 to 13.50 cents a pound on October 22; thereafter it rose to 14.50 cents on November 12 but dropped again to 14.00 cents on November 24 and rose to 14.75 on December 30. Scrap and secondary prices fluctuated with the change in primary prices; the year's average New York price for heavy scrap lead was 13.12 cents per pound. The quoted battery-plate smelting charge ranged from $40 to $50 in January, increased to $60–$70 in May, dropped to $40 in August, was $55 to $60 in October, and fell again to $40 at the end of the year.

TABLE 18.—Stocks and consumption of new and old lead scrap in the United States in 1952, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Smelters and refiners:						
Soft lead	3,102	54,893	----------	52,014	52,014	5,981
Hard lead	2,724	17,235	----------	17,060	17,060	2,899
Cable lead	317	18,418	----------	18,152	18,152	583
Battery-lead plates	21,457	382,423	----------	383,198	383,198	20,682
Mixed common babbitt	604	7,859	----------	7,837	7,837	626
Solder and tinny lead	494	13,252	----------	13,359	13,359	387
Type metals	1,256	22,284	----------	22,744	22,744	796
Dross and residues	24,808	75,941	78,439	----------	78,439	22,310
Total	54,762	592,305	78,439	514,364	592,803	54,264
Foundries and other manufacturers:						
Soft lead	188	974	38	1,007	1,045	117
Hard lead	77	471	2	535	537	11
Cable lead	27	239	1	240	241	25
Battery-lead plates	2	80	----------	82	82	----------
Mixed common babbitt	1,319	12,303	378	12,300	12,678	944
Solder and tinny lead	348	1,737	1,078	431	1,509	576
Type metals	5	56	----------	59	59	2
Dross and residues	82	72	58	----------	58	96
Total	2,048	15,932	1,555	14,654	16,209	1,771
Grand total:						
Soft lead	3,290	55,867	38	53,021	53,059	6,098
Hard lead	2,801	17,706	2	17,595	17,597	2,910
Cable lead	344	18,657	1	18,392	18,393	608
Battery-lead plates	21,459	382,503	----------	383,280	383,280	20,682
Mixed common babbitt	1,923	20,162	378	20,137	20,515	1,570
Solder and tinny lead	842	14,989	1,078	13,790	14,868	963
Type metals	1,261	22,340	----------	22,803	22,803	798
Dross and residues	24,890	76,013	78,497	----------	78,497	22,406
Total	56,810	608,237	79,994	529,018	609,012	56,035

Percentage and remelt metals reshipped within the secondary lead industry in 1952 totaled 35,000 tons. Shipments consisted of 5,000 tons of solder, 3,000 tons of lead-base babbitt, 11,000 tons of remelt and secondary refined soft lead, 2,000 tons of type metals, 1,000 tons of cable lead, 13,000 tons of antimonial lead, and small quantities of tin-base babbitt, remelt tin, and pewter. In addition, smelters shipped 440,000 tons of these metals to consumers in 1952.

General imports of lead scrap totaled 12,000 tons (lead content) in 1952 compared with 9,000 tons in 1951.

SECONDARY MAGNESIUM

Secondary magnesium recovered from purchased scrap, including scrap treated on toll, in 1952, totaled 11,480 short tons valued at $5,624,000 compared with 11,530 tons valued at $5,648,000 in 1951. Values have been calculated at 24.5 cents a pound, the price for primary magnesium ingot (98.5 percent), f. o. b. Freeport, Tex., during the 2 years. Production of primary magnesium in 1952 was 106,000 tons and consumption 44,000 tons.

The figures for magnesium recovered from aluminum scrap show large increases for both 1951 and 1952 because Bureau of Mines magnesium percentages of several types of aluminum scrap were revised upward to allow for increased quantities of magnesium used in aluminum alloys during those years.

TABLE 19.—Magnesium recovered from scrap processed in the United States, 1951–52, in short tons

Recoverable magnesium-alloy content of scrap processed

Kind of scrap	1951	1952
New scrap:		
Magnesium-base	3,727	2,529
Aluminum-base	1,639	1,711
Total	5,366	4,240
Old scrap:		
Magnesium-base	5,366	6,519
Aluminum-base	794	718
Total	6,160	7,237
Grand total	11,526	11,477

Magnesium recovered [1] from scrap processed

Form of recovery	1951	1952
Magnesium-alloy ingot [2] (gross weight)	5,662	6,411
Magnesium-alloy castings (gross weight)	1,675	716
Magnesium-alloy shapes	25	1
In aluminum alloys	3,393	3,022
In zinc and other alloys	55	40
Chemical and other dissipative uses	101	14
Cathodic protection	615	1,273
Grand total	11,526	11,477

[1] Includes alloying elements.
[2] Figures include secondary magnesium incorporated in primary magnesium ingot.

Magnesium-base scrap consumed in 1952 decreased 4 percent from the 10,390 tons used in 1951, whereas use of primary magnesium increased 23 percent. Consumption of new scrap decreased 31 percent from 1951 consumption, and use of old scrap increased 15 percent. The large percentage of decrease in new scrap may be explained by the increased use of the primary metal by small concerns in producing structural products. Some companies were not well equipped to process the scrap generated in their plants, and only the scrap that could be kept clean and dry to be shipped out was salvaged. Borings and turnings, which offer the greatest fire hazard in handling magnesium scrap, were, to a large extent, lost in the smaller plants, which destroyed them as they were generated.

As with aluminum scrap, it is impossible to determine the composition of magnesium scrap from the color. If the scrap is all of the same composition, a lot can be accurately sampled, but mixed scrap has to be melted before it can be sampled satisfactorily. It is therefore often more convenient to use primary magnesium or magnesium alloy than scrap.

TABLE 20.—Stocks and consumption of new and old magnesium scrap in the United States in 1952, gross weight in short tons

Scrap item	Stocks, beginning of year	Receipts	Consumption: New scrap	Consumption: Old scrap	Consumption: Total	Stocks, end of year
Cast scrap	1,581	7,014	373	7,086	7,459	1,136
Solid wrought scrap	109	1,277	1,231		1,231	155
Borings, grindings, drosses, etc	139	1,330	1,315		1,315	154
Total	1,829	9,621	2,919	7,086	[1] 10,005	1,445

[1] Includes 805 tons consumed in making magnesium castings, 2 tons in wrought products, 563 tons in aluminum alloys, 45 tons in other alloys, 7,089 tons in magnesium-alloy ingot, 1,464 tons in cathodic protection and 37 tons in dissipative uses.

Although primary magnesium was sold at a definite ceiling price of 24.5 cents throughout 1951 and 1952, magnesium scrap ceiling prices, which were controlled only by the General Price Regulation, Economic Stabilization Agency Order 2, varied according to the prices received by sellers in the base period. The price of remelt magnesium ingot was quoted at 31.5 cents a pound throughout 1952.

SECONDARY NICKEL

The recovery of secondary nickel from nonferrous scrap totaled 7,500 short tons valued at $8,800,000 in 1952, a decrease of 13 percent in quantity below the 8,600 tons valued at $9,760,000 recovered in 1951. The total value was calculated at 58.83 cents a pound in 1952 and 56.73 cents in 1951, the average spot-delivery prices of Grade F nickel ingots and shot in 10,000 pound lots at New York. Secondary nickel recovered in copper-base alloys in 1952 rose 6 percent to 2,700 tons and in chemical compounds 17 percent to 1,100 tons but declined 47 percent to 1,100 tons in iron and steel. Nickel recovery in nickel- and aluminum-base alloys was about 1,000 tons each in both 1951 and 1952.

TABLE 21.—Nickel recovered from scrap processed in the United States, 1951–52, in short tons

Recoverable nickel content of scrap processed			Nickel recovered from scrap processed		
Kind of scrap	1951	1952	Form of recovery	1951	1952
New scrap:			As metal	684	274
Nickel-base	1,143	941	In nickel-base alloys	1,096	1,067
Copper-base	1,875	1,458	In copper-base alloys	2,554	2,708
Aluminum-base	770	821	In aluminum-base alloys	1,125	1,141
			In lead-base alloys	26	24
Total	3,788	3,220	In cast iron and steel [1]	2,149	1,130
			In chemical compounds	968	1,135
Old scrap:					
Nickel-base	3,896	3,604	Grand total	8,602	7,479
Copper-base	563	362			
Aluminum-base	353	291			
Lead-base	2	2			
Total	4,814	4,259			
Grand total	8,602	7,479			

[1] Includes only nonferrous nickel scrap added to cast iron and steel.

As was the case with most nonferrous metals, the availability of primary nickel in 1952 was greater than of nickel scrap; consumption of the latter, excluding nickel silver, increased 3 percent or to 7,400 tons, whereas consumption of primary nickel increased 17 percent or to 101,000 tons. The scrap consumed in 1952 was of lower average grade than that used in 1951, and the recovery of metal was lower. Consumption of nickel silver, a copper-base item, is customarily tabulated in both the copper-scrap and the nickel-scrap tables. Its composition varies, being from one-half to two-thirds copper and about one-fifth nickel, with tin, lead, and zinc, one or all, constituting the remainder. Consumption of nickel-silver scrap decreased 24 percent, or to 11,300 tons, in 1952. About three-quarters of the total consumed was used by brass mills in both years. The largest item of nickel-base scrap was nickel residues, including black nickel oxide from wornout storage batteries and spent-nickel catalyst. Treatment of this category more than doubled in 1952. Use of monel scrap, the next largest nickel-base scrap item, declined to 2,600 tons in 1952 from 3,200 tons in 1951.

TABLE 22.—Stocks and consumption of new and old nickel scrap in the United States in 1952, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Smelters and refiners:						
Unalloyed nickel	36	540	27	491	518	58
Monel metal	183	1,916	555	1,228	1,783	316
Nickel silver [1]	484	2,966	348	2,641	2,989	461
Miscellaneous nickel alloys	16	85	56	25	81	20
Nickel residues	37	226		243	243	20
Total	756	5,733	986	4,628	5,614	875
Foundries and plants of other manufacturers:						
Unalloyed nickel	109	569	322	259	581	97
Monel metal	395	861	102	688	790	466
Nickel silver [1]	897	8,222	8,285	14	8,299	820
Miscellaneous nickel alloys	93	302	14	309	323	72
Nickel residues	277	3,079	209	2,834	3,043	313
Total	1,771	13,033	8,932	4,104	13,036	1,768
Grand total:						
Unalloyed nickel	145	1,109	349	750	1,099	155
Monel metal	578	2,777	657	1,916	2,573	782
Nickel silver	1,381	11,188	8,633	2,655	11,288	1,281
Miscellaneous nickel alloys	109	387	70	334	404	92
Nickel residues	314	3,305	209	3,077	3,286	333
Total	2,527	18,766	9,918	8,732	18,650	2,643

[1] Copper-base scrap, and so tabulated except in this table.

The price of primary nickel remained the same throughout the year, as did dealers' buying prices at New York for scrap-nickel clippings (36 cents) and monel clippings (20 cents).

Imports of nickel scrap in 1950, 1951, and 1952 were 600 tons, 800, and 500, respectively. Exports in 1952 totaled 5,800 tons compared with 4,000 in 1951 and 2,800 tons in 1950.

SECONDARY TIN

Recovery of secondary tin in 1952 totaled 32,000 tons valued at $77,710,000, a 6-percent decrease in quantity from the 34,000 tons valued at $88,363,000 reclaimed in 1951. Values are computed at 120.44 cents per pound for 1952 and 128.31 cents for 1951, the average New York selling price for Straits tin in each year.

Less tin was recovered in 1952, both as metal and in alloys, as shown on the right side of table 23. Detinners' recovery, as metal, dropped 14 percent, and recovery in chemical compounds dropped 30 percent. Secondary lead and tin smelters' recovery of tin, as metal, increased 11 percent; in solder, in tin babbitt, and in lead-base alloys the increases amounted to 48, 30, and 3 percent, respectively. Tin reclaimed in brass and bronze, however, decreased about 22 percent and totaled

16,000 tons. Of this quantity, secondary copper smelters recovered about 64 percent and brass foundries the remainder, except for a few hundred tons credited to brass mills. All tin recovered as metal came from tin plate or unalloyed tin scrap. All tin reclaimed from alloy scrap was recovered in alloys without separation from the other metals in the scrap.

TABLE 23.—Tin recovered from scrap processed in the United States, 1951–52, in short tons

Recoverable tin content of scrap processed			Tin recovered from scrap processed		
Kind of scrap	1951	1952	Form of recovery	1951	1952
New scrap:			As metal:		
Tin plate	3,826	3,117	At detinning plants	3,529	3,022
Tin-base	1,505	1,447	At other plants	166	185
Lead-base	2,682	2,435			
Copper-base	3,463	2,329	Total	3,695	3,207
Total	11,476	9,328	In solder	5,591	8,255
			In tin babbitt	681	885
Old scrap:			In chemical compounds	542	382
Tin cans	166	185	In lead-base alloys	3,790	3,916
Tin-base	3,128	3,855	In brass and bronze	20,135	15,616
Lead-base	6,985	6,822			
Copper-base	12,679	12,071	Total	30,739	29,054
Total	22,958	22,933	Grand total	34,434	32,261
Grand total	34,434	32,261			

Secondary smelters consumed 7,000 tons of tin-base scrap and residues compared with 6,000 tons in 1951. Greater use was made of block-tin pipe, scruff and dross, and high-tin babbitt, but considerably less tin residues were treated. This increased consumption of tin scrap was reflected in increased recovery from 4,600 tons in 1951 to 5,300 in 1952, as indicated in table 23.

Data in the left side of table 23 indicate that tin recovery from old scrap was virtually the same in 1952 as in 1951 but that recovery from new scrap declined 2,000 tons to 9,000. The decline resulted chiefly from reduced reclamation of tin from tin-plate scrap and from new copper-base scrap. Virtually all the copper-base scrap was used in making copper-base alloys. However, a small quantity of unalloyed copper scrap was reported used in making babbitt. Table 22, in the Lead section of this chapter, indicates small quantities of secondary copper content in shipments of babbitt and other lead and tin alloys, in most of which it is considered an impurity. The tin contained in the copper-base scrap consumed was chiefly that in the scrap used by smelters and foundries. Tin is absent from most kinds of brass-mill scrap.

The average New York monthly price of scrap-tin pipe was slightly over $1.01 per pound. The low point of the year was January's average (94.77 cents), with February, March, and April holding the highest average ($1.05). Two price reductions dropped the average to $1 in June, where it remained for the rest of the year—about 20 cents under Straits tin quotations.

TABLE 24.—Stocks and consumption of new and old tin scrap in the United States in 1952, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Smelters and refiners:						
Block-tin pipe, scrap, and foil	203	1,476		1,632	1,632	47
Tin scruff and dross	776	1,866	2,224		2,224	418
No. 1 pewter	14	111		103	103	22
High-tin babbitt	221	2,438		2,337	2,337	322
Residues	285	404	230		230	459
Total	1,499	6,295	2,454	4,072	6,526	1,268
Foundries and other manufacturers:						
Block-tin pipe, scrap, and foil		39	6	32	38	1
High-tin babbitt		97	4	76	80	17
Residues		2				2
Total		138	10	108	118	20
Grand total:						
Block-tin pipe, scrap, and foil	203	1,515	6	1,664	1,670	48
Tin scruff and dross	776	1,866	2,224		2,224	418
No. 1 pewter	14	111		103	103	22
High-tin babbitt	221	2,535	4	2,413	2,417	339
Residues	285	406	230		230	461
Total	1,499	6,433	2,464	4,180	6,644	1,288

TABLE 25.—Tin recovered from scrap processed at detinning plants in the United States, 1951–52

	1951	1952
Scrap treated:		
Clean tin-plate clippings ..... long tons	481,443	439,321
Old tin-coated containers ..... do	22,131	25,890
Total ..... do	503,574	465,211
Tin recovered:		
From new tin-plate clippings ..... short tons	3,826	3,117
From old tin-coated containers ..... do	166	185
Total ..... do	3,992	3,302
Form of recovery:		
As metal ..... do	3,529	2,952
In compounds ..... do	463	350
Total ..... do	[1] 3,992	[1] 3,302
Weight of tin compounds produced ..... do	958	719
Average quantity of tin recovered per long ton of clean tin-plate scrap used ..... pounds	15.89	14.19
Average quantity of tin recovered per long ton of old tin-coated containers used ..... pounds	14.98	14.31
Average delivered cost of clean tin-plate scrap ..... per long ton	$41.28	$36.50
Average delivered cost of old tin-coated containers ..... do	$32.45	$33.33

[1] Recovery from tin-plate clippings and old containers only. In addition, detinners recovered 102 tons of tin as metal and in compounds from tin-base scrap and residues in 1952, and 79 tons from these sources in 1951.

Secondary tin recovered by detinning plants, as metal and in chemical compounds, decreased 16 percent in 1952. The total tin recovered was 3,000 short tons in 1952 compared with 4,000 in 1951. Tin-plate clippings and old cans were the source of 3,302 tons in 1952, of which 2,952 was reclaimed as metal and 350 tons in the form of tin compounds. During 1951 the usage of such material provided 4,000 tons comprising 3,500 tons of metal and 500 in compounds. The treatment of other tin-bearing materials accounts for the remaining production of 102 tons in 1952 and 79 in 1951.

The industry reported treating 439,000 long tons of tin-plate clippings in 1952—9 percent less than the 481,000 tons processed in 1951, the peak year. The average cost of such clippings delivered at plants decreased from $41.28 a long ton in 1951 to $36.50 in 1952. The average quoted composite price of No. 1 Heavy-Melting steel scrap was $41.79 a long ton in 1952 compared with the record-high of $43.15 in 1951. Ceiling prices for steel scrap were in effect throughout 1952. Steel scrap is one of the products of the detinning industry, being sold to open-hearth mills. Old cans processed increased 17 percent to 26,000 long tons in 1952 compared with 22,000 tons in 1951; this was a small figure, however, compared with the record use of 176,000 tons in 1943. Tin recovered from tin-plate clippings in 1952 was 3,100 tons, 19 percent less than 1951, while that from old cans, 200 tons (mostly in the form of pig tin), increased 11 percent.

The average quantity of tin recovered per long ton of tin-plate scrap treated was 14.19 pounds in 1952 compared with 15.89 pounds in 1951. The lower recovery continued to reflect the treatment of larger proportion of electrolytic tin plate carrying a much thinner coating of tin than the hot-dipped product. The average quantity of tin recovered per long ton of old tin cans decreased slightly from 14.98 pounds in 1951 to 14.31 pounds in 1952.

Imports of tin-plate scrap were 43,000 long tons in 1952 against 52,000 in 1951 (if detinned, this material would yield about 300 tons of tin). In 1952 exports of tin-plate scrap were 3,600 long tons (810 in 1951), the highest since 1939. Mexico was the destination of most of the tin-plate scrap exported in 1952.

Exports of tin-base scrap totaled 7,000 short tons in 1952 compared with 6,000 tons in 1951 and consisted chiefly of drosses and residues.

TABLE 26.—Tin-plate scrap imported into the United States, by countries, 1951–52, in long tons

[U. S. Department of Commerce]

Country	1951	1952
Australia	11,169	7,817
Canada	23,364	25,505
Cuba	2,039	1,337
French Morocco	2,716	1,953
New Zealand	2,028	384
Sweden	2,323	
Union of South Africa	6,187	4,239
All others	1,745	1,424
Total	51,571	42,659

SECONDARY ZINC

Secondary zinc recovered in 1952 from purchased scrap and residues totaled 310,000 short tons, with a value of $103,060,000, representing a decrease in quantity of 1 percent from the 314,000 tons valued at $114,433,000 recovered in 1951. The values have been calculated at the average weighted price for all grades of refined zinc sold by producers—16.6 cents a pound in 1952 and 18.2 cents in 1951.

Zinc recovered from copper-base scrap during 1952 increased 6 percent to 176,000 tons, following increases of 58 and 5 percent, respectively, in 1950 and 1951, owing to increased use of process scrap by brass mills. The latter recovered 77 percent of the total zinc recovered from copper-base scrap in 1952. Copper-base scrap used by brass mills averaged 27 percent zinc in 1952 compared with 10 percent by smelters and 5 percent by foundries. Recovery of zinc from zinc-base scrap declined 10 percent to 133,000 tons, chiefly on account of reduced receipts and consumption of dross. The decline in dross, in turn, was due to a 6-percent drop in the quantity of slab zinc used in the galvanizing process in which dross is generated. The quantity of zinc recoverable from copper-base scrap, as shown in table 27, is comparable to that shown as recovered in brass and bronze, because most copper-base scrap is used in making copper-base products. The same is true of secondary zinc from zinc scrap and in zinc products.

TABLE 27.—Zinc recovered from scrap processed in the United States, 1951–52, in short tons

Recoverable zinc content of scrap processed			Zinc recovered [1] from scrap processed		
Kind of scrap	1951	1952	Form of recovery	1951	1952
New scrap:			As metal:		
Zinc-base	127,901	108,273	By distillation:		
Copper-base	117,532	126,625	Slab zinc	48,067	54,560
Aluminum-base	770	820	Zinc dust	29,002	22,292
Magnesium-base		40	By remelting	8,044	6,275
Total	246,203	235,758	Total	85,113	83,127
Old scrap:					
Zinc-base	20,018	24,997	In zinc-base alloys	9,840	9,875
Copper-base	47,871	49,312	In brass and bronze	177,565	184,935
Aluminum-base	285	226	In aluminum-base alloys	1,099	1,120
Magnesium-base		130	In magnesium-base alloys		161
			In chemical products:		
Total	68,174	74,665	Zinc oxide (lead-free)	9,711	8,914
			Zinc sulfate	4,933	3,871
Grand total	314,377	310,423	Zinc chloride	13,121	10,794
			Lithopone	12,013	6,922
			Miscellaneous	982	704
			Total	229,264	227,296
			Grand total	314,377	310,423

[1] Zinc content.

TABLE 28.—Production of secondary zinc and zinc-alloy products in the United States, 1943–47 (average) and 1948–52, gross weight in short tons

Products	1943–47 (average)	1948	1949	1950	1951	1952
Redistilled slab zinc	50,110	62,320	55,041	66,970	48,657	55,111
Zinc dust	24,865	29,932	21,243	27,507	29,754	25,113
Remelt spelter [1]	7,778	7,796	6,045	7,243	4,454	3,197
Remelt die-cast slab	5,510	10,543	8,266	12,647	5,596	7,098
Zinc-die and die-casting alloys	2,477	3,377	3,873	5,233	4,919	3,400
Galvanizing stock	707	580	406	354	198	203
Rolled zinc	2,154	2,778	2,775	3,589	3,474	2,948
Secondary zinc in chemical products	42,154	48,995	37,424	43,693	40,760	31,205

[1] Contains small tonnages of bars, anodes, etc.

The gross weight of slab zinc produced increased 13 percent in 1952 or to 55,000 tons, but output of all other secondary zinc products declined. Output of zinc dust from scrap, after rising for 3 years, decreased 23 percent in 1952. Secondary zinc in chemical products was also 23 percent lower.

TABLE 29.—Stocks and consumption of new and old zinc scrap in the United States in 1952, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Smelters and distillers:						
Clippings	172	1,937	1,965		1,965	144
Sheet and strip	229	3,531		3,414	3,414	346
Engravers' plates	187	1,201		1,263	1,263	125
Skimmings and ashes	3,483	38,028	37,856		37,856	3,655
Sal skimmings	714	1,522	1,759		1,759	477
Die-cast skimmings	906	6,503	6,511		6,511	898
Dross	3,893	53,732	52,785		52,785	4,840
Die castings	1,713	25,807		24,873	24,873	2,647
Rod and die scrap	109	883		773	773	219
Flue dust	1,051	6,720	7,401		7,401	370
Chemical residues	924	10,838	9,953		9,953	1,809
Total	13,381	150,702	118,230	30,323	148,553	15,530
Chemical plants, foundries, and other manufacturers:						
Clippings	75	4,159	4,095		4,095	139
Sheet and strip	13	126		124	124	15
Engravers' plates	6	219		209	209	16
Skimmings and ashes	328	11,233	9,571		9,571	1,990
Sal skimmings	1,238	21,396	18,634		18,634	4,000
Die castings	28	1,590	1,376	206	1,582	36
Rod and die scrap		44		32	32	12
Flue dust	561	2,514	2,815		2,815	260
Chemical residues	1,564	6,780	7,468		7,468	876
Total	3,813	48,061	43,959	571	44,530	7,344
Grand total:						
Clippings	247	6,096	6,060		6,060	283
Sheet and strip	242	3,657		3,538	3,538	361
Engravers' plates	193	1,420		1,472	1,472	141
Skimmings and ashes	3,811	49,261	47,427		47,427	5,645
Sal skimmings	1,952	22,918	20,393		20,393	4,477
Die-cast skimmings	906	6,503	6,511		6,511	898
Dross	3,893	53,732	52,785		52,785	4,840
Die castings	1,741	27,397	1,376	25,079	26,455	2,683
Rod and die scrap	109	927		805	805	231
Flue dust	1,612	9,234	10,216		10,216	630
Chemical residues	2,488	17,618	17,421		17,421	2,685
Total	17,194	198,763	162,189	30,894	193,083	22,874

Consumption of zinc scrap by smelters and distillers, which use chiefly dross and solid scrap, declined 5 percent or to 149,000 tons, whereas consumption by chemical plants and other manufacturers, which used chiefly residues, dropped 30 percent or to 45,000 tons. Total stocks of zinc scrap held by both groups increased during 1952. Of the 193,000 tons of zinc scrap treated, 84 percent was new scrap and 16 percent old scrap. In 1951 the breakdown was 89 percent new scrap and 11 percent old. The only important exception to the decline in the treatment of zinc scrap in 1952 was die castings, consumption of which increased 7,000 tons.

In time of peace, galvanizing is the chief use of zinc and generates over half of the scrap and residues arising as the result of the consumption of zinc. In 1952, 378,000 tons of slab zinc was used in galvanizing, resulting in the formation of 117,000 tons of dross, dry skimmings, and sal skimmings. Of these, dross was the most important as a source of salvaged zinc.

According to Rutherford,[3] galvanizers' dross is a mixture of compounds of iron and zinc and entrained zinc that generated in England, containing about 96 percent zinc, one-third being unalloyed. From a survey conducted in the United States by the Bureau of Mines, the weighted average zinc content of dross generated in 1 month in 1952 was 93 percent. The remainder is chiefly iron with smaller percentages of other metals, such as aluminum and lead. Dross gathers on the bottom of the kettle and is periodically removed with a perforated scoop suspended from a crane. A dross pump and separator have been invented for this purpose and are in use to some extent in Europe, but in 1952 there were as yet no installations in the United States. Dross is commonly redistilled at secondary smelters to make zinc dust or slab zinc. About 90 percent of the zinc is recovered. A zinc-dross sample at a domestic plant, containing 5 percent iron, 1 percent aluminum, and 1 percent lead, yielded a residue containing 2 percent zinc, 63 percent iron, 15 percent aluminum, and 20 percent lead.

Dry skimmings form as a crust of zinc oxide on the exposed surface of molten zinc. The skimmings generated in galvanizing are about three-quarters zinc; the remainder is oxygen, iron, and other impurities. Rutherford [4] gives the metallic zinc content as about 75 percent and the total zinc as about 85 percent for skimmings in England. According to the Bureau of Mines survey previously mentioned, the total zinc content averaged 77 percent in the United States, with a range between 40 and 95. Many galvanizers tumble the skimmings, screen out the coarse metallics, and return them to the galvanizing kettle. The oxide content of these metallics can be reduced by melting and reskimming before returning them to the galvanizing bath. Partial immersion of a cylinder set vertically in a corner of the kettle, in which the skimmings can be deposited and rabbled to release the entrained zinc, has been recommended.[5] The oxidized portion of the skimmings may be dissolved in muriatic acid to make zinc chloride at chemical plants or mixed with coke and concentrates for distillation at primary zinc plants. Much of the metallic zinc consists of such fine particles that it will dissolve readily in the acid. Some smelters roast zinc skimmings to oxidize the metallics and drive off the chlorine, which is often present from admixture of sal skimmings. The product is a zinc oxide pure enough for use by lithopone or zinc chloride manufacturers or at primary zinc plants.

In most hot-dip galvanizing operations a flux cover, usually zinc ammonium chloride or sal ammoniac, is used to cause the molten zinc to adhere to the steel. According to Daniels,[6] a strip of clean, mild steel, if dipped into molten zinc, will not be coated, since there

---

[3] Rutherford, N. B., Experiments on Zinc Recovery from Residues: Sheet Metal Industries (London) vol. 30, No. 310, February 1953, pp. 119–134.

[4] Work cited in footnote 3.

[5] Fagg, D. N., and Rutherford, N. B., Zinc Economy Trials in Hot-Dip Galvanizing: Sheet Metal Industries (London), vol. 29, No. 308, December 1952, pp. 1117–1125.

[6] Daniels, Edward J., Some Reactions Occurring in "Hot-Dipping" Processes: Jour. Inst. Metals (London), vol. 49, No. 2, 1932, pp. 169–182.

is enough oxide on the steel surface to prevent wetting by the zinc; but if a zinc ammonium chloride flux is used, the steel will be wetted and a coating produced. The work must be removed from the bath at a place where there is no flux cover; otherwise, the flux will corrode the zinc coating. The cover may be raked back before the work is removed, or the surface of the bath may be partitioned so that the work may enter through the part covered with flux and emerge in the uncovered part.

A dark froth forms on the surface of the zinc when these fluxes are used, which is primarily a complex basic zinc oxide. The residue skimmed off when the flux is saturated is known as sal skimmings, the approximate composition of which is: Total zinc 50 percent, metallic zinc 5 percent, chlorine 25 percent, and moisture 3 percent, the remainder being oxygen and small quantities of iron, lead, cadmium, etc. Because of their frothy nature, the hot sal skimmings do not retain as much metallic zinc as the dry skimmings. Sal skimmings tend to oxidize and absorb moisture. This combination sometimes liberates hydrogen, which may ignite spontaneously. These skimmings, which solidify on cooling, may be shipped in drums, such as old carbide cans, or they may be broken with an air hammer and shipped in gondolas. Most sal skimmings made are consumed by chemical plants in manufacturing zinc chloride. In the process most of the metallic zinc is removed by crushing and screening. The zinc chloride is water soluble, but the basic zinc oxide and the remaining metallic zinc are not, necessitating use of muriatic acid as a solvent. A minor quantity of sal skimmings is roasted to drive off the chlorine and convert part of the zinc to zinc oxide, but this involves a loss because the chlorine is volatilized as zinc chloride.

Sal skimmings are customarily sold on a gross-weight basis, dry skimmings on the basis of zinc content. The steady demand for sal skimmings by manufacturers of zinc chloride kept the price at about $35 a ton, f. o. b. consumers' plants, during 1952. The price of dry skimmings, being based on zinc content and the price of zinc, varied considerably. The price f. o. b. consumers' plants at the end of 1952 was 3½ cents per pound of contained zinc.

The graph in figure 1 indicates that the ratio between consumption of galvanizers' dross and consumption of slab zinc in galvanizing has been decreasing. According to a survey conducted by the Bureau of Mines in 1952, it appears that nearly all of the residue generated is consumed and that little is discarded. This indicates that the quantity of residue generated, per ton of slab zinc consumed in galvanizing, is declining. It is known that continuous galvanizing, in which a smaller proportion of residue is generated than in regular hot dip, is increasing. Also it is probably true that the efficiency of galvanizing in general has been increasing. In 1952 about 17 percent of all galvanizing was continuous, meaning that in which a temperature-controlled reducing atmosphere is used. In this type of galvanizing the molten zinc is exposed to the atmosphere in only a small area where the galvanized product emerges. Usually no zinc ammonium chloride or sal ammoniac flux is used, but brightener containing aluminum is added to the bath, resulting in formation of zinc-aluminum skimmings containing about 87 percent zinc and 2 percent aluminum. Galvanizers' dross is also generated but in much less quantity than in ordinary hot-dip galvanizing.

In electrolytic galvanizing no flux is used and no skimmings or dross generated, but this type of galvanizing accounted for less than 5 percent of the total in 1952.

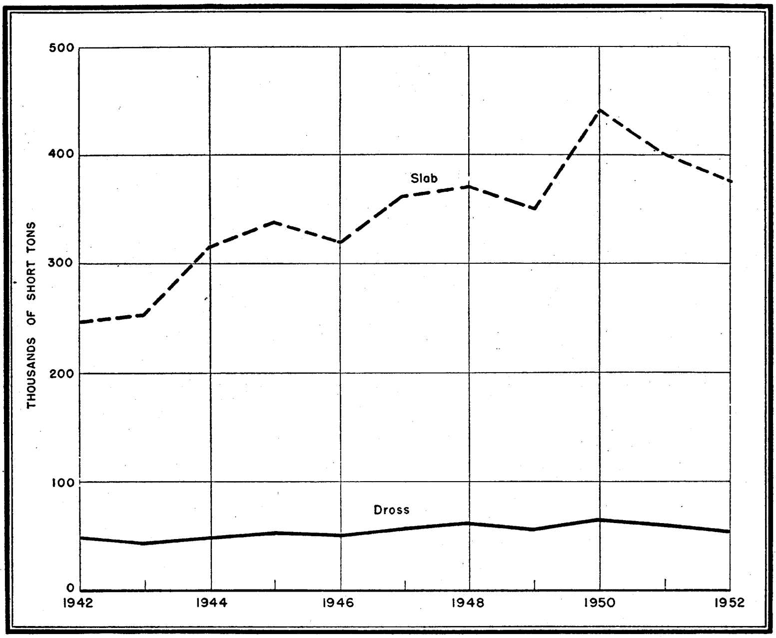

FIGURE 1.—Consumption of slab zinc in galvanizing and of galvanizers' dross, 1942–52.

United States imports of old zinc scrap totaled 470 short tons in 1952 compared with 146 tons in 1951. Imported drosses and residues totaled 3,022 tons in 1952 compared with 6,457 tons in 1951. Exports of zinc scrap were 972 tons (zinc content) in 1952 and 4,613 tons (zinc content) in 1951.

Slag—Iron Blast-Furnace

By Oliver S. North [1]

DUE principally to a disruption of several weeks in the source of supply, the total tonnage processed in 1952 by the blast-furnace slag industry was lower than in 1951, the record year, but higher than in any other previous year. The major tonnage drop was in the output of screened air-cooled slag, while unscreened air-cooled slag showed the largest percentage decline, and expanded slag was produced in slightly lesser quantity. The only type of processed slag produced in greater quantity in 1952 than in 1951 was granulated, which increased 11 percent.

Among major uses, only air-cooled screened used in the manufacture of mineral wool, granulated used for road fill, and granulated used for agricultural purposes were consumed in greater quantities in 1952 than in 1951; most others were a few percentage points lower than in the preceding year.

Except for 2 or 3 materials, average values of the products of the industry were a few cents per ton higher than in 1951.

Inasmuch as processed-slag stocks are relatively small and constant from year to year, production virtually equals sales, and therefore those terms are used interchangeably in this chapter.

TABLE 1.—Iron blast-furnace slag processed in the United States, 1943–47 (average) and 1948–52, by types

[National Slag Association]

Year	Air-cooled						Granulated		Expanded		
	Screened			Unscreened			Short tons	Value [1]	Short tons	Value	
	Short tons	Value		Short tons	Value					Total	Average per ton
		Total	Average per ton		Total	Average per ton					
1943–47 (av.)	13,388,003	$12,222,402	$0.91	718,544	$290,643	$0.40	984,903	$153,356	476,137	$826,127	$1.74
1948	17,656,200	19,254,900	1.09	604,100	370,000	.61	1,517,500	184,700	1,353,200	2,550,400	1.88
1949	17,769,330	21,090,445	1.19	727,595	372,727	.51	1,885,428	416,632	1,199,026	2,698,908	2.25
1950	20,047,844	24,444,231	1.22	1,005,436	639,499	.64	2,168,365	647,665	1,704,388	3,749,463	2.20
1951	23,276,692	29,531,983	1.27	1,732,969	969,975	.56	2,249,281	888,644	2,068,492	4,917,091	2.38
1952	21,056,846	27,501,892	1.31	1,364,463	749,375	.55	2,507,604	1,041,835	1,970,463	4,581,107	2.32

[1] Excludes value of slag used for hydraulic cement manufacture.

[1] Commodity-industry analyst.

DOMESTIC PRODUCTION

The output of slag from iron blast furnaces in 1952 amounted to 34,753,697 short tons compared with 38,977,191 tons reported for the preceding year.

The quantity of slag processed in the United States in 1952 for commercial use, according to reports of processors to the National Slag Association, was 26,899,376 short tons valued at $33,874,209. These totals were 8 and 7 percent, respectively, below the preceding year's figures of 29,327,434 short tons valued at $36,307,693. The output in 1952 came from 42 companies operating 67 plants for processing air-cooled slag and from 18 plants producing expanded slag. Fourteen companies reported production of granulated slag.

During 1952, iron blast-furnace slag was processed in the following States: Alabama, California, Colorado, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, New York, Ohio, Pennsylvania, Tennessee, Texas, and West Virginia. The majority of the plants are east of the Mississippi River.

As in 1951 and other recent years, output in Ohio was greater than in any other State, although in 1952 the slag industry in Ohio produced only 22 percent of the national total compared to 28 percent in 1951. Despite the general decline, nearly a half million more tons was processed in Pennsylvania in 1952 than in 1951, and that State took over second ranking from Alabama. These three States supplied 62 percent of the total tonnage reported for 1952.

TABLE 2.—Iron blast-furnace slag processed in the United States, 1951–52, by States

[National Slag Association]

	Screened air-cooled			All types		
	Quantity		Value	Quantity		Value
	Short tons	Percent of total		Short tons	Percent of total	
1951						
Alabama	5,157,552	22	$5,352,752	6,156,745	21	$6,791,654
Ohio	5,675,671	24	8,025,708	8,078,142	28	9,781,764
Pennsylvania	4,130,577	18	6,119,694	5,071,810	17	7,332,495
Other States [1]	8,312,892	36	10,033,829	10,020,737	34	12,401,780
Total	23,276,692	100	29,531,983	29,327,434	100	36,307,693
1952						
Alabama	4,375,814	21	4,911,511	5,314,333	20	6,248,691
Ohio	5,037,045	24	7,155,350	5,985,416	22	8,643,132
Pennsylvania	3,786,269	18	5,677,735	5,510,624	20	7,002,658
Other States [1]	7,857,718	37	9,757,296	10,089,003	38	11,979,728
Total	21,056,846	100	27,501,892	26,899,376	100	33,874,209

[1] California, Colorado, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, New York, Tennessee, Texas, and West Virginia.

PREPARATION

Blast-furnace slag is processed for the market in three ways:

1. By allowing molten slag to flow into pits adjacent to the furnace or by transporting it to a slag bank or modified pit and permitting it to cool and solidify under atmospheric conditions. This air-cooled slag is then processed in the same manner as are other mineral aggregates. Most of this type is crushed and screened to meet particle size specifications, although a small percentage is crushed and used without screening. About four-fifths of all processed slag sold is the air-cooled screened type.
2. By suddenly chilling the molten slag by immersing it in water. A granular, glass product is formed.
3. By expanding or "foaming" the slag. This is accomplished by applying a limited quantity of water to the molten slag. The quantity of water used is less than that required for granulation; consequently, a relatively dry, cellular lump product is formed.

TRANSPORTATION

As in past years, virtually the entire tonnage of processed slag in 1952 was moved by rail and truck, with waterway transportation again accounting for but 2 percent of the total. The quantity shipped by each method of transportation and the tonnage used locally by the producers are shown in table 3.

TABLE 3.—Shipments of iron blast-furnace slag in the United States, 1951-52, by method of transportation

[National Slag Association]

Method of transportation	1951		1952	
	Short tons	Percent of total	Short tons	Percent of total
Rail	12, 752, 189	44	11, 839, 427	45
Truck	15, 706, 078	54	14, 023, 030	53
Waterway	469, 840	2	494, 440	2
Total shipments	28, 928, 107	100	26, 356, 897	100
Interplant handling [1]	399, 327		542, 479	
Total processed	29, 327, 434		26, 899, 376	

[1] This tonnage is used by the processor locally in making such products as concrete block, asphaltic concrete, etc.

CONSUMPTION AND USES

Screened air-cooled slag, the major type processed by the industry, constituted 78 percent of the total output of processed slag in 1952. The remaining 22 percent was divided among the other types as follows: Unscreened air-cooled, 5 percent; granulated, 10 percent; and expanded, 7 percent.

Screened Air-Cooled Slag.—Consumption of screened air-cooled slag was over 2 million tons lower than in the record year (1951) but was higher than in any other previous year. The 21,056,846 short tons of screened air-cooled slag represented a slightly lower percentage of the total slag processed than in former years. The use of screened air-cooled slag as aggregate in portland-cement concrete construction, bituminous construction, and highway and airport construction other than portland-cement and bituminous, and as railroad ballast consumed 19,002,814 short tons, or 90 percent of the total tonnage of screened air-cooled slag. Other important uses for the material were in the manufacture of concrete block, mineral wool, and builtup roofing and roofing granules. Contrary to the general decline, utilization of screened air-cooled slag as a raw material for the manufacture of mineral wool increased 20 percent from the previous year.

Unscreened Air-Cooled Slag.—In 1952 the quantity of unscreened air-cooled slag processed totaled 1,364,463 short tons valued at $749,375—decreases of 21 and 23 percent, respectively, from the 1951 record totals. About 40 percent of this material was used as aggregate in highway and airport construction.

TABLE 4.—Air-cooled iron blast-furnace slag sold or used by processors in the United States, 1951–52, by uses

[National Slag Association]

Use	Screened		Unscreened	
	Short tons	Value	Short tons	Value
1951				
Aggregate in:				
Portland-cement concrete construction	2,367,983	$3,145,684		
Bituminous construction (all types)	5,973,795	8,321,401		
Highway and airport construction [1]	8,033,436	10,707,112	877,725	$566,498
Manufacture of concrete block	746,462	937,495		
Railroad ballast	4,700,845	4,399,072	228,224	80,694
Mineral wool	467,714	619,573	108	108
Roofing (cover material and granules)	431,182	793,828		
Sewage trickling filter medium	41,075	72,789		
Agricultural slag, liming	18,274	25,067		
Other uses	495,926	509,962	626,912	322,675
Total	23,276,692	29,531,983	1,732,969	969,975
1952				
Aggregate in:				
Portland-cement concrete construction	2,192,409	2,983,031		
Bituminous construction (all types)	5,010,360	7,114,062		
Highway and airport construction [1]	7,456,701	10,233,228	528,713	340,296
Manufacture of concrete block	743,876	989,577		
Railroad ballast	4,343,344	4,248,970	236,519	82,782
Mineral wool	560,819	753,272		
Roofing (cover material and granules)	328,059	646,492		
Sewage trickling filter medium	48,168	81,557		
Agricultural slag, liming	13,572	19,757		
Other uses	359,538	431,946	599,231	326,297
Total	21,056,846	27,501,892	1,364,463	749,375

[1] Other than in portland-cement concrete and bituminous construction.

Granulated Slag.—The consumption of granulated slag in 1952 amounted to 2,507,604 short tons—an increase of 11 percent compared to the 1951 figure. Of this tonnage, 48 percent found application as road-fill material, 43 percent was utilized as a raw material in the manufacture of hydraulic cement, and 4 percent was used as aggregate in concrete blocks. Granulated slag used for agricultural and liming purposes increased 51 percent from 1951 and represented 3 percent of the total output of granulated slag.

Expanded Slag Aggregate.—Consumption of expanded slag in 1952 was 1,970,463 short tons valued at $4,581,107—totals 5 and 7 percent lower, respectively, than for expanded slag in 1951. The bulk of this output was used in concrete-block manufacture, and a small percentage found use as aggregate in lightweight concrete.

TABLE 5.—Granulated and expanded iron blast-furnace slag sold or used by processors in the United States, 1951–52, by uses

[National Slag Association]

Use	Granulated		Expanded	
	Short tons	Value	Short tons	Value
1951				
Road fill, etc	765,362	$577,467		
Agricultural slag, liming	47,786	61,690		
Manufacture of hydraulic cement	1,193,585	(1)		
Aggregate for concrete-block manufacture	166,454	210,665	2,015,530	$4,776,353
Aggregate in lightweight concrete			46,667	122,588
Other uses	76,094	38,822	6,295	18,150
Total	2,249,281	[2] 888,644	2,068,492	4,917,091
1952				
Road fill, etc	1,198,137	764,851		
Agricultural slag, liming	72,245	96,564		
Manufacture of hydraulic cement	1,077,103	(1)		
Aggregate for concrete-block manufacture	90,619	140,420	1,904,519	4,409,944
Aggregate in lightweight concrete			63,498	166,638
Other uses	69,500	40,000	2,446	4,525
Total	2,507,604	[2] 1,041,835	1,970,463	4,581,107

[1] Data not available.
[2] Excludes value of slag used for hydraulic cement manufacture.

PRICES

Average values per ton for the various types of processed slag in 1952 are shown in table 6. Values for screened air-cooled slag ranged from 98 cents per short ton for railroad ballast to $1.97 for slag used in the roofing industry; most averages were a few cents higher than in 1951, although the average value for material used as sewage trickling filter medium declined from $1.77 to $1.69. Unscreened air-cooled-slag values ranged from 35 cents for railroad ballast to 64 cents for aggregates used in highway and airport construction. Among the use classifications of granulated slag, the value of road fill declined 11 cents from 1951, while concrete-block aggregate increased 28 cents and agricultural slag was up 5 cents per ton. The values of expanded slag showed little change in either of its principal use classifications.

TABLE 6.—Average value per short ton of iron blast-furnace slag sold or used by processors in the United States in 1952, by uses

[National Slag Association]

Use	Air-cooled		Granulated	Expanded
	Screened	Unscreened		
Aggregate in:				
Portland-cement concrete construction	$1.36			[1] $2.62
Bituminous construction (all types)	1.42			
Highway and airport construction [2]	1.37	$0.64		
Manufacture of concrete block	1.33		$1.55	2.32
Railroad ballast	.98	.35		
Mineral wool	1.34			
Roofing (cover material and granules)	1.97			
Sewage trickling filter medium	1.69			
Agricultural slag, liming	1.46		1.34	
Road fill, etc			.64	
Other uses	1.20	.54	.58	1.85

[1] Lightweight concrete.
[2] Other than in portland-cement and bituminous construction.

IRON RECOVERY

The recovery of iron by slag processors during 1952 amounted to 351,774 short tons—a decrease of 5 percent compared to the preceding year's figure. Iron is recovered from slag either by magnetic methods or by hand picking; and the material is returned to the furnaces, where it becomes a useful contribution to the iron and steel industry.

EMPLOYMENT

An average of 1,975 plant and yard personnel per active day worked 4,957,740 man-hours in producing processed slag during 1952. This compares with 5,369,000 man-hours and an average per active day of 2,100 plant and yard employees in 1951.

TECHNOLOGY

A method for manufacturing a corrosion-resistant cement lining was patented. The lining is composed of a mixture of specified percentages of finely ground, granulated, blast-furnace slag, portland cement, sand, and gypsum. The resultant lining is stated to have high strength, good machinability, low solubility in acid waters, and low shrinkage. The coefficient of expansion of the cement lining is claimed to be the same as that of steel, so that when it is used with steel pipe, tanks, containers, etc., it will not fracture or crumble under high-temperature operating conditions.[2]

A newly issued patent describes the use of blast-furnace slag as a raw material in the manufacture of cement. Dried, pulverized blast-furnace slag is blown into the flame of the rotary kiln. The raw mixture contains calcium oxide in excess to compensate for the slag. The pulverized slag may be incorporated with the fuel, or it may be blown in through a separate feed pipe.[3]

[2] Peckman, A. L. (assigned to United States Steel Co.), Cement Lining for Metal Pipe: U. S. Patent 2,597,370, May 20, 1952.
[3] Mooser, H. W., Process for the Utilization of Blast Furnace Slag in Rotary Cement Furnaces: U. S. Patent 2,600,515, June 17, 1952.

A new apparatus designed for the production of expanded slag was patented. Molten slag is subjected to strong jets of water, which force the cooling, cellular product against a target plate. The slag cake formed on the target breaks loose from time to time and later is crushed to produce lightweight aggregate.[4]

A British patent covered the use of an electric current to promote the setting of a mortar consisting mainly of powdered blast-furnace slag and cement. Iron or brass wires embedded in the material act as cathodes and may be left permanently in the product. Graphite or magnetite anodes are maintained, preferably in running water, outside the mortar, and a direct current is established. The process may be carried out either before or after setting actually starts.[5]

An agricultural college studied the value of blast-furnace slag as a soil additive for growing various crops. Using limestone and granulated and air-cooled blast-furnace slags, comparative studies were made of the yields of alfalfa, mixed hay, and corn, as influenced by fineness, rate of application, and soil reaction changes. It was concluded that granulated-slag screenings were significantly better than the air-cooled slag or limestone screenings. Air-cooled slag and dolomitic limestone were reported to be equally effective in increasing crop yields when they were of equal fineness.[6]

Underwriters' Laboratories, Inc., made a series of fire tests of expanded-slag block walls. Objectives of the investigation were to determine (1) the effect of variations in the unit weight of the expanded slag aggregates, (2) the relationship of equivalent thickness (that is, the average thickness of the solid material in the block) in the design of blocks, and (3) the effect of filling the core spaces with expanded slag aggregate. Fire ratings of 2, 3, and 4 hours were assigned. Several interesting conclusions and observations are given in the report.[7] These tests were described in detail in a magazine article.[8]

According to an item in a British publication, the North of Scotland Hydro-Electric Board plans to use ground blast-furnace slag in constructing the Chuanie and Loyne Dams of the Glen Moriston hydroelectric project in Invernessshire. The Trief process of grinding the slag on the site will be used. The slag will be used in partial replacement of cement. Similar mixtures used in construction of dams in France are said to have shown cost economies, generation of less heat during setting than ordinary concrete, and better resistance to acid water than pure portland-cement concrete.[9]

---

[4] Wheeler, D. G. (assigned to Celotex Corp.), Apparatus for Expanding Slag: U. S. Patent 2,605,501, Aug. 5, 1952.

[5] Société anonyme des fondiéres laminoirs et ateliers de biache Saint-Vaast, Blast-Furnace Slag Cement: British Patent 672,137, May 14, 1952. (Abs. in Chem. Abs., vol. 46, No. 19, Oct. 10, 1952, col. 9279, item d).

[6] Volk, G. W., Harding, R. B., and Evans, C. E., A Comparison of Blast Furnace Slag and Limestone as a Soil Amendment: Ohio Agric. Exp. Sta., Research Bull. 708, November 1952. 19 pp.

[7] Underwriters' Laboratories, Inc., Report on 8-in. Bearing Walls of Concrete Masonry Units (Blocks) Made With Expanded Slag Aggregates: Retardant Rept. 3460-1-2-3, July 1, 1952, 37 pp; Underwriters' Laboratories, Inc., Revision of Standard on Concrete Masonry Units: Bull. on Subject 618, June 12, 1953, 2 pp.

[8] Concrete, Fire Tests on Expanded Slag Block Walls: Vol. 60, No. 11, November 1952, pp. 3–7.

[9] Engineering (London), Blast-Furnace Slag as Material for Dams: Vol. 173, No. 4503, May 16, 1952, p. 635.

A Federal agency published a report showing results of shrinkage tests of concrete masonry units made with different types of aggregates and cured under varying conditions.[10] Aggregates included expanded slag. Conclusions drawn from the results of the investigation indicated that expanded slag, when cured in a like manner, shows approximately the same shrinkage as several of the other lightweight aggregates tested.

The United States Department of Agriculture measured quantitatively, by chemical analysis, the occurrence of trace elements in a large number of different types of slags. The results of this investigation have recently been published. It is believed that the presence of trace elements in a soil amendment may be responsible for greater crop yields than could be expected from the liming action alone. The trace elements include manganese, boron, copper, cobalt, lead, molybdenum, and zinc.[11]

---

[10] Housing and Home Finance Agency, Relation of Shrinkage to Moisture Content in Concrete Masonry Units: Div. of Housing Research, Paper 25, March 1953, 28 pp.

[11] Chichilo, P. P., and Whittaker, C. W., Trace Elements in Agricultural Slags: Agronomy Jour., vol. 45, No. 1, January 1953, pp. 1-5.

Slate

By Oliver Bowles[1] and Nan C. Jensen[2]

SALES of slate during 1952 declined greatly compared with 1951. The industry evidently is facing increasing difficulty in meeting competition from substitute products. For virtually every use to which slate is applied some other product may be used. Slate producers endeavor to maintain their competitive position by emphasizing the durability, architectural adaptability, and other favorable qualities of their products, and it is evident that continued activity in this and other movements designed to maintain or increase sales is becoming imperative.

Sales of roofing slate dropped 29 percent in quantity and 30 percent in value in 1952 compared with 1951. The average value per square declined from $21.24 to $21.06. Declines of 25 to 30 percent were registered in all the principal roofing-slate areas.

Sales by the mill-stock branch of the industry declined 14 percent in quantity and 4 percent in value. Among the principal uses the largest decline was in sales of blackboards and bulletin boards—19 percent in quantity and 17 percent in value. A notable exception to the otherwise general downward trend was the gain of 9 percent in quantity and 7 percent in value of structural and sanitary slate. Sales of electrical slate declined 4 percent in quantity but gained 11 percent in value. The largest declines were in the minor applications. For the first time in the history of the industry, school-slate manufacture was in so few hands that the figures could not be shown separately and were combined with those for blackboards and bulletin boards. Sales of flagstones and related products changed slightly.

Slate granules and flour are included in this chapter, although they have little relation to the dimension-slate industry. A small proportion of these products is made from waste that accumulates at roofing and mill-stock quarries; however, by far the largest part is obtained from deposits that are classed lithologically as slate but consist of rock unsuitable for either roofing or mill stock. Granules are used chiefly for surfacing prepared roofing and slate flour as a filler in paint, linoleum, roofing mastic, and other products.

Sales of granules and flour declined 8 percent in quantity and 6 percent in value in 1952 compared with 1951. The average value per ton was 24 cents higher. Figures for all types of granules, including slate, are given in a table in the chapter on Stone of this volume.

[1] Commodity specialist.
[2] Statistical assistant.

TABLE 1.—Salient statistics of the slate industry in the United States, 1951–52

Domestic production (sales by producers)	1951 Quantity: Unit of measurement	1951 Quantity: Approximate equivalent short tons	1951 Value	1952 Quantity: Unit of measurement	1952 Quantity: Approximate equivalent short tons	1952 Value	Percent of change in—Quantity (unit as reported)	Percent of change in—Value
	Squares			*Squares*				
Roofing slate	205, 120	77, 500	$4, 357, 412	145, 640	54, 050	$3, 067, 513	−29	−30
Mill stock:	*Sq. ft.*			*Sq. ft.*				
Electrical slate	326, 090	2, 350	470, 179	311, 710	2, 250	519, 619	−4	+11
Structural and sanitary slate	1, 250, 810	9, 910	836, 492	1, 360, 880	11, 220	896, 093	+9	+7
Grave vaults and covers	12, 880	110	10, 681	8, 960	80	7, 103	−30	−33
Blackboards and bulletin boards	1, 133, 770	2, 660	667, 011	[1] 922, 860	[1] 2, 270	[1] 553, 509	−19	−17
Billiard-table tops	207, 490	1, 560	131, 081	121, 250	900	73, 571	−42	−44
School slates	[2] 237, 500	300	11, 943	(1)	(1)	(1)		
Total mill stock	3, 168, 540	16, 890	2, 127, 387	2, 725, 660	16, 720	2, 049, 895	−14	−4
Flagstones, etc.[3]	12, 183, 280	76, 760	1, 522, 911	12,274,890	75, 480	1, 469, 396	+1	−4
Total slate as dimension stone		171, 150	8, 007, 710		146, 250	6, 586, 804	−15	−18
Granules and flour		[4] 648, 210	[4] 6, 526, 617		593, 390	6, 119, 847	−8	−6
Grand total		[4] 819, 360	[4] 14,534,327		739, 640	12, 706, 651	−10	−13

[1] A small quantity of school slates included with blackboards and bulletin boards.
[2] Square feet approximate. Number of pieces: 395,000.
[3] Includes slate used for walkways, stepping stones, and miscellaneous uses.
[4] Revised figure.

SALES

Dimension Slate.—Dimension slate includes products cut to specified sizes and shapes contrasted with crushed or pulverized products, such as granules and flour. Table 2 shows sales of dimension slate for the latest 5-year period.

Roofing slate is used chiefly in residential building; but, as indicated in figure 1, it has failed even to approach the new dwelling-unit trend

TABLE 2.—Dimension slate sold by producers in the United States, 1943–47 (average) and 1948–52

Year	Roofing: Squares	Roofing: Approximate equivalent short tons	Roofing: Value	Mill stock: Approximate short tons	Mill stock: Value	Other[1]: Approximate short tons	Other[1]: Value	Total: Approximate short tons	Total: Value
1943–47 (average)	120, 798	45, 390	$1, 539, 552	13, 122	$974, 764	24, 024	$312, 858	82, 536	$2, 827, 174
1948	218, 650	82, 090	4, 566, 056	11, 950	1, 600, 019	46, 490	700, 477	140, 530	6, 866, 552
1949	181, 490	68, 260	3, 759, 564	12, 730	1, 727, 649	51, 000	912, 503	131, 990	6, 399, 716
1950	197, 570	74, 060	4. 098, 842	15, 140	2, 130, 430	79, 440	1, 342, 053	168, 640	7, 571, 325
1951	205, 120	77, 500	4, 357, 412	16, 890	2, 127, 387	76, 760	1, 522, 911	171, 150	8, 007, 710
1952	145, 640	54, 050	3, 067, 513	16, 720	2, 049, 895	75, 480	1, 469, 396	146, 250	6, 586, 804

[1] Includes flagstones, walkways, stepping stones, and miscellaneous slate.

since 1944. This may be due in part to the preponderance of types of roof construction for which slate is not adapted. Another reason for the lag in roofing-slate sales is the current tendency toward using flat roofs coated with asphalt and gravel or similar materials on schoolhouses and other public buildings that formerly used slate. The keen competition with other roofing materials, such as tile and asbestos-cement shingles, is another depressing factor.

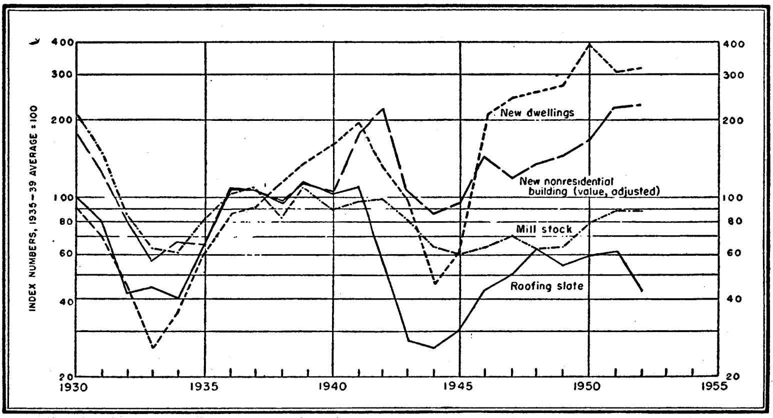

FIGURE 1.—Sales of roofing slate and mill stock compared with number of new dwelling units and value of new nonresidential construction, 1930–52. Data on number of new dwelling units in nonfarm areas from U. S. Department of Labor; on value of nonresidential construction activity (adjusted to 1939 prices) from U. S. Department of Commerce, Survey of Current Business.

Mill-stock slate is used for blackboards in schools and for steps, baseboard, wainscoting, and similar units in office buildings and other nonresidential structures. Accordingly, sales of mill stock should, in general, follow the trend of nonresidential construction. Figure 1 shows that slate of mill-stock grades followed this trend some years ago, notably from 1930 to 1939. Since 1944, however, nonresidential construction has made phenomenal gains and in 1952 surpassed all previous records. During this period mill-stock sales have made only small gains.

To increase and maintain slate sales is a major problem facing the slate industry. One method proposed is to discover means of reducing the cost of production (and selling prices) because thereby slate could compete more favorably with substitute materials and thereby promote a healthier state in the industry. The problem of improved equipment and technique is a prolific field for research. Methods of making roofing slates are virtually the same today as 150 years ago. The technique of mill-stock manufacture has made greater progress, but further advances are possible.

The high cost that, it is believed, is an important factor in limiting sales of slate, is due in part to the excessive waste that accompanies slate quarrying and manufacture. The wire saw has reduced quarry waste substantially in Pennsylvania, but this equipment has not been accepted in other slate regions. The development of wider uses for waste slate is another promising approach to the waste problem.

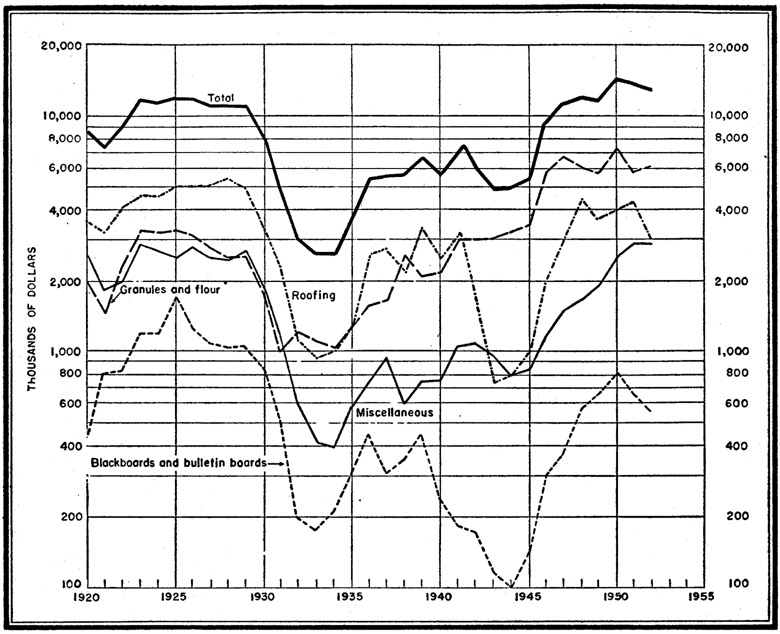

FIGURE 2.—Value of slate sold in the United States, 1920–52, by principal uses.

Figure 2 presents in graphic form the value of slate sold from 1920 to 1952, by principal uses. The two peaks shown on the chart—1925 and 1950—represent periods of high activity in the building industries. The trough of 1932 to 1934 reflects the nationwide depression, and the trough of 1943 to 1945 the depressing effect of World War II on slate production.

Granules and Flour.—Sales of granules declined 10 percent in quantity and 7 percent in value in 1952. The average value per ton increased from $11.54 to $11.93. Sales of slate flour dropped 4 percent in quantity and 3 percent in value. The average sales price per ton in 1952 was $5.16, 6 cents higher than in 1951. Granules and flour were produced in Arkansas, California, Georgia, New York, Pennsylvania, and Vermont. Granules, but no flour, were sold in Maryland and Virginia. Sales of these products for the latest 5-year period are shown in table 3.

TABLE 3.—Crushed slate (granules and flour) sold by producers in the United States, 1943–47 (average) and 1948–52

Year	Granules		Flour		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	416,728	$3,894,094	127,610	$491,333	544,338	$4,385,427
1948	499,440	5,306,568	159,430	707,809	658,870	6,014,377
1949	463,290	5,136,992	144,980	627,568	608,270	5,764,560
1950	595,200	6,747,325	166,530	728,831	761,730	7,476,156
1951	[1] 500,320	[1] 5,771,971	[1] 147,890	[1] 754,646	[1] 648,210	[1] 6,526,617
1952	451,870	5,390,202	141,520	729,645	593,390	6,119,847

[1] Revised figure.

REVIEW BY STATES AND DISTRICTS

As shown in table 1, the total domestic production of slate declined 10 percent in quantity in 1952 compared with 1951. Seventy operators reported production during the year, a decline of 7. Table 4 shows sales in 1952, by States and uses.

TABLE 4.—Slate sold by producers in the United States, 1943–47 (average) and 1948–52, by States and uses

	Operators	Roofing		Mill stock		Other uses (value)[1]	Total value
		Squares (100 square feet)	Value	Square feet	Value		
1943–47 (average)	55	120,798	$1,539,552	2,342,806	$974,764	$4,698,285	$7,212,601
1948	83	218,650	4,566,056	2,541,250	1,600,019	6,714,854	12,880,929
1949	80	181,490	3,759,564	2,741,040	1,727,649	6,677,063	12,164,276
1950	94	197,570	4,098,842	3,180,600	2,130,430	8,818,209	15,047,481
1951	77	205,120	4,357,412	3,168,540	2,127,387	[2] 8,049,528	[2] 14,534,327
1952							
Arkansas	1					(3)	(3)
California	2					(3)	(3)
Georgia	1					(3)	(3)
Maryland	1					(3)	(3)
New York	20	600	21,456			1,789,409	1,810,865
Pennsylvania	18	93,200	1,866,479	2,078,020	1,227,471	1,393,698	4,487,648
Vermont and Maine	22	35,190	742,482	647,640	822,424	2,886,799	4,451,705
Virginia	5	16,650	437,096			(3)	(3)
Undistributed						1,519,337	1,956,433
Total	70	145,640	3,067,513	2,725,660	2,049,895	7,589,243	12,706,651

[1] Flagging and similar products, granules, and flour.
[2] Revised figure.
[3] Included with "Undistributed" to avoid disclosure of individual company operations.

Maine.—The Maine quarries specialize in electrical slate. They are situated near Monson, Piscataquis County. In 1952, as in recent years, only one company was active.

New York.—There were 20 operators in New York in 1952, 1 more than in 1951, but total sales of slate products were 9 percent less in value than in 1951. The principal products were flagging, granules, and flour. As indicated in table 4, roofing-slate manufacture is of minor importance.

Pennsylvania.—All types of slate products are made in the "soft-vein" belt of Lehigh and Northampton Counties, the most productive slate area in the United States. Roofing-slate manufacture is an important branch of the industry, but large quantities of blackboards, structural slate (such as steps and baseboards), and all other mill-stock products are also made. Slate produced in York County in the Peach Bottom district on the Maryland-Pennsylvania border may not be shown separately and therefore is included with Northampton County in table 5, wherein detailed figures for Pennsylvania are given.

The Pennsylvania slate industry suffered a serious decline in 1952, as the total value of slate products sold decreased 21 percent compared with 1951. The trend in 1952 was the reverse of that in 1951, when the gain over the preceding year was 3 percent. All products shared the recession except structural and sanitary slate, sales of which made small gains in both quantity and value. The reversal in trend was most pronounced in electrical slate, which experienced substantial

TABLE 5.—Slate sold by producers in Pennsylvania in 1952, by counties and uses

County	Operators	Roofing slate: Squares (100 square feet)	Roofing slate: Value	Mill stock: Electrical: Square feet	Mill stock: Electrical: Value	Mill stock: Structural and sanitary: Square feet	Mill stock: Structural and sanitary: Value	Mill stock: Vaults and covers: Square feet	Mill stock: Vaults and covers: Value
Lehigh	2	2,870	$58,132	2,630	$3,518	1,022,390	$589,845	------	------
Northampton and York [1]	16	90,330	1,808,347					8,890	$7,028
Total: 1952	18	93,200	1,866,479	2,630	3,518	1,022,390	589,845	8,890	7,028
1951	25	134,180	2,681,072	13,830	16,167	983,930	580,119	12,570	10,336

County	Mill stock—Continued: Blackboards and bulletin boards: Square feet	Blackboards and bulletin boards: Value	Billiard-table tops: Square feet	Billiard-table tops: Value	School slates: Square feet	School slates: Value	Other uses (value)	Total value
Lehigh	[2] 176,580	[2] $81,840	121,250	$73,571	(2)	(2)	$13,102	$188,683
Northampton and York [1]	746,280	471,669			--------	--------	1,380,596	4,298,965
Total: 1952	[2] 922,860	[2] 553,509	121,250	73,571	(2)	(2)	1,393,698	4,487,648
1951	1,133,770	667,011	207,490	131,081	237,500	$11,943	1,591,141	5,688,870

[1] York County produced granules and flour only; included with Northampton County to avoid disclosure of individual company operations.
[2] A small quantity of school slates included with blackboards and bulletin boards.

gains in 1951 but suffered remarkable losses in 1952. The percentage changes in the various items in 1952 compared with 1951 were as follows: Roofing slate, decline of 31 percent in quantity and 30 percent in value; electrical slate, decline of 81 percent in quantity and 78 percent in value; structural and sanitary slate, increase of 4 percent in quantity and 2 percent in value; blackboards and bulletin boards, decline of 19 percent in quantity and 17 percent in value; billiard-table tops, decline of 42 percent in quantity and 44 percent in value; and vaults and covers, decline of 29 percent in quantity and 32 percent in value. School slates, as indicated previously, were produced by so few operators that the figures cannot be shown separately. Other slate products declined 12 percent in value. The number of operators decreased by seven.

Vermont.—Maine has been included with Vermont in table 4 to avoid revealing the production of the single company operating. The slate industry of these areas maintained a higher level of activity than prevailed in any other major slate-producing center. The total value of sales dropped only 3 percent below 1951 and was only 1 percent below the total of Pennsylvania. Roofing-slate production declined 25 percent in quantity and 27 percent in value, but mill-stock sales increased 12 percent in quantity and 16 percent in value. The sale of other products, mainly granules and flour, increased 1 percent.

Virginia.—Roofing slate is the principal product of the Virginia quarries. The rock is not adapted for mill-stock manufacture. Roofing-slate sales declined 30 percent in quantity and 31 percent in value. Granules for surfacing prepared roofing are made in substantial quantities, but the figures are concealed to avoid revealing the output of individual companies.

Other Districts.—Granules and flour are produced in Montgomery County, Ark., not far from Glenwood, which is just over the county line in Pike County. They are also produced in El Dorado County, Calif., and near Fairmount, Bartow County, Ga. Granules, but no flour, were produced near Whiteford, Harford County, Md. Flagging was produced in El Dorado County, Calif.

PRICES

The average value of roofing slate, f. o. b. quarry or mill, as reported to the Bureau of Mines, declined 18 cents per square to $21.06 in 1952. In Pennsylvania it was $20.03 per square, in New York $35.76, in Vermont and Maine $21.10, and in Virginia $26.25. The most noteworthy change was in New York, where the average price dropped $7.75 a square.

The average value of mill stock was 75 cents per square foot, 8 cents higher than in 1951. Electrical slate increased 23 cents (to $1.67) per square foot; structural and sanitary slate declined 1 cent (to $0.66); blackboards and bulletin boards increased 1 cent (to $0.60); vaults and covers declined 4 cents (to $0.79); and billiard-table tops declined 2 cents (to $0.61). The average value per ton of granules increased 39 cents (to $11.93), while slate flour increased 6 cents (to $5.16).

Price History.—The trend in yearly average selling price of roofing slate and mill stock compared with wholesale prices of all building materials over a 23-year period is indicated in figure 3. Since 1933 mill-stock prices have paralleled closely the trend of wholesale prices. Roofing-slate prices, however, remained consistently below building-material prices in general from 1933 to 1946 and again from 1950 to 1952.

TABLE 6.—Slate imported for consumption in the United States, 1948–52, by countries

[U. S. Department of Commerce]

Country	1948	1949	1950	1951	1952
Australia				$70	
Brazil					$1,201
Canada	$1,078	$1,125		10,257	4,117
China	66	9	$123		
Germany, West			1	8,241	26,623
Italy	11,584	17,589	66,548	187,702	121,366
Japan	89	51	288	295	98
Netherlands					219
Norway	10		967		
Portugal	317	1,549	27,320	45,561	79,743
Spain	424				846
Switzerland	31	406	328	64	63
United Kingdom	53	24	2,172	12	1,993
Total	13,652	20,753	97,747	252,202	236,269

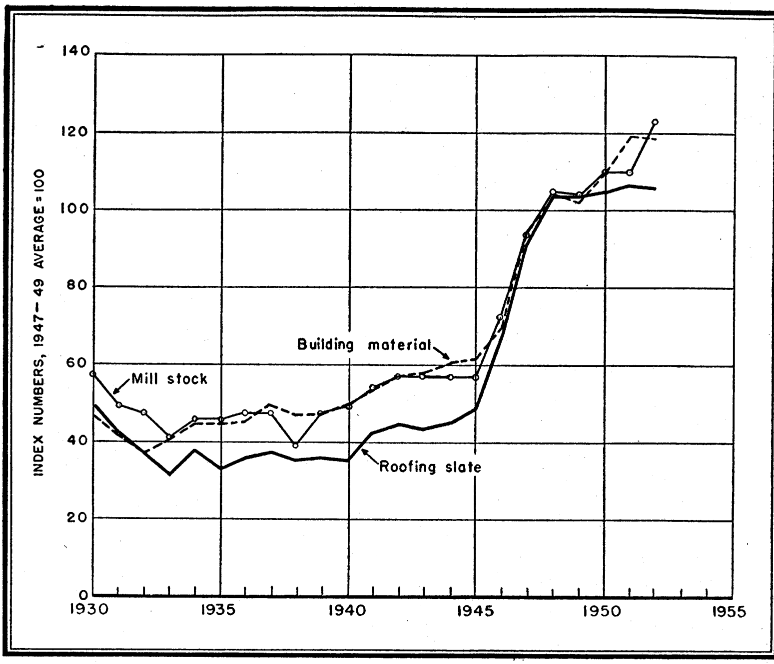

FIGURE 3.—Average selling price of slate compared with wholesale prices of building materials in general, 1930–52. Wholesale prices from U. S. Department of Labor.

FOREIGN TRADE[3]

Imports.—The value of slate imported for consumption in 1952 was 6 percent lower than in 1951. Italy and Portugal are the chief foreign sources, but imports from West Germany increased greatly in 1952. There were no imports of roofing slate. As in 1951, most of the imports consisted of both framed and unframed school slates from Italy and Portugal. In view of the current decline in school-slate manufacture in the United States, as indicated elsewhere in

TABLE 7.—Slate exported from the United States, 1943–47 (average) and 1948–52, by uses [1]

Use	1943–47 (average)	1948	1949	1950	1951	1952
Roofing	$6,619	$4,476	$9,503	$19,824	$4,138	$15,110
School slates [2]	19,967	25,846	16,601	8,138	3,891	2,355
Electrical	3,603	4,245	10,151	14,635	13,819	10,041
Blackboards	25,788	65,314	65,052	107,466	51,056	62,992
Billiard tables	83,167	58,692	79,687	47,000	88,669	85,657
Structural (including floors and walkways) } Slate granules and flour	280,658	428,755	414,029	417,148	[3] 294,007	201,748
Total	419,802	587,328	595,023	614,211	[3] 455,580	377,903

[1] Figures collected by the Bureau of Mines from shippers of products named.
[2] Includes slate used for pencils and educational toys.
[3] Revised figure.

[3] Figures on imports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

this chapter, it would appear that imported school slates are being substituted widely for those of domestic origin.

Exports.—Table 7 gives the value of exports of slate products for the latest 5-year period, as reported by shippers to the Bureau of Mines. The downward trend reported in 1951 continued in 1952 with a further drop of 17 percent. Exports in 1952 were the lowest since 1944.

TECHNOLOGY

The National Slate Association, 255 West 23d Street, New York, N. Y., has issued a third edition of its comprehensive bulletin, Slate Roofs. The report includes descriptions of domestic slates and furnishes instructions for placing slate on roofs.

Many slate quarries in the Pennsylvania region have been abandoned through the years, usually because they have been sunk to such great depths that they have become dangerous or uneconomic. According to press reports, options have been acquired by Esso Standard Oil Co. on 11 of these quarries to be used for oil storage. As the stored oil will float on water, the oil level may be controlled by pumping water in or out from the bottom of the quarry. This is the first tangible use that has been proposed for abandoned pits.

Tests by the Bureau of Mines in 1952 indicated that Buckingham County, Va., slate is a satisfactory raw material, together with lime, for making mineral wool. The samples made compared favorably with commercial wools in color, fiber size, and shot content. These results suggest that the manufacture of mineral wool might prove to be a profitable means of utilizing waste slate.

Sodium and Sodium Compounds[1]

By Joseph C. Arundale[2] and Flora B. Mentch[3]

SODIUM compounds have been known and used since ancient times. They are the foundation of the great modern alkali industry. Production of both soda ash and salt cake decreased during the year, but output of sodium metal continued to increase.

DOMESTIC PRODUCTION

Both sodium carbonate (soda ash) and sodium sulfate (salt cake) are recovered as naturally occurring minerals and also are manufactured. Many saline deposits and playas in the West contain sodium carbonate. In 1952 natural soda ash was recovered from the brine of Searles and Owens Lakes in California and from a bedded deposit in Wyoming.

Although production of soda ash, both manufactured and natural, was substantially lower than in the previous year, the production trend was up at the end of the year.

TABLE 1.—Manufactured sodium carbonate produced [1] and natural sodium carbonates sold or used by producers in the United States, 1943–47 (average) and 1948–52

Year	Manufactured soda ash (ammonia-soda process)[2]	Natural sodium carbonates[3]	
	Short tons	Short tons	Value
1943–47 (average)	4,425,983	210,708	$3,547,342
1948	4,575,452	[4] 288,769	[4] 6,623,280
1949	3,916,016	[4] 200,496	[4] 4,163,714
1950	3,991,199	351,075	7,543,769
1951	5,093,927	350,688	8,368,037
1952	4,442,450	323,479	7,828,033

[1] U. S. Bureau of the Census.
[2] Total wet and dry (98–100 percent Na_2CO_3). Includes quantities consumed in the manufacture of finished light and finished dense soda ash, caustic soda as well as quantities consumed in the manufacture of refined sodium bicarbonate.
[3] Soda ash and trona (sesquicarbonate).
[4] Exclusive of Wyoming.

Production of natural soda ash was reported by the following producers in California: American Potash & Chemical Corp., 3030 West Sixth St., Los Angeles 54, Calif., plant at Trona on Searles Lake; Columbia-Southern Chemical Corp., a subsidiary of Pittsburgh Plate Glass Co., Bartlett, Calif.; Natural Soda Products Co., 405 Montgomery St., San Francisco 4, Calif., plant at Keeler (discontinued operations in June 1952); and West End Chemical Co., 608

[1] Salt (sodium chloride) is discussed in a separate chapter.
[2] Assistant chief, Construction and Chemical Materials Branch.
[3] Statistical assistant.

Latham Square Bldg., Oakland 12, Calif., plant at Westend on Searles Lake.

In Wyoming natural sodium carbonate is produced at Westvaco near Green River by Intermountain Chemical Corp., which is owned by Food Machinery & Chemical Corp. and National Distillers Products Corp. This operation was described in some detail in an article published during the year.[4]

The deposits in this area were discovered in 1938 in an exploratory well being drilled for oil or gas. A bed of trona (hydrous sodium carbonate) 10 to 20 feet thick was encountered at a depth of approximately 1,500 feet. On the basis of test holes drilled to the formation, an estimated 250 million tons of trona reserves has been reported, which would yield about 170 million tons of soda ash. In 1947 a 12-foot circular shaft was sunk to the ore body and a pilot plant built to treat the material extracted in developing the mine. From that time until the present this plant has turned out a marketable product. In 1951 expansion of this facility was begun, and National Production Authority issued a certificate of necessity allowing accelerated amortization of the facilities. The designed capacity of the surface plant is reported to be 300,000 tons of refined soda ash per year. A second shaft 14 feet in diameter has been sunk, and the new facilities were expected to be completed early in 1953.

In 1952 the following firms and individuals reported production of natural sodium sulfate: American Potash & Chemical Corp., 3030 West Sixth St., Los Angeles 54, Calif., plant at Trona, Calif.; Ozark-Mahoning Co., Box 449, Tulsa, Okla., plant at Monahans, Tex.; Wm. E. Pratt, Box 738, Casper, Wyo.; and Iowa Soda Products Co., Box 476, Council Bluffs, Iowa, plant at Rawlins, Wyo.

TABLE 2.—Sodium sulfate produced and sold or used, by producers in the United States, 1943–47 (average) and 1948–52

Year	Production (manufactured [1] and natural), short tons			Sold or used by producers (natural only)	
	Salt cake (crude)	Glauber's salt (100 percent $Na_2SO_4.10H_2O$)	Anhydrous refined (100 percent Na_2SO_4)	Short tons [2]	Value
1943–47 (average)	578,893	202,697	99,097	192,763	$1,936,239
1948	668,246	184,744	169,018	265,862	4,248,613
1949	537,843	156,634	136,276	186,223	2,733,853
1950	561,395	185,626	184,254	186,537	2,199,336
1951	707,338	219,942	233,666	(3)	(3)
1952	662,373	177,929	202,813	236,825	3,217,000

[1] U. S. Bureau of the Census.
[2] Includes Glauber's salt converted to 100-percent Na_2SO_4 basis.
[3] Figures withheld to avoid disclosure of individual company operations.

Sodium sulfate is recovered both from natural deposits and chemical reactions. It is obtained as a byproduct in the Mannheim process, in which salt and sulfuric acid are used to make hydrochloric acid and salt cake; and in rayon manufacture, wherein a little more than 1 pound of sodium sulfate is produced per pound of rayon spun (not all of this is recovered). In addition to these, some sodium sulfate

[4] Romano, C. A., Trona in Southwestern Wyoming: Mines Mag., vol. 42, No. 3, March 1952, pp. 69–70.

is recovered in the manufacture of phenol and lithium, boron, and chromium compounds.

The condition of the sodium sulfate industry has changed several times during recent years, and in 1952 the outlook again was changing.[5]

Several changes in the supply situation are likely. Any future easing of demand for hydrochloric acid probably will reduce production by the Mannheim process more than by other processes. Increasing recovery of sodium sulfate from rayon spinning baths may balance this possible decrease in Mannheim cake.

According to the Bureau of the Census, United States Department of Commerce, production of sodium metal in the United States in 1952 totaled 123,187 short tons compared with 118,904 short tons in 1951. The following firms reported production: Ethyl Corp. with plants in Baton Rouge, La., and Houston, Tex., the latter completed during 1952; E. I. du Pont de Nemours & Co., Inc., plant at Niagara Falls, N. Y.; and National Distillers Chemical Corp., plant at Ashtabula, Ohio. National Distillers reportedly canceled plans for expanding its Ashtabula plant because of market uncertainties.[6]

CONSUMPTION AND USES

Soda ash is one of the basic industrial chemicals and the most important product of the alkali industry. It enters directly into the production of glass, soap, detergents, cleaners, water softening, petroleum refining, aluminum production, textiles, pulp and paper, iron and steel, sodium nitrate, caustic soda, and various other products and services.

Estimated consumption of soda ash was down in 1952 in nearly all the major categories of use.[7] The exception was nonferrous metallurgy, where new aluminum-refining capacity was reflected in the estimate.

TABLE 3.—Estimated consumption of sodium carbonate in the United States, 1943–47 (average) and 1948–52, by industries, in thousands of short tons

[Chemical Engineering]

Industry	1943–47 (average)	1948	1949	1950	1951	1952
Glass	1,330	1,370	1,190	1,225	1,640	1,610
Caustic and bicarbonate	1,083	1,137	875	700	994	701
Nonferrous metals	260	210	210	245	333	363
Pulp and paper	190	230	200	200	320	305
Soap	143	130	125	105	120	110
Cleansers [1]	110	135	130	110	142	135
Water softeners	99	110	110	100	105	95
Textiles	67	69	55	65	56	37
Exports	(2)	207	76	50	152	75
Petroleum refining	22	24	24	24	29	31
Other chemicals	975	1,030	950	1,050	1,253	1,178
Miscellaneous	[2] 342	220	175	151	296	100
Total	4,621	4,872	4,120	4,025	5,440	4,740

[1] Includes modified sodas.
[2] Exports included with "Miscellaneous," 1944–47 (average) of exports (81) and of miscellaneous (255).

[5] Chemical Week, Plus for Salt Cake: Vol. 69, No. 17, Oct. 27, 1951, pp. 39–40.
[6] Chemical Week, Sodium to Diversify: Vol. 70, No. 14, Apr. 5, 1952, pp. 55–56.
[7] Chemical Engineering, vol. 60, No. 3, March 1953, p. 193.

Decline in consumption of soda ash in manufacture of caustic is attributed to the increase in availability of byproduct caustic from the production of electrolytic chlorine. The decline in the use of soda ash in soap is expected to be partially compensated by increased use in phosphates for detergents. Upward trends are expected for glass, aluminum, paper, and phosphates. Downward trends are expected for caustic and soap.[8]

One important use for soda ash is in water softening. The lime-soda method is an effective procedure for water conditioning. Hydrated lime rids the water of most of its carbonate and bicarbonate hardness. Soda ash eliminates most of the noncarbonate hardness from water. This type of hardness comes from the compounds of calcium and magnesium other than the carbonates. In most waters these are sulfates and chlorides predominately. Soda ash reacts with these soluble noncarbonates to precipitate calcium as carbonate and, precipitate with the aid of lime, magnesium as hydride. This method of conditioning water was described in an article.[9]

About three-fourths of the salt cake consumed goes into the production of kraft pulp. Glass and synthetic detergents take the next greatest tonnages. The remainder is used in making sodium alum, sodium silicate, in ceramics, mineral stock feeds, pharmaceuticals, and other applications.

Although the kraft-pulp industry has expanded greatly, increase in the use of salt cake has not been proportionate. The United States Pulp Producers Association estimates that 194 pounds of salt cake are needed to produce 1 ton of kraft as compared with 241 pounds 5 years ago. Improved pulp washing, use of electronic precipitators, improved evaporators to concentrate the pulping liquor largely are responsible for this reduced requirement. The development of the neutral sulfite pulping bath also held down the requirement for salt cake. In this process soda ash is dissolved and sulfur dioxide blown into it. A new pulping procedure for hard woods may reverse the trend of decreasing use of sulfate.[10] In detergents, demand for solid synthetics has gone up, with a consequent increase in demand for sulfate. In the production of alkyl sulfates, for example, manufacturers were using more salt cake.

The outlook for sodium metal was reviewed.[11] E. I. du Pont de Nemours Co., Inc., was increasing capacity for production of tetraethyllead (TEL) and thereby creating new demand for sodium. Ethyl and Du Pont reportedly disposed of most of their sodium for TEL manufacture; National Distillers sold much of its output for other than TEL purposes. One of the principal uses was reduction of glycerides to lauryl or other fatty alcohols. These were converted to alkyl sulfates, which are the main ingredients of certain detergents. The question of how competition from other detergents, such as petroleum-based alkyl aryl sulfonates, will affect the demand for alkyl sulfates, was said to be responsible in part for National Distillers decision not to expand at Ashtabula. Another factor that affected

[8] Chemical Engineering, Soda Ash Is and Will Be Ample: vol. 60, No. 3, March 1953, p. 193.
[9] Brindisi, Paul, Water-Softening Methods 2: Lime Soda: Power, vol. 96, No. 1, January 1952, pp. 80-81, 216, 218, 220.
[10] Chemical Week, Now—Hardwood Pulp: vol. 69, No. 17, Oct. 27, 1951, pp. 31, 33.
[11] Chemical Week, Sodium To Diversify: vol. 70, No. 14, Apr. 5, 1952, pp. 55-56.

the demand for sodium was the process competition between sodium reduction and high pressure hydrogenation in making glycerides. Still another factor was the role of aromatics in increasing the octane rating of motor fuels.

Other products requiring sodium in their manufacture include sodium peroxide, sodium cyanide, sodium hydride, organic intermediates, and pharmaceuticals.

PRICES

According to Oil, Paint and Drug Reporter, the price of soda ash was quoted at $1.60 per 100 pounds of dense ash, 58 percent, paper-bags, carlots, works; $1.30 per 100 pounds, bulk, same basis; light ash, 58 percent, same basis, was quoted at $1.50 and $1.20 per 100 pounds, respectively. Salt cake, bulk, works, 100 percent Na_2SO_4 basis, was quoted at $17 per ton. Glauber's salt, anhydrous, crystalline, bags, carlots, works, freight allowed, was quoted at $45 per ton. These prices prevailed throughout the year.

According to E&MJ Metal and Mineral Markets, the price of sodium per pound, carlots, in drums, was 16½ cents; less than carlots, 17 cents. These prices prevailed throughout the year.

FOREIGN TRADE [12]

The bulk of the sodium sulfate imported into the United States came from Canada, Belgium, and Germany. Imports of sodium carbonate came largely from France and Germany.

TABLE 4.—Sodium sulfate imported for consumption in the United States 1943–47 (average) and 1948–52

[U. S. Department of Commerce]

Year	Crude (salt cake)		Crystallized (Glauber's salt)		Anhydrous		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	31,198	$431,786	18	$352	1	$95	31,217	$432,233
1948	29,612	468,561					29,612	468,561
1949	21,090	294,367	53	1,152	245	4,953	21,388	300,472
1950	61,612	737,118			5,565	107,330	67,177	844,448
1951	77,559	940,202			3,904	101,139	81,463	1,041,341
1952	50,822	803,054			5,105	141,254	55,927	944,308

[12] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 5.—Sodium carbonate and sodium sulfate exported from the United States, 1943–47 (average) and 1948–52

[U. S. Department of Commerce]

Year	Sodium carbonate		Sodium sulfate	
	Short tons	Value	Short tons	Value
1943–47 (average)	95,352	$3,782,511	(1)	(1)
1948	207,090	9,654,178	(1)	(1)
1949	75,585	2,817,635	14,440	$500,000
1950	63,497	2,173,428	16,834	422,263
1951	155,146	6,903,150	25,634	797,360
1952	105,933	4,031,110	27,909	781,582

1 Not separately classified prior to 1949.

TECHNOLOGY

As a result of efforts to utilize power from nuclear reactors, interest in liquid-metal coolants has spurred the study of sodium for this purpose. Some of this research was discussed in articles published during the year.[13] Sodium is an excellent coolant and has acceptable nuclear characteristics. Sodium's high specific heat makes it economical to pump, and more heat is removed by sodium per pound pumped than by any other liquid metal except lithium.

National Distillers Chemical Corp. has released the fourth in a series of technical bulletins on sodium dispersions, summarizing the preparation properties and uses of this form of metallic sodium. The bulletin presents technical data on the formulation of sodium dispersions in various mediums. Sodium content, stability, fluidity, and other properties of these dispersions are reviewed.[14]

Solvay Sales Division, Allied Chemical & Dye Corp., issued a new edition of its technical bulletin on soda ash. The bulletin includes data on properties, uses, handling, and storage.[15]

RESERVES

A report was published on the results of an investigation conducted by the Bureau of Mines on the sodium sulfate deposits in Divide, Williams, Mountrail, Ward, and Ransey Counties, N. Dak., and in Sheridan County, Mont. Of the 14 deposits included in the investigation, 12 are in North Dakota and 2 in Montana. Some of these deposits had been sampled by the Federal Emergency Relief Administration, the University of North Dakota, and the North Dakota Geological Survey. Seven deposits sampled by the Bureau of Mines were found to contain a permanent bed of Glauber's salt.

13 Koenig, R. F. and Vandenberg, S. R., Liquid Sodium—a Noncorrosive Coolant: Metal Progress, vol. 61, No. 3, March 1952, pp. 71–75.
Evans, George E., Wanted: Better Materials for Nuclear Reactors: Iron Age, vol. 169, No. 11, Mar. 13, 1952, pp. 93–97.

14 National Distillers Chemical Corp., Sodium Dispersions: Tech. Bull. 104, Ashtabula, Ohio, 4 pp.

15 Solvay Sales Division, Allied Chemical & Dye Corp., Soda Ash, Technical and Engineering Bull. No. 5, New York, 64 pp.

The seven deposits are estimated to contain a total of 19,140,000 short tons of impure Glauber's salt or approximately 11,707,000 short tons of pure Glauber's salt in the permanent beds alone. This, with the tonnage developed by the FERA, gives a total of 23,849,000 short tons of Glauber's salt or 10,507,000 short tons of anhydrous sodium sulfate in the permanent beds of all deposits.

An additional reserve of 2,450,500 short tons of Glauber's salt in intermittent crystals, 421,000 short tons in the brines, and 3,718,600 tons in other material also was developed by the Bureau of Mines. Analyses, areas, and tonnages for the bedded material in the individual lakes were given in the report.[16]

WORLD REVIEW

As many countries strive for self-sufficiency in basic chemical materials, new sodium compound plants are being built. Widespread occurrences of salt, the raw material for the manufactured product, facilitate the development of such industry in many countries.

Colombia.—Completion of the soda ash plant of Planta de Soda de Betania was announced. This plant was designed to produce 100 tons of soda ash daily. The product will go largely into glass, caustic, and bicarbonate, and will save the country several million dollars annually in foreign exchange.[17]

India.—At Didwana about 40 miles northwest of Sambhar is situated the only source of mirabilite (sodium sulfate) in India. This lake is an oval depression about 4 miles long and 1½ miles wide. It is estimated that the total crystallizing area of the lake is about 2½ million square feet.

The crystallizing period begins immediately after the monsoon, and the sulfate may be obtained best during the winter months. The crust (crude sulfate) is broken and stored near the banks of the pans. Several pans are worked simultaneously, and the output is transported in bullock carts to the railway station about 1½ miles away. A plant at Bhagat-ki-kothi, Jodhpur, converts a portion of the sodium sulfate to the sulfite which is used largely in the leather-tanning industry. Most of the remainder of the sulfite is used in paper manufacture and chemical industries.[18]

It is reported that deposits of soda have been found in Uttar, Pradesh. It was believed that the brines would yield substantial quantities of soda ash, sodium bicarbonate, sodium sulfate, and other salts.[19]

---

[16] Binyon, E. O., North Dakota Sodium Sulfate Deposits: Bureau of Mines Rept. of Investigations 4880, 1952, 41 pp.

[17] Bureau of Mines, Mineral Trade Notes: vol. 35, No. 1, July 1952, p. 43

[18] Information abstracted from reports by A. V. Corry, American Embassy attaché, New Delhi, India.

[19] U. S. Department of Commerce, Foreign Commerce Weekly: vol. 46, No. 10, Mar. 10, 1952, p. 23.

Canada.—The sodium sulfate deposits of Saskatchewan were described.[20] Over 200 alkali deposits and lakes in that Province are reported to contain a reserve of over 60 million tons of anhydrous sodium sulfate. The deposits occur in undrained basins, where evaporation has concentrated the alkali salt. In some deposits the salt is present as a strong brine and in others as a brine overlying permanent beds of solid crystal.

[20] Williams, A. J., Saskatchewan's Industrial Minerals: Min. Eng., vol. 4, No. 4, April 1952, p. 398.

Stone

By Oliver Bowles[1] and Nan C. Jensen[2]

COMBINED sales of dimension and crushed stone in 1952 set a new alltime high record of 300,687,670 short tons valued at $465,377,549. These sales were 5 percent higher in quantity and 7 percent higher in value than in 1951. Sales of dimension stone gained 2 percent in quantity but declined 5 percent in value. Sales of crushed and broken stone gained 5 percent in quantity and 8 percent in value over 1951. Furnace-flux and refractory stone production declined, but the other major uses increased.

The tables in this chapter give the quantities of stone sold or used by producers and the value f. o. b. quarries or mills. Stone quarried and also used by producers is considered sold and is therefore included with sales in the statistics. Stone made into abrasives, such as grindstones, and stone used in making cement and lime are, however, not included herein. They are reported in terms of finished products in the Abrasive Materials, Lime, and Cement chapters. Dimension stone and crushed stone are considered separately, except in introductory tables 1 to 4 (which show total sales of stone by kinds, uses, and States) and in tables of imports and exports.

TABLE 1.—Stone sold or used by producers in the United States,[1] 1943–47, (average) and 1948–52, by kinds

Year	Granite		Basalt and related rocks (traprock)		Marble		Limestone	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	9, 587, 702	$23, 217, 122	15, 871, 046	$19, 765, 994	185, 174	$6, 288, 417	128, 437, 410	$141, 897, 237
1948	13, 685, 880	38, 807, 266	20, 654, 580	29, 916, 965	276, 000	10, 421, 254	166, 742, 390	215, 451, 016
1949	16, 944, 050	42, 566, 336	21, 386, 260	30, 486, 257	239, 440	12, 292, 822	163, 746, 260	222, 513, 012
1950	22, 553, 180	52, 220, 660	22, 894, 830	34, 372, 735	267, 220	10, 932, 234	180, 918, 910	252, 755, 827
1951	[2] 20,297, 365	[2] 50,285, 648	29, 404, 512	42, 914, 706	256, 339	10, 641, 219	205, 479, 815	287, 675, 332
1952	22, 288, 843	52, 480, 380	29, 674, 760	46, 285, 787	238, 048	10, 888, 353	217, 255, 454	308, 924, 214

Year	Sandstone		Other stone[3]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	5, 856, 966	$11, 752, 464	13, 408, 740	$9, 669, 578	173, 347, 038	$212, 590, 812
1948	7, 289, 950	18, 048, 947	16, 886, 590	16, 339, 123	225, 535, 390	328, 984, 571
1949	6, 954, 660	19, 906, 326	14, 755, 900	13, 676, 892	224, 026, 570	341, 441, 645
1950	9, 100, 890	23, 787, 019	16, 378, 020	16, 513, 622	252, 113, 050	390, 582, 097
1951	8, 792, 232	24, 979, 317	21, 320, 568	20, 332, 981	[2] 285, 550, 831	[2] 436,829, 203
1952	8, 649, 584	25, 004, 372	22, 580, 981	21, 794, 443	300, 687, 670	465, 377, 549

[1] Includes Alaska, Hawaii, and Puerto Rico.
[2] Revised figure.
[3] Includes mica schist, conglomerate, argillite, various light-color volcanic rocks, serpentine not used as marble, soapstone sold as dimension stone, etc.

[1] Commodity specialist.
[2] Statistical assistant.

TABLE 2.—Stone sold or used by producers in the United States,[1] 1951–52, by uses

Use	1951 Quantity	1951 Value	1952 Quantity	1952 Value
Dimension stone:				
Building stone:				
Rough construction ... short tons	239, 385	$1, 148, 161	281, 646	$1, 346, 396
Cut stone, slabs, and mill blocks [2] ... cubic feet	13, 201, 354	37, 679, 144	12, 087, 739	34, 008, 464
Approximate equivalent in short tons	997, 474		917, 771	
Rubble ... short tons	252, 991	590, 925	320, 042	826, 716
Monumental stone ... cubic feet	2, 851, 687	16, 851, 224	2, 793, 689	17, 117, 060
Approximate equivalent in short tons	234, 753		230, 490	
Paving blocks ... number	430, 550	51, 999	682, 587	37, 742
Approximate equivalent in short tons	3, 270		2, 256	
Curbing ... cubic feet	1, 006, 140	2, 871, 881	1, 052, 899	2, 576, 216
Approximate equivalent in short tons	82, 481		86, 179	
Flagging ... cubic feet	640, 543	976, 518	720, 871	1, 108, 170
Approximate equivalent in short tons	51, 335		57, 946	
Total dimension stone (quantities approximate, in short tons)	1, 861, 689	60, 169, 852	1, 896, 330	57, 020, 764
Crushed and broken stone:				
Riprap ... short tons	6, 989, 284	8, 437, 614	8, 778, 585	11, 156, 047
Crushed stone ... do	[3]190,134,640	[3]236,755,481	207, 588, 633	265, 586, 961
Furnace flux (limestone) ... do	39, 929, 957	45, 622, 125	34, 908, 815	41, 119, 351
Refractory stone [4] ... do	2, 365, 804	7, 810, 013	1, 950, 786	7, 262, 048
Agriculture (limestone) ... do	19, 400, 610	31, 051, 933	21, 152, 208	34, 463, 963
Other uses ... do	24, 868, 847	46, 982, 185	24, 412, 313	48, 768, 415
Total crushed and broken stone ... do	[3]283,689,142	[3]376,659,351	298, 791, 340	408, 356, 785
Grand total (quantities approximate, in short tons)	[3]285,550,831	[3]436,829,203	300, 687, 670	465, 377, 549

[1] Includes Alaska, Hawaii, and Puerto Rico.
[2] To avoid disclosure of individual outputs, dimension stone for refractory use is included with building stone. Sawed building stone includes: 1951—539,940 cubic feet (39,167 tons) of stone for refractory use valued at $1,304,561; 1952—437,935 cubic feet (31,760 tons), $1,103,642.
[3] Revised figure.
[4] Ganister (sandstone), mica schist, soapstone, and dolomite.

TABLE 3.—Stone sold or used by noncommercial producers in the United States,[1] 1951–52, by uses

[Included in total production]

Use	1951 Short tons	1951 Value	1952 Short tons	1952 Value
Building stone	9, 866	$73, 315	15, 866	$30, 088
Rubble	63, 227	80, 060	70, 784	162, 617
Riprap	2, 508, 343	2, 297, 375	2, 101, 316	2, 510, 061
Crushed stone	18, 770, 495	21, 627, 615	17, 670, 570	22, 529, 104
Agricultural (limestone)	484, 312	739, 123	468, 660	660, 718
Other uses	4, 480, 789	5, 167, 482	2, 421, 708	2, 469, 633
Total	26, 317, 032	29, 984, 970	22, 748, 904	28, 362, 221

[1] Includes Alaska and Puerto Rico.

TABLE 4.—Stone sold or used by producers in the United States, 1951–52, by States

State	1951		1952	
	Short tons	Value	Short tons	Value
Alabama	2,818,421	$7,254,671	3,052,150	$7,948,410
Arizona	308,881	353,872	235,020	355,709
Arkansas	2,535,746	3,216,426	[1] 2,967,479	[1] 3,346,201
California	12,537,344	14,714,524	14,374,930	17,697,085
Colorado	1,470,123	2,334,376	1,708,872	2,566,401
Connecticut	2,278,466	3,360,378	2,837,045	4,101,060
Delaware	99,201	245,002	94,911	251,759
Florida	8,032,966	9,419,682	7,836,634	9,577,541
Georgia	[2] 5,234,131	[2] 14,813,413	7,141,923	18,114,604
Idaho	1,457,182	1,811,422	[1] 1,630,034	[1] 2,441,236
Illinois	19,298,968	23,474,516	22,334,887	28,326,060
Indiana	[1] 8,641,670	[1] 23,729,433	9,126,837	21,965,454
Iowa	9,261,317	12,170,082	9,899,404	13,036,726
Kansas	7,191,483	9,058,512	8,830,871	12,051,740
Kentucky	7,048,771	8,609,609	[1] 8,817,859	[1] 10,816,707
Louisiana	-----------	-----------	(3)	(3)
Maine	644,594	2,582,541	[1] 316,874	[1] 1,795,768
Maryland	3,181,434	5,983,380	[1] 3,391,679	[1] 6,330,443
Massachusetts	[1] 3,225,839	[1] 9,172,425	[1] 3,355,819	[1] 9,331,871
Michigan	20,851,733	17,514,720	17,973,685	15,770,816
Minnesota	[1] 1,906,407	[1] 5,613,157	[1] 2,394,178	[1] 5,498,177
Mississippi	171,131	168,933	90,000	103,500
Missouri	11,294,227	15,255,427	15,106,544	20,676,958
Montana	871,508	986,327	[1] 690,081	[1] 792,897
Nebraska	942,967	1,437,899	1,245,106	1,946,448
Nevada	834,807	959,815	830,712	1,158,608
New Hampshire	[1] 62,355	[1] 349,606	69,850	546,177
New Jersey	6,457,248	10,987,705	6,102,324	12,307,480
New Mexico	1,022,901	592,179	[1] 317,894	[1] 191,642
New York	15,559,372	24,326,118	16,234,549	25,244,245
North Carolina	[1] 8,612,967	[1] 13,292,690	[1] 9,647,513	[1] 14,694,698
North Dakota	281,219	213,061	67,064	4,968
Ohio	[1] 25,190,277	[1] 36,436,081	[1] 24,693,189	[1] 36,197,485
Oklahoma	6,966,676	6,917,548	[1] 9,636,475	[1] 8,974,334
Oregon	8,721,799	10,831,483	6,250,849	8,893,368
Pennsylvania	[1] 27,399,564	[1] 46,668,590	[1] 25,609,812	[1] 44,676,456
Rhode Island	239,248	651,931	168,993	654,782
South Carolina	[1] 2,828,868	[1] 3,690,114	[1] 2,914,839	[1] 3,881,178
South Dakota	1,263,322	4,660,074	1,671,187	4,806,882
Tennessee	[1] 8,838,796	14,765,988	10,377,320	17,652,763
Texas	[1] 7,351,069	[1] 7,626,122	7,604,468	8,664,633
Utah	1,226,710	1,291,118	[1] 852,351	[1] 1,123,108
Vermont	450,980	7,253,824	404,391	6,016,530
Virginia	9,277,252	16,621,116	9,670,961	16,969,952
Washington	5,029,735	5,664,433	4,523,234	5,491,525
West Virginia	[1] 5,754,378	[1] 8,472,639	4,869,442	[1] 6,826,113
Wisconsin	7,609,323	14,671,858	8,578,882	16,754,675
Wyoming	1,645,475	1,857,267	1,466,567	1,688,890
Undistributed	226,648	1,842,438	989,683	2,799,985
Total	[2] 284,155,499	[2] 433,924,525	299,005,371	461,064,048
Alaska, Hawaii, Puerto Rico	1,395,332	2,904,678	1,682,299	4,313,501
Grand total	[2] 285,550,831	[2] 436,829,203	300,687,670	465,377,549

[1] To avoid disclosing confidential information certain State totals are incomplete, the portion not included being combined with "Undistributed." The class of stone omitted from such State totals is noted in the State tables in the Statistical Summary chapter of this volume.
[2] Revised figure.
[3] Included with "Undistributed."

DIMENSION STONE

The term "dimension stone," as used in this chapter, is applied to faced blocks of natural stone, employed principally as building stone or for making memorials. Crushed and broken stone, on the other hand, consists primarily of irregular fragments sized chiefly by mechanical screening; it is used chiefly as concrete aggregate, railroad ballast, furnace flux, and agricultural limestone.

Dimension-stone producers may be divided into three main groups on the basis of method of operation. The first group quarries stone and sells it as rough blocks or slabs; the second quarries stone and also manufactures it into finished products; and the third buys sawed slabs or rough blocks of stone and manufactures them into finished products. The Bureau of Mines statistical canvass covers the first and second groups but not the third. Bureau of Mines statistics are compiled from reports of quantities and values of original sales and include some material sold as rough blocks and some sold as finished products.

Total sales of dimension stone (including slate) in 1952 were almost identical in quantity with sales in 1951, but the value of sales declined 7 percent. Although these overall figures include slate, detailed statistics of that branch of the industry appear in the Slate chapter.

TABLE 5.—Dimension stone sold or used by producers in the United States,[1] 1951–52, by kinds and uses

Kind and use	1951	1952	
		Amount	Percent of change from 1951
Granite:			
Building stone:			
Rough construction .... short tons	74,214	66,250	−11
Value	$500,133	$573,743	+15
Average per ton	$6.74	$8.66	+28
Cut stone, slabs, and mill blocks .... cubic feet	825,882	737,561	−11
Value	$5,061,985	$4,669,886	−8
Average per cubic foot	$6.13	$6.33	+3
Rubble .... short tons	94,043	102,629	+9
Value	$291,702	$284,013	−3
Monumental stone .... cubic feet	2,609,134	2,508,994	−4
Value	$14,606,453	$14,458,426	−1
Average per cubic foot	$5.60	$5.76	+3
Paving blocks .... number	430,550	682,587	+59
Value	$51,999	$37,742	−27
Curbing .... cubic feet	944,389	974,565	+3
Value	$2,709,935	$2,373,604	−12
Total:			
Quantity .... approximate short tons	531,857	518,838	−2
Value	$23,222,207	$22,397,414	−4
Basalt and related rocks (traprock):			
Building stone:			
Rough construction .... short tons	32,746	33,766	+3
Value	$114,225	$106,912	−6
Average per ton	$3.49	$3.17	−9
Rubble .... short tons	205	24,230	+11,720
Value	$100	$31,250	+31,150
Total:			
Quantity .... short tons	32,951	57,996	+76
Value	$114,325	$138,162	+21
Marble:			
Building stone (cut stone, slabs, and mill blocks) .... cubic feet	783,861	763,770	−3
Value	$6,659,913	$6,620,584	−1
Average per cubic foot	$8.50	$8.67	+2
Monumental stone .... cubic feet	242,553	284,695	+17
Value	$2,244,771	$2,658,634	+18
Average per cubic foot	$9.25	$9.34	+1
Total:			
Quantity .... approximate short tons	87,191	89,051	+2
Value	$8,904,684	$9,279,218	+4

See footnotes at end of table.

TABLE 5.—Dimension stone sold or used by producers in the United States,[1] 1951–52, by kinds and uses—Continued

Kind and use	1951	1952 Amount	1952 Percent of change from 1951
Limestone:			
Building stone:			
Rough construction .... short tons..	101,244	138,396	+37
Value	$375,826	$400,304	+7
Average per ton	$3.71	$2.89	−22
Cut stone, slabs, and mill blocks .... cubic feet..	8,096,710	7,098,075	−12
Value	$17,630,077	$14,284,500	−19
Average per cubic foot	$2.18	$2.01	−8
Rubble .... short tons..	94,628	111,092	+17
Value	$194,640	$256,526	+32
Flagging .... cubic feet..	175,527	145,418	−17
Value	$126,580	$119,719	−6
Total:			
Quantity .... approximate short tons..	806,842	786,757	−2
Value	$18,327,123	$15,061,049	−18
Sandstone:			
Building stone:			
Rough construction .... short tons..	31,181	43,234	+39
Value	$157,977	$265,437	+68
Average per ton	$5.07	$6.14	+21
Cut stone, slabs, and mill blocks .... cubic feet..	2,811,207	2,789,566	−1
Value	$6,071,863	$6,026,975	−1
Average per cubic foot	$2.16	$2.16	....
Rubble .... short tons..	11,921	57,122	+379
Value	$48,478	$192,487	+297
Curbing .... cubic feet..	61,751	78,334	+27
Value	$161,946	$202,612	+25
Flagging .... cubic feet..	441,756	483,080	+9
Value	$806,652	$891,969	+11
Total:			
Quantity .... approximate short tons..	291,253	352,230	+21
Value	$7,246,916	$7,579,480	+5
Miscellaneous stone: [2]			
Building stone .... cubic feet..	683,694	698,767	+2
Value	$2,255,306	$2,406,519	+7
Average per cubic foot	$3.30	$3.44	+4
Rubble .... short tons..	52,194	24,969	−52
Value	$56,005	$62,440	+11
Flagging .... cubic feet..	23,260	92,373	+297
Value	$43,286	$96,482	+123
Total:			
Quantity .... approximate short tons..	111,595	91,458	−18
Value	$2,354,597	$2,565,441	+9
Total dimension stone, excluding slate:			
Quantity .... approximate short tons..	1,861,689	1,896,330	+2
Value	$60,169,852	$57,020,764	−5
Slate as dimension stone [3] .... approximate short tons..	171,150	146,250	−15
Value	$8,007,710	$6,586,804	−18
Total dimension stone, including slate:			
Quantity .... approximate short tons..	2,032,839	2,042,580	....
Value	$68,177,562	$63,607,568	−7

[1] Includes Puerto Rico.
[2] Includes soapstone, mica schist, volcanic rocks, argillite, and other varieties that cannot be classified in the principal groups.
[3] Details of production, by uses, are given in the Slate chapter of this volume.

BUILDING STONE

The largest use of dimension stone is for building purposes. Sales of building stone in 1952 declined 4 percent in quantity and 9 percent in value compared with 1951. The principal declines were in sales of limestone and granite. Table 6 gives the quantity and value of the major types of building stone sold or used in 1952.

TABLE 6.—Building stone sold or used by producers in the United States [1] in 1952, by kinds

Kind	Rough			
	Construction		Architectural	
	Cubic feet	Value	Cubic feet	Value
Granite	797,571	$573,743	172,350	$420,365
Basalt	401,452	106,912		
Marble			280,117	786,158
Limestone	1,681,909	400,304	2,738,382	2,974,848
Sandstone	546,929	265,437	1,024,825	1,574,133
Miscellaneous				
Total	3,427,861	1,346,396	4,215,674	5,755,504

Kind	Finished				Total	
	Sawed		Cut			
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value
Granite [2]	362,161	$1,798,564	203,050	$2,450,957	1,535,132	$5,243,629
Basalt					401,452	106,912
Marble	155,670	1,126,682	327,983	4,707,744	763,770	6,620,584
Limestone	3,187,145	5,194,295	1,172,548	6,115,357	8,779,984	14,684,804
Sandstone	1,665,541	3,760,780	99,200	692,062	3,336,495	6,292,412
Miscellaneous	[3] 698,767	[3] 2,406,519			698,767	2,406,519
Total	[3] 6,069,284	[3] 14,286,840	1,802,781	13,966,120	15,515,600	35,354,860

[1] Includes Puerto Rico.
[2] Sawed stone corresponds to dressed stone for construction work (walls, foundations, bridges) and cut stone to architectural stone for high-class buildings.
[3] Rough and cut miscellaneous stone included with sawed stone.

GRANITE

Sales of granite as dimension stone in 1952 declined 2 percent in quantity and 4 percent in value compared with 1951. All items declined, except rubble and curbing. Unit values dropped for all items, except dressed monumental and rough construction stone. The average value of granite sold in 1952 was $43.17 a short ton, 49 cents lower than in 1951.

The decorative and building stones of Minnesota, comprising chiefly the granites of St. Cloud and the Minnesota River Valley and the dolomitic limestones of Mankato, Kasota, and Winona, have been described.[3]

Tables 8 and 9 show sales of monumental granite in the Barre district, Vermont, exclusive of small quantities sold for construction or as crushed stone. The large decline in 1952 was due to a strike which affected the territory for about 5 months.

[3] Schwartz, G. M., and Thiel, G. A., Dimension Stone in Minnesota: Min. Eng., vol. 4, No. 1, January 1952, pp. 77-80.

TABLE 7.—Granite (dimension stone) sold or used by producers in the United States in 1952, by States and uses

State	Active plants	Building								Monumental				Paving blocks		Curbing		Total	
		Rough				Dressed		Rubble		Rough		Dressed							
		Construction		Architectural															
		Short tons	Value	Cubic feet	Value	Cubic feet	Value	Short tons	Value	Cubic feet	Value	Cubic feet	Value	Number	Value	Cubic feet	Value	Short tons (approximate)	Value
California	12	30	$60	5,979	$25,410	4,690	$84,650	4,507	$9,297	23,676	$93,712	11,590	$161,065	-	-	-	-	8,304	$374,194
Colorado	3	-	-	-	-	-	-	536	2,300	515	1,545	-	-	-	-	-	-	579	3,845
Connecticut	6	2,133	6,438	(1)	(1)	11,460	36,626	1,348	13,928	10,563	83,415	(1)	(1)	-	-	(1)	(1)	5,714	178,562
Georgia	16	-	-	-	-	(1)	(1)	56,000	112,440	666,329	1,527,521	170,977	1,327,501	(1)	(1)	(1)	(1)	139,358	3,357,150
Maine	8	2,623	17,172	81,316	149,432	76,455	749,627	(1)	(1)	10,054	27,419	9,590	114,370	(1)	(1)	30,225	$80,761	20,328	1,142,618
Maryland	4	15,288	166,350	5,902	6,590	-	-	27,530	87,575	-	-	-	-	-	-	20,732	13,800	45,002	274,315
Massachusetts	6	7,740	97,418	37,868	145,759	(1)	(1)	1,226	8,085	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	95,745	3,846,617
Minnesota	17	-	-	-	-	36,878	458,988	-	-	24,341	81,921	126,392	1,420,929	-	-	-	-	15,572	1,961,838
Missouri	1	-	-	-	-	-	-	107	605	40,689	70,105	8,243	68,355	-	-	-	-	4,193	139,065
Montana	1	-	-	-	-	-	-	-	-	(1)	(1)	-	-	-	-	-	-	(1)	(1)
New Hampshire	4	850	3,161	(1)	(1)	(1)	(1)	(1)	(1)	1,500	5,400	3,445	22,909	-	-	(1)	(1)	3,917	411,603
New York	3	(1)	(1)	19,334	36,800	16,867	79,000	3,250	9,000	(1)	(1)	-	-	-	-	600	1,200	8,493	154,962
North Carolina	8	4,150	40,278	(1)	(1)	(1)	(1)	(1)	(1)	35,329	158,143	(1)	(1)	(1)	(1)	(1)	(1)	24,190	1,317,249
Oklahoma	5	-	-	-	-	-	-	-	-	6,972	22,702	51,660	487,871	-	-	-	-	4,837	510,573
Pennsylvania	7	29,811	192,528	-	-	5,000	29,805	4,372	13,322	-	-	19,449	243,148	-	-	-	-	36,237	478,803
Rhode Island	2	(1)	(1)	(1)	(1)	-	-	-	-	(1)	(1)	-	-	-	-	-	-	(1)	(1)
South Carolina	1	-	-	-	-	-	-	-	-	(1)	(1)	-	-	-	-	-	-	(1)	(1)
South Dakota	10	-	-	(1)	(1)	(1)	(1)	-	-	76,604	277,967	153,341	2,056,313	-	-	-	-	19,921	2,468,058
Texas	2	-	-	-	-	(1)	(1)	-	-	(1)	(1)	(1)	(1)	-	-	-	-	(1)	(1)
Vermont	3	-	-	-	-	-	-	-	-	599,544	3,010,130	-	-	-	-	-	-	48,563	3,010,130
Washington	4	-	-	24	54	-	-	166	500	1,389	11,564	-	-	-	-	1,976	4,075	446	16,193
Wisconsin	8	-	-	8,368	37,656	-	-	-	-	20,332	62,301	85,560	1,364,329	-	-	-	-	9,426	1,464,286
Undistributed	-	3,625	50,338	13,559	18,664	413,861	2,810,825	3,587	26,961	306,955	1,114,448	43,955	643,343	682,587	$37,742	921,032	2,273,768	28,013	1,287,353
Total	131	66,250	573,743	172,350	420,365	565,211	4,249,521	102,629	284,013	1,824,792	6,548,293	684,202	7,910,133	682,587	37,742	974,565	2,373,604	518,838	22,397,414
Average unit value	-	-	$8.66	-	$2.44	-	$7.52	-	$2.77	-	$3.59	-	$11.56	-	$0.06	-	$2.44	-	$43.17
Short tons (approximate)	-	(2)	-	14,247	-	46,695	-		-	149,888	-	56,402	-	2,256	-	80,471	-	-	-

1 Included with "Undistributed" to avoid disclosure of individual company operations.
2 797,571 cubic feet (approximate).

TABLE 8.—Monumental granite sold by quarrymen in the Barre district, Vermont, 1943–47 (average) and 1948–52

Year	Cubic feet	Value	Year	Cubic feet	Value
1943–47 (average)	801, 892	$2, 825, 313	1950	917, 310	$3, 868, 351
1948	1, 039, 580	3, 952, 622	1951	853, 963	4, 100, 912
1949	890, 080	3, 528, 756	1952	599, 544	3, 010, 130

TABLE 9.—Estimated output of monumental granite in the Barre district, Vermont, 1950–52

[Barre Granite Association, Inc.]

	1950	1951	1952
Total quarry output, rough stock ---- cubic feet	917, 685	863, 265	462, 280
Shipped out of Barre district in rough ---- do	183, 537	172, 653	92, 457
Manufactured in Barre district ---- do	734, 148	690, 612	369, 823
Light stock consumed in district ---- do	489, 432	460, 408	246, 549
Dark stock consumed in district ---- do	244, 716	230, 204	123, 274
Number of cutters in district	1, 748	1, 748	1, 748
Average daily wage	$13. 90	$15. 00	$15. 38
Average number of days worked	248	248	155
Total pay roll for year	$6, 025, 706	$6, 502, 560	$4, 166, 805
Estimated overhead	3, 012, 853	3, 251, 280	2, 083, 403
Estimated value of light stock	2, 938, 460	2, 859, 765	1, 525, 535
Estimated value of dark stock	1, 590, 654	1, 495, 326	801, 289
Estimated polishing cost	1, 846, 840	1, 737, 220	930, 344
Estimated sawing cost	1, 445, 354	1, 359, 642	728, 096
Total value of granite	16, 859, 867	17, 205, 793	10, 235, 472

BASALT AND RELATED ROCKS (TRAPROCK)

Basalt and related dark igneous rocks are used in relatively small quantities as building stone. Sales of rough construction stone were slightly higher than in 1951, while rubble sales made a remarkable gain. Total sales of basalt increased 76 percent, but the value per ton declined 31 percent. Basalt and related rocks, such as syenites and diorites, are used to some extent for memorials but are classed in the trade as "black granite," and are therefore included with the figures for monumental granite.

TABLE 10.—Basalt and related rocks (traprock) (dimension stone) sold or used by producers in the United States in 1952, by States and uses

State	Active plants	Building stone				Total	
		Rough construction		Rubble			
		Short tons	Value	Short tons	Value	Short tons	Value
California	1			1, 900	$9, 500	1, 900	$9, 500
Connecticut	1	(1)	(1)			(1)	(1)
Idaho	1			490	350	490	350
Oregon	2	3, 604	$16, 610	21, 840	21, 400	25, 444	38, 010
Pennsylvania	1	(1)	(1)			(1)	(1)
Undistributed		30, 162	90, 302			30, 162	90, 302
Total	6	[2] 33, 766	106, 912	24, 230	31, 250	57, 996	138, 162
Average unit value			$3. 17		$1. 29		$2. 38

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] 401,452 cubic feet (approximate).

MARBLE

Total sales of marble increased slightly both in quantity and value over 1951. Building-marble sales declined, while monumental marble sales increased—the reverse of the situation in 1951. Unit value increased 2 percent. Tables 11 and 12 give sales data on marble, by uses and States.

TABLE 11.—Marble (dimension stone) sold by producers in the United States, 1951–52, by uses

Use	1951		1952	
	Cubic feet	Value	Cubic feet	Value
Building stone:				
Rough:				
Exterior	10,030	$40,900	25,562	$111,969
Interior	274,352	1,002,678	254,555	674,189
Finished:				
Exterior	115,154	1,071,897	161,123	1,580,782
Interior	384,325	4,544,438	322,530	4,253,644
Total exterior	125,184	1,112,797	186,685	1,692,751
Total interior	658,677	5,547,116	577,085	4,927,833
Total building stone	783,861	6,659,913	763,770	6,620,584
Monumental stone:				
Rough } Finished }	242,553	2,244,771	284,695	2,658,634
Total monumental stone	242,553	2,244,771	284,695	2,658,634
Total building and monumental	1,026,414	8,904,684	1,048,465	9,279,218
Approximate short tons	87,191		89,051	

TABLE 12.—Marble (dimension stone) sold by producers in the United States in 1952, by States and uses

State	Active plants	Building		Monumental		Total		
						Quantity		Value
		Cubic feet	Value	Cubic feet	Value	Cubic feet	Short tons (approximate)	
Alabama	2	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Arkansas	1	3,140	$14,038	50	$350	3,190	271	$14,388
Colorado	1	3,151	9,453			3,151	268	9,453
Georgia	1	57,862	811,366	153,349	1,534,613	211,211	17,953	2,345,979
Maryland	1	(1)	(1)			(1)	(1)	(1)
Minnesota	1	6,021	29,000			6,021	443	29,000
Missouri	2	(1)	(1)	2,658	17,681	(1)	(1)	(1)
North Carolina	1			(1)	(1)	(1)	(1)	(1)
Tennessee	6	470,196	3,659,210	34,977	210,796	505,173	42,940	3,870,006
Vermont	5	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Undistributed		223,400	2,097,517	93,661	895,194	319,719	27,176	3,010,392
Total	21	763,770	6,620,584	284,695	2,658,634	1,048,465	89,051	9,279,218
Average unit value			$8.67		$9.34			[2] $8.85
Short tons (approximate)		64,851		24,200				

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Average value per cubic foot.

TABLE 13.—Limestone (dimension stone) sold or used by producers in the United States in 1952, by States and uses

State	Active plants	Building								Flagging		Total	
		Rough				Finished (cut and sawed)		Rubble					
		Construction		Architectural									
		Short tons	Value	Cubic feet	Value	Cubic feet	Value	Short tons	Value	Cubic feet	Value	Short tons (approximate)	Value
Alabama	1			(1)	(1)	(1)	(1)	(1)	(1)			(1)	(1)
Arkansas	1	111	$1,110									111	$1,110
California	3	(1)	(1)			(1)	(1)	(1)	(1)			3,377	53,998
Colorado	1							217	$868			217	868
Connecticut	1	183	739									183	739
Florida	2	84	368	5,345	$4,366			24	32	193	$200	510	4,966
Georgia	1							(1)	(1)			(1)	(1)
Illinois	7	(1)	(1)			(1)	(1)	719	3,812	6,659	4,656	1,865	18,960
Indiana	16	(1)	(1)	2,220,698	2,417,319	3,397,036	$8,238,750	(1)	(1)	(1)	(1)	451,445	10,745,400
Iowa	3	(1)	(1)			2,650	8,000	(1)	(1)	3,000	2,000	7,432	32,887
Kansas	15	2,518	5,492	(1)	(1)	274,854	706,238	(1)	(1)	4,374	1,996	50,913	825,665
Kentucky	1	1,000	3,000									1,000	3,000
Maryland	1									(1)	(1)	(1)	(1)
Michigan	5	2,414	17,248			(1)	(1)	(1)	(1)	(1)	(1)	5,322	45,925
Minnesota	5			58,437	91,000	151,853	568,150	5,576	22,204	16,250	11,500	23,699	692,854
Missouri	12	38,314	158,785					3,239	16,589	20,435	18,285	43,290	193,659
New York	2	(1)	(1)					(1)	(1)	(1)	(1)	5,369	6,748
Ohio	3	12,251	26,545					4,306	9,831			16,557	36,376
Oklahoma	2	(1)	(1)									(1)	(1)
Pennsylvania	4	46,219	126,650					(1)	(1)	(1)	(1)	46,366	127,034
Puerto Rico	4	8,876	12,275					4,808	9,591			13,684	21,866
Tennessee	2	526	526					2,700	5,400			3,226	5,926
Texas	7	(1)	(1)	(1)	(1)	127,910	454,869	(1)	(1)			45,051	606,094
West Virginia	1	(1)	(1)									(1)	(1)
Wisconsin	19	2,180	9,685	100,155	199,093	256,928	672,784	13,995	39,747	71,664	65,447	50,474	986,756
Undistributed		23,720	37,881	353,747	263,070	148,462	660,861	75,508	148,452	22,843	15,635	16,666	650,218
Total	119	138,396	400,304	2,738,382	2,974,848	4,359,693	11,309,652	111,092	256,526	145,418	119,719	786,757	15,061,049
Average unit value			$2.89		$1.09		$2.59		$2.31		$0.82		$19.14
Short tons (approximate)		(2)		202,237		323,185				11,847			

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] 1,681,909 cubic feet (approximate).

LIMESTONE

The principal use of limestone in blocks or slabs is for building purposes, such as interiors and exteriors of public buildings and commercial structures. Sales of dimension limestone declined 2 percent in quantity and 18 percent in value in 1952 compared with 1951. Rubble and rough construction stone were the only classes to show gains in 1952. Sales of cut stone decreased 15 percent.

The Bedford-Bloomington area, Indiana, continued to produce most of the dimension limestone in the United States. The total output of the region in 1952 was 79 percent of the national total of cut stone, slabs, and mill blocks in quantity and 75 percent in value. Tables 14 to 16 show production in the Bedford-Bloomington, Ind., and Carthage, Mo., areas over a series of years.

TABLE 14.—Limestone sold by producers in the Indiana oolitic limestone district, 1943–47 (average) and 1948–52, by classes

Year	Construction					
	Rough block		Sawed and semifinished		Cut	
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value
1943–47 (average)	1,119,240	$659,757	764,618	$754,205	302,232	$923,903
1948	2,328,180	1,914,559	1,974,730	2,312,829	682,480	3,205,984
1949	1,896,780	1,742,517	2,215,940	2,805,866	803,140	3,377,699
1950	2,192,140	2,309,303	3,213,160	4,669,493	1,191,200	5,682,062
1951	2,517,714	2,591,339	3,159,924	4,990,385	976,600	5,901,568
1952	2,220,698	2,417,319	2,736,654	4,322,803	660,382	3,915,947

Year	Construction—Continued			Other uses		Total	
	Total						
	Cubic feet	Short tons (approximate)	Value	Short tons	Value	Short tons (approximate)	Value
1943–47 (average)	2,186,090	158,504	$2,337,865	71,992	$114,154	230,496	$2,452,019
1948	4,985,390	361,440	7,433,372	165,400	328,656	526,840	7,762,028
1949	4,915,860	356,400	7,926,082	48,320	149,753	404,720	8,075,835
1950	6,596,500	478,250	12,660,858	276,620	441,797	754,870	13,102,655
1951	6,654,238	482,432	13,483,292	156,084	281,102	638,516	13,764,394
1952	5,617,734	407,286	10,656,069	176,688	327,255	583,974	10,983,324

TABLE 15.—Purchased Indiana limestone sold by mills in the Indiana oolitic limestone district, 1943–47 (average) and 1948–52, by classes

Year	Sawed and semifinished		Cut		Total	
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value
1943–47 (average)	36,866	$35,038	464,074	$1,438,801	500,940	$1,473,839
1948	357,080	491,898	845,850	3,558,754	1,202,930	4,050,652
1949	117,270	166,809	1,016,050	5,365,837	1,133,320	5,532,646
1950	141,510	198,859	921,900	4,674,820	1,063,410	4,873,679
1951	127,159	179,946	742,745	4,579,979	869,904	4,759,925
1952	156,935	229,940	661,844	3,687,401	818,779	3,917,341

TABLE 16.—Limestone and marble sold by producers in the Carthage district, Jasper County, Mo., 1943–47 (average) and 1948–52, by classes

Year	Dimension stone (rough and dressed)							Other uses		Total	
	Building		Monumental		Total						
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Short tons (approximate)	Value	Short tons	Value	Short tons (approximate)	Value
1943–47 (average)	32,754	$229,926	10,666	$44,627	43,420	3,654	$274,553	261,404	$494,612	265,058	$769,165
1948	64,510	532,905	5,380	29,636	69,890	5,940	562,541	230,540	396,006	236,480	958,547
1949	84,810	934,036	4,530	26,772	89,340	7,590	960,808	238,250	420,833	245,840	1,381,641
1950	75,630	805,532	2,430	17,185	78,060	6,640	822,717	252,960	467,926	259,600	1,290,643
1951	135,715	872,264	1,850	12,509	137,565	11,693	884,773	257,609	440,496	269,302	1,325,269
1952	107,430	772,513	2,658	17,681	11[illegible],088	9,358	790,194	226,274	448,249	235,632	1,238,443

SANDSTONE

Sales of sandstone in 1952 increased 21 percent in quantity and 5 percent in value over 1951. The average unit value declined 14 percent. Gains were reported for every use except dressed and sawed building stone. Rubble sales were nearly five times as great as in 1951.

Ohio continued to produce the largest quantity, contributing 43 percent of the total. Other States, in order of production, were Pennsylvania, Tennessee, Arkansas, California, Colorado, and New York.

Sales of bluestone in 1943–52 are indicated in table 18. Bluestone is a type of sandstone that splits easily into thin, uniform slabs. It is well adapted for flagging but is also used for building stone and curbing.

TABLE 17.—Sandstone (dimension stone) sold or used by producers in the United States in 1952, by States and uses

State	Active plants	Building										Curbing		Flagging		Total	
		Rough construction		Rough architectural		Dressed				Rubble							
						Sawed		Cut									
		Short tons	Value	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value	Short tons	Value	Cubic feet	Value	Cubic feet	Value	Short tons (approximate)	Value
Alabama	1			3,500	$5,500					100	$500			2,500	$3,000	568	$9,000
Arizona	1													5,000	4,000	388	4,000
Arkansas	3	(1)	(1)	(1)	(1)					(1)	(1)					28,271	115,017
California	4	2,062	$16,350			231	$576			18,030	93,884					20,110	110,810
Colorado	5	305	3,967	138,178	143,637					2,407	11,791			45,001	31,556	17,000	190,951
Indiana	1					25,641	60,000									2,000	60,000
Kansas	1									150	188					150	188
Kentucky	2	(1)	(1)	(1)	(1)									1,446	1,800	(1)	(1)
Massachusetts	1			(1)	(1)			(1)	(1)							(1)	(1)
Michigan	1	116	312							670	3,350			1,525	1,464	908	5,126
Missouri	1	(1)	(1)													(1)	(1)
Nevada	2			13,167	21,350	6,410	12,500							6,410	12,500	2,027	46,350
New Jersey	1			8,688	8,340											695	8,340
New Mexico	1					410	960			13	80			1,667	2,730	175	3,770
New York (bluestone)	9	195	1,600	13,769	22,051	15,904	104,722	6,600	$90,081	(1)	(1)	(1)	(1)	137,095	196.467	15,448	423,039
Ohio	9			199,374	377,702	1,616,945	3,582,022	47,971	406,347			74,542	$199,594	131,107	287,567	150,071	4,853,232
Oklahoma	3	(1)	(1)	(1)	(1)											950	10,900
Pennsylvania [2]	18	37,744	232,281	(1)	(1)					(1)	(1)	(1)	(1)	89,867	156,915	50,130	411,810
Tennessee	8			479,089	663,748					5,853	11,706			45,475	171,230	46,769	846,684
Texas	2			7,359	11,480									4,487	4,600	924	16,080
Virginia	1									2,700	18,900			11,250	18,000	3,600	36,900
Washington	3			62,207	203,469			8,147	73,420					250	140	5,648	277,029
Wisconsin	5	250	255	(1)	(1)			(1)	(1)							2,729	62,869
Undistributed		2,562	10,672	99,494	116,856			36,482	122,214	27,199	52,088	3,792	3,018			3,669	87,385
Total	83	43,234	265,437	1,024,825	1,574,133	1,665,541	3,760,780	99,200	692,062	57,122	192,487	78,334	202,612	483,080	891,969	352,230	7,579,480
Average unit value			$6.14		$1.54		$2.26		$6.98		$3.37		$2.59		$1.85		$21.52
Short tons (approximate)		(3)		79,122		121,123		7,607				5,708		38,314			

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Includes 135,377 cubic feet of bluestone (approximately 11,439 tons) valued at $160,931 sold for rough building and flagging.
[3] 546,929 cubic feet (approximate).

TABLE 18.—Bluestone (dimension stone) sold or used in the United States, 1943–47 (average) and 1948–52 [1]

Year	Cubic feet	Value	Year	Cubic feet	Value
1943–47 (average)	182, 746	$178, 185	1950	390, 460	$604, 137
1948	325, 940	462, 716	1951	253, 935	464, 200
1949	395, 500	533, 727	1952	318, 198	583, 970

[1] New York and Pennsylvania were the only producing States.

MISCELLANEOUS STONE

Types of stone other than those included in the major groups discussed are covered in table 19. The principal types in this classification are mica schist, argillite, light-color volcanic rocks (such as rhyolite), soapstone, and greenstone. The total quantity sold declined 18 percent in quantity but increased 9 percent in value compared with 1951.

TABLE 19.—Miscellaneous varieties of stone (dimension stone) sold or used by producers in the United States in 1952, by States and uses

State	Active plants	Building				Flagging		Total	
		Rough and dressed		Rubble					
		Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Arkansas	1			(1)	(1)			(1)	(1)
California	7	4, 067	$36, 872	8, 309	$7, 465	640	$11, 000	13, 016	$55, 337
Colorado	1			1, 200	480			1, 200	480
Georgia	2	480	2, 400			(1)	(1)	(1)	(1)
Maryland	6	11, 002	72, 843	(1)	(1)	(1)	(1)	12, 155	85, 160
New Mexico	1			75	240			75	240
New York	2	(1)	(1)					(1)	(1)
Ohio	1	(1)	(1)					(1)	(1)
Pennsylvania	7	33, 076	154, 830			3, 515	27, 284	36, 591	182, 114
Puerto Rico	1	306	612	13, 500	27, 000			13, 806	27, 612
Virginia	4	(1)	(1)			1, 257	29, 300	(1)	(1)
Washington	1	190	456					190	456
Wisconsin	1	(1)	(1)					(1)	(1)
Undistributed		9, 583	2, 138, 506	1, 885	27, 255	2, 373	28, 898	14, 425	2, 214, 042
Total	35	[2] 58, 704	2, 406, 519	24, 969	62, 440	[3] 7, 785	96, 482	91, 458	2, 565, 441
Average unit value			$40. 99		$2. 50		$12. 39		$28. 05

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Approximately 698,767 cubic feet.
[3] Approximately 92,373 cubic feet.

CONSUMPTION AND USES

Figure 1 presents a 37-year history of the sales of dimension stone, by kinds. This figure illustrates strikingly how wars and depressions adversely influence the sales of dimension stone.

Figure 2 traces, for a 38-year period, the history of building-stone sales as a whole and of the chief variety, limestone, in their relation to nonresidential building, the class of construction using stone most extensively. During recent years building-stone sales have not paced construction. This may be due partly to extensive building construction of types that normally use stone sparingly, and partly to the wider use of alternate materials, such as aluminum, stainless steel, glass block, and ceramic products.

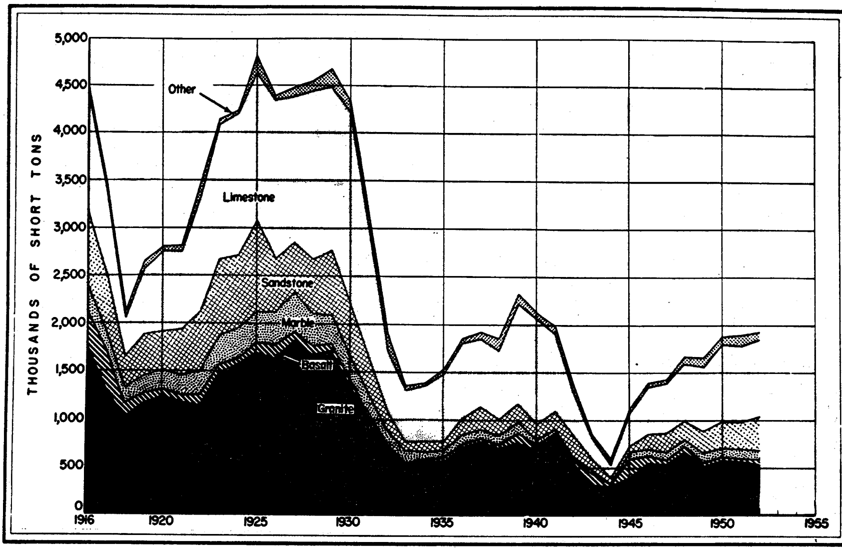

FIGURE 1.—Sales of dimension stone in the United States, by kinds, 1916–52.

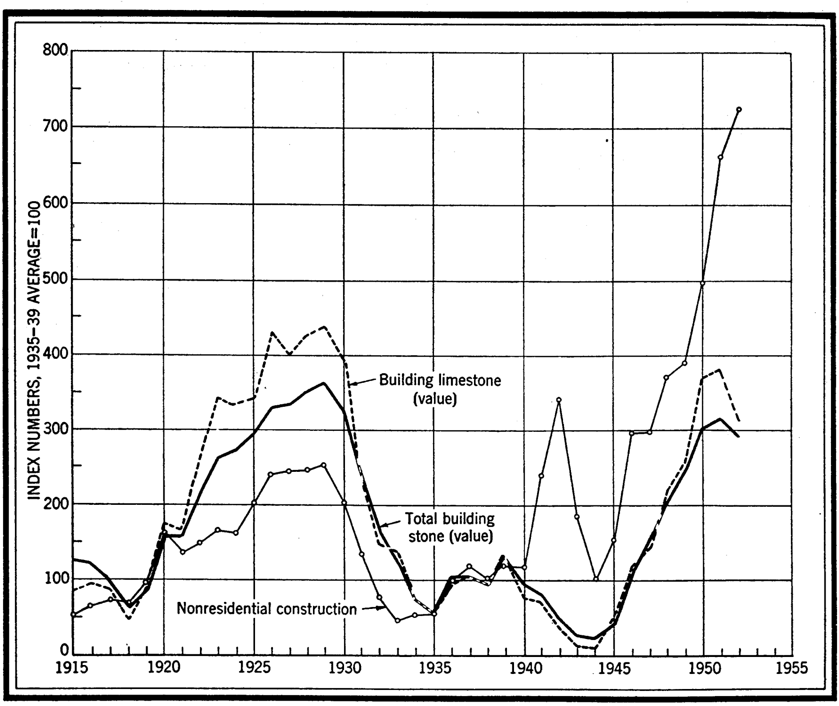

FIGURE 2.—Sales of all building stone and building limestone compared with nonresidential construction (public and private), 1915–52. Data on nonresidential-building construction from Survey of Current Business, U. S. Department of Commerce.

TECHNOLOGY

Although the destructive activities of termites on woodwork are widely known, stonework is generally regarded as immune from the attack of insects. However, it is recorded that the mason bee is causing considerable damage to sandstone churches in England by boring into the stone to depths of 3 or 4 inches. The necessity for extensive restoration has resulted.[4]

Oolitic limestone on the island of Portland, England, was first worked in 1619. The durability and strength of the better grades are due to intergrowth of the grains. Waste-rock overburden ranges from 20 to 44 feet. Quarry methods are governed by the joints or natural partings, which form a more or less rectangular grid. Some of the joints are open, forming "gullies" that may be 12 inches to as much as 6 feet wide. Blocks of stone are broken loose by wedging in the joints. Further subdivision is accomplished by cutting V-shape pits 4 to 6 inches deep and driving wedges in them. Except for the use of steel wedges, the process is almost as primitive as that used by the Egyptians in fashioning stone for the pyramids. A description of quarry methods has recently been published.[5]

The stonecutter's and stonemason's art with respect to Portland stone is described in some detail in a second article.[6] Stone fabrication, unlike quarrying, has attained a high level of mechanical efficiency. Diamond saws and carborundum wheels have greatly increased speed in cutting blocks of stone to conform to detailed specifications.

A new substitute for natural stone is a concrete block with a facing consisting of a glazed tilelike material, either white or colored, which is made as an integral part of the block.[7]

The quarrying and milling of building stone have made remarkable progress in France since World War II. Hand methods of quarrying have been replaced by machines, such as circular saws and chain saws equipped with tungsten carbide-tipped teeth. The improved equipment is said to have increased quarry output sevenfold. A wire saw used in one quarry consists of an endless cable on which tungsten carbide teeth are attached at intervals. Similar saws are used for block subdivision, and mill output is increased greatly by making 2, 4, or 6 cuts simultaneously. Costs have been reduced so greatly that stone can compete favorably with other building materials in large housing projects.[8]

The Siskol electric cutter is said to give effective service in underground workings from which building stone is produced in France. The machine is mounted on a vertical column fixed firmly between floor and roof. The percussion cutting head is swung to and fro across the face, cutting in an arc. At the end of each foot of advance, a longer cutting rod is inserted. The machine makes a cut 3½ inches wide at a rate of about 40 square feet an hour in limestone.[9]

---

[4] Stone Trades Journal (London), Mason Bee Attacking Churches: Vol. 71, No. 7, September 1952, p. 87.

[5] Hounsell, B., Portland and Its Stone: Mine and Quarry Eng. (London), vol. 18, No. 4, April 1952, pp. 107–114.

[6] Hounsell, B., The Fabrication of Portland Stone: Mine and Quarry Eng. (London), vol. 18, No. 5, May 1952, pp. 143–147.

[7] Pit and Quarry, Stone-Faced Blocks: Vol. 45, No. 2, August 1952, p. 168.

[8] Marini, A., and Demarre, G., Modernization of Methods Used for Quarrying and Dressing Building Stones: Quarry Managers' Jour. (London), vol. 35, No. 6, December 1951, pp. 327–335; No. 7, January 1952, pp. 381–387;
Stone Trades Journal (London), vol. 71, No. 1, January 1952, pp. 8–9; No. 2, February 1952, pp. 14–16; No. 3, March 1952, pp. 23–26.

[9] Stone Trades Journal London), Efficient Stone Cutting Lowers Cost: Vol. 72, No. 1, January 1953, pp. 6–7.

WORLD REVIEW

From a review of British technical journals pertaining to the stone industries, it appears that, both in Great Britain and continental Europe, remarkable progress is being made in developing new stone sawing and cutting devices that are greatly reducing the cost of quarrying and fabrication. In consequence, stone is being used more widely in housing projects and other low-cost types of construction.

The Italian marble industry has not yet recovered from the depressed conditions of the World War II period, although the trend is upward. About half of the output of marble and other dimension stone is used within the country, and the remainder is exported. The domestic demand is being sustained at a moderate level by a Government-supported home-building program. Export trade has been hampered by limited demand in continental Europe and by import restrictions imposed by some foreign countries, for instance, Pakistan and India have prohibited stone imports.[10]

"Wonderstone" has been worked in a small way for centuries in the Union of South Africa. It is so named because of its remarkable adaptability to a great variety of uses. It is a fine-grained, bluish-gray rock, which approaches pyrophyllite in chemical composition. It is well adapted for carving and is highly resistant to weathering and abrasion. Because of its chemical resistance, it is used for laboratory tabletops and sinks in the same way that soapstone is employed. Production has been small for many years but recently has attained much greater importance. Production in 1950 was only 199 short tons; in 1951 it was 343 tons; and, during the first quarter of 1952, it reached 1,423 tons. Some is shipped to the United States.[11]

Rich deposits of alabaster are said to occur in central Anatolia, Turkey. A license has been granted by the Turkish Government to permit export to Germany. Production of 1,720 metric tons of alabaster was reported in South Korea in 1952. No output was recorded for 1951.[12]

CRUSHED AND BROKEN STONE

An alltime record production of nearly 300 million tons of crushed and broken stone, in addition to that used for making cement and lime, was reported for 1952. This output represents an increase of 5 percent in quantity and 8 percent in value over 1951. The average sales price per ton increased 4 cents to $1.37. Most of the major uses declined slightly to moderately, but these losses were more than compensated by the 10-percent increase in the largest item, concrete and road metal.

Table 20 shows the quantity and value of sales, by uses, during 1951 and 1952. Detailed data on asphaltic stone and slate granules and flour are given in the Asphalt and Slate chapters of this volume.

Tables 21 and 22 show the tonnage and value of stone used for concrete and road metal and for railroad ballast for a series of years and by States for 1952.

[10] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 1, January 1952, p. 31.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 4, October 1952, p. 48.
[12] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, p. 27.

TABLE 20.—Crushed and broken stone sold or used by producers in the United States,[1] 1951–52, by principal uses

Use	1951			1952		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Concrete and road metal	[2] 168, 766, 088	[2] $216, 418, 613	$1. 28	186, 205, 565	$245, 567, 866	$1. 32
Railroad ballast	21, 368, 552	20, 336, 868	. 95	21, 383, 068	20, 019, 095	. 94
Metallurgical	39, 929, 957	45, 622, 125	1. 14	34, 908, 815	41, 119, 351	1. 18
Alkali works	7, 708, 686	7, 207, 496	. 93	6, 557, 940	6, 448, 388	. 98
Riprap	6, 989, 284	8, 437, 614	1. 21	8, 778, 585	11, 156, 047	1. 27
Agricultural	19, 400, 610	31, 051, 933	1. 60	20, 683, 548	33, 803, 245	1. 63
Refractory (ganister, mica schist, dolomite, soapstone)	2, 365, 804	7, 810, 013	3. 30	1, 950, 786	7, 262, 048	3. 72
Asphalt filler	1, 047, 223	3, 159, 714	3. 02	1, 002, 849	2, 934, 211	2. 93
Calcium carbide works	888, 628	903, 816	1. 02	722, 729	762, 257	1. 05
Sugar factories	563, 064	1, 369, 475	2. 43	541, 419	1, 404, 391	2. 59
Glass factories	793, 896	1, 906, 751	2. 40	814, 302	1, 933, 165	2. 37
Paper mills	445, 861	943, 300	2. 12	359, 904	820, 769	2. 28
Other uses	13, 421, 489	31, 491, 633	2. 35	14, 881, 830	35, 125, 952	2. 36
Total	[2] 283, 689, 142	[2] 376, 659, 351	1. 33	298, 791, 340	408, 356, 785	1. 37
Portland and natural cement and cement rock [3]	64, 284, 000	(4)	----------	64, 305, 000	(4)	----------
Lime [5]	16, 511, 000	(4)	----------	16, 146, 000	(4)	----------
Grand total	[2] 364, 484, 000	(4)	----------	379, 242, 000	(4)	----------
Asphaltic stone	1, 378, 434	4, 159, 259	3. 02	1, 570, 698	4, 687, 512	2. 98
Slate granules and flour	[2] 648, 210	[2] 6, 526, 617	[2] 10. 07	593, 390	6, 119, 847	10. 31

[1] Includes Alaska, Hawaii, and Puerto Rico.
[2] Revised figure.
[3] Value reported as cement in chapter on Cement.
[4] No value available for stone used in manufacture of cement and lime.
[5] Value reported as lime in chapter on Lime.

TABLE 21.—Crushed stone for concrete and road metal and railroad ballast sold or used by producers in the United States,[1] 1943–47 (average) and 1948–52

Year	Concrete and road metal		Railroad ballast		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	81, 750, 510	$87, 719, 312	18, 008, 888	$13, 098, 218	99, 759, 398	$100, 817, 530
1948	121, 542, 170	149, 879, 694	18, 180, 990	16, 315, 834	139, 723, 160	166, 195, 528
1949	124, 367, 210	158, 357, 911	17, 054, 180	15, 376, 880	141, 421, 390	173, 734, 791
1950	147, 107, 670	192, 293, 884	18, 614, 040	17, 519, 533	165, 721, 710	209, 813, 417
1951	[2] 168, 766, 088	[2] 216, 418, 613	21, 368, 552	20, 336, 868	[2] 190, 134, 640	[2] 236, 755, 481
1952	186, 205, 565	245, 567, 866	21, 383, 068	20, 019, 095	207, 588, 633	265, 586, 961

[1] Includes Alaska, Hawaii, and Puerto Rico.
[2] Revised figure.

TABLE 22.—Crushed stone for concrete and road metal and railroad ballast sold or used by producers in the United States in 1952, by States

State	Concrete and road metal		Railroad ballast		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	531,508	$1,302,532			531,508	$1,302,532
Arizona	209,870	316,423			209,870	316,423
Arkansas	[1] 100,787	[1] 145,787	(2)	(2)	[1] 100,787	[1] 145,787
California	[1] 8,734,220	[1] 9,240,865	526,654	$404,843	[1] 9,260,874	[1] 9,645,708
Colorado	[1] 134,796	[1] 404,968			[1] 134,796	[1] 404,968
Connecticut	2,495,680	3,270,346	187,163	205,877	2,682,843	3,476,223
Delaware	84,911	229,259			84,911	229,259
Florida	6,092,378	7,178,484	34,864	39,475	6,127,242	7,217,959
Georgia	5,772,657	9,122,951	394,013	470,850	6,166,670	9,593,801
Idaho	718,062	958,373	487,982	410,513	1,206,044	1,368,886
Illinois	15,702,331	18,929,697	1,172,642	1,214,646	16,874,973	20,144,343
Indiana	5,682,691	6,910,201	483,047	571,383	6,165,738	7,481,584
Iowa	7,919,998	9,882,960	3,500	5,250	7,923,498	9,888,210
Kansas	6,044,265	8,085,491	[1] 189,268	[1] 270,141	[1] 6,233,533	[1] 8,355,632
Kentucky	7,131,284	8,911,758	535,346	465,526	7,666,630	9,377,284
Maine	[1] 288,202	[1] 637,703			[1] 288,202	[1] 637,703
Maryland	[1] 2,326,765	[1] 3,483,129	[1] 21,778	[1] 31,142	3,122,531	4,852,953
Massachusetts	2,809,773	4,183,733	180,380	188,687	2,990,153	4,372,420
Michigan	3,261,767	3,506,656	169,929	209,512	3,431,696	3,716,168
Minnesota	[1] 1,257,360	[1] 1,614,311	502,610	557,413	[1] 1,759,970	[1] 2,171,724
Missouri	9,043,489	11,707,473	1,469,262	448,838	10,512,751	12,156,311
Montana	9,472	11,437	466,750	496,257	476,222	507,694
Nebraska	438,969	695,559			438,969	695,559
Nevada	[1] 18,813	[1] 19,390	(2)	(2)	[1] 18,813	[1] 19,390
New Hampshire	63,253	132,698			63,253	132,698
New Jersey	5,377,917	10,013,093	246,600	459,230	5,624,517	10,472,323
New Mexico	156,007	88,794	220,485	163,608	376,492	252,402
New York	[1] 11,504,819	[1] 17,912,104	[1] 1,025,970	[1] 1,221,318	[1] 12,530,789	[1] 19,133,422
North Carolina	9,422,720	12,861,606	[1] 10,365	[1] 11,401	[1] 9,433,085	[1] 12,873,007
Ohio	[1] 10,981,421	[1] 12,946,509	1,660,624	1,823,223	[1] 12,642,045	[1] 14,769,732
Oklahoma	6,055,114	6,203,843	[1] 2,799,247	[1] 1,284,277	[1] 8,854,361	[1] 7,488,120
Oregon	[1] 5,552,840	[1] 8,084,027	[1] 237,926	[1] 245,318	[1] 5,790,766	[1] 8,329,345
Pennsylvania	12,261,332	17,660,729	993,301	1,500,238	13,254,633	19,160,967
Rhode Island	128,490	268,720			128,490	268,720
South Carolina	2,191,104	3,120,645	400,219	485,754	2,591,323	3,606,399
South Dakota	1,349,768	1,908,652	[1] 6,500	[1] 10,000	[1] 1,356,268	[1] 1,918,652
Tennessee	8,432,737	10,288,311	554,488	525,500	8,987,225	10,813,811
Texas	3,947,117	4,578,739	[1] 953,194	[1] 855,855	[1] 4,900,311	[1] 5,434,594
Utah	[1] 12,500	[1] 12,500	(2)	(2)	[1] 12,500	[1] 12,500
Vermont	[1] 98,643	[1] 135,451	(2)	(2)	[1] 98,643	[1] 135,451
Virginia	[1] 6,067,157	[1] 8,560,924	[1] 867,588	[1] 1,002,433	[1] 6,934,745	[1] 9,563,357
Washington	3,527,163	3,638,379	509,006	518,385	4,036,169	4,156,764
West Virginia	[1] 1,027,709	[1] 1,655,694	509,276	517,482	[1] 1,536,985	[1] 2,173,176
Wisconsin	[1] 5,852,655	[1] 6,421,761	212,991	262,402	[1] 6,065,646	[1] 6,684,163
Wyoming	[1] 10,551	[1] 10,388	[1] 634,259	[1] 608,570	[1] 644,810	[1] 618,958
Undistributed	3,840,409	4,192,146	2,708,968	2,524,110	5,775,389	5,377,574
Total	184,671,474	241,445,199	21,376,195	20,009,457	206,047,669	261,454,656
Alaska, Hawaii, Puerto Rico	1,534,091	4,122,667	6,873	9,638	1,540,964	4,132,305
Grand total	186,205,565	245,567,866	21,383,068	20,019,095	207,588,633	265,586,961

[1] To avoid disclosing confidential information, total is somewhat incomplete, the portion not included being combined as "Undistributed."
[2] Included with "Undistributed."

COMMERCIAL AND NONCOMMERCIAL OPERATIONS

Commercial production includes stone that is sold primarily in the open market. Noncommercial operations represent tonnages reported by States, counties, municipalities, and other Government agencies as being produced by themselves or by contractors for their own consumption. Table 23 shows the production of crushed stone for concrete and road metal during recent years by both types of operations. Noncommercial output during 1952 declined 6 percent from the 1951 level, whereas commercial production was 12 percent higher. Nine percent of the total output in 1952 was noncommercial, and 91 percent commercial, the same proportions as the 1943–47 average.

TABLE 23.—Crushed stone for concrete and road metal sold or used by commercial and noncommercial operators in the United States,[1] 1943–47 (average) and 1948–52

[Figures for "noncommercial operations" represent tonnages reported by States, counties, municipalities, and other Government agencies, produced either by themselves or by contractors expressly for their consumption, often with publicly owned equipment; they do not include purchases from commercial producers. Figures for "commercial operations" represent tonnages reported by all other producers.]

Year	Commercial operations				Noncommercial operations				Total	
	Short tons	Average value per ton	Percent of change in quantity from preceding year	Percent of total quantity	Short tons	Average value per ton	Percent of change in quantity from preceding year	Percent of total quantity	Short tons	Percent of change in quantity from preceding year
1943–47 (average)	74,025,580	$1.07		91	7,724,930	$1.10		9	81,750,510	
1948	108,029,360	1.23	+14	89	13,512,810	1.25	+14	11	121,542,170	+14
1949	111,094,390	1.27	+3	89	13,272,820	1.27	−2	11	124,367,210	+2
1950	130,977,250	1.32	+18	89	16,130,420	1.20	+22	11	147,107,670	+18
1951	[2]149,995,593	1.30	+15	89	18,770,495	1.15	+16	11	[2]168,766,088	+15
1952	168,534,995	1.32	+12	91	17,670,570	1.27	−6	9	186,205,565	+10

[1] Includes Alaska, Hawaii, and Puerto Rico.
[2] Revised figure.

GRANULES

The output of granules for roofing purposes has been canvassed since 1942. Table 24 shows total production and value during recent years. Separate figures for slate granules are given in the chapter of this volume on Slate.

TABLE 24.—Roofing granules [1] sold or used in the United States, 1943–47 (average) and 1948–52, by kinds

Year	Natural		Artificially colored		Brick		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	376,580	$2,933,159	764,208	$11,336,487	57,186	$906,979	1,197,974	$15,176,625
1948	448,150	3,828,307	1,002,430	16,563,351	35,110	586,173	1,485,690	20,977,831
1949	352,846	3,088,402	977,934	16,489,253	23,425	400,919	1,354,205	19,978,574
1950	489,794	4,312,531	1,294,275	22,276,565	13,660	263,752	1,797,729	26,852,848
1951	[2] 422,973	[2] 3,714,634	[3]1,184,544	[3] 20,809,752	(3)	(3)	[2] 1,607,517	[2] 24,524,386
1952	368,454	3,350,290	[3]1,250,741	[3] 22,772,567	(3)	(3)	1,619,195	26,122,857

[1] Manufactured from stone, slate, slag, and brick.
[2] Revised figure.
[3] A small quantity of brick included with artificially colored granules.

SIZE OF PLANTS

The number of active crushed-stone plants in the United States increased 5 percent in 1952 compared with 1951, and average annual plant production advanced 2 percent to about 171,000 tons. Plants producing less than 25,000 tons a year numbered 422 but supplied only 1½ percent of the total output. On the other hand, the 45 plants that produced over 900,000 tons each contributed 27 percent of the total. Table 25 shows the size pattern of stone-industry units during 1951 and 1952.

TABLE 25.—Number and production of commercial crushed-stone[1] plants in the United States in 1951–52, by size of output

Size of output	1951 Number of plants	1951 Total production of plants (short tons)	1951 Percent of total	1951 Cumulative total (short tons)	1952 Number of plants	1952 Total production of plants (short tons)	1952 Percent of total	1952 Cumulative total (short tons)
Less than 1,000 tons	48	18,249	0.01	18,249	39	18,220	0.01	18,220
1,000 to 25,000	368	4,204,412	[2] 1.64	4,222,661	383	4,091,743	1.48	4,109,963
25,000 to 50,000	224	8,098,050	[2] 3.15	12,320,711	227	8,209,243	2.98	12,319,206
50,000 to 75,000	182	11,115,485	[2] 4.32	23,436,196	183	11,294,205	4.09	23,613,411
75,000 to 100,000	125	10,722,285	[2] 4.17	34,158,481	133	11,382,893	4.13	34,996,304
100,000 to 200,000	243	34,302,878	[2] 13.33	68,461,359	280	38,978,620	14.12	73,974,924
200,000 to 300,000	128	31,112,151	[2] 12.09	99,573,510	130	31,708,725	11.49	105,683,649
300,000 to 400,000	73	25,388,587	[2] 9.87	124,962,097	75	26,141,876	9.47	131,825,525
400,000 to 500,000	44	19,632,484	[2] 7.63	144,594,581	47	20,955,656	7.59	152,781,181
500,000 to 600,000	19	10,311,283	[2] 4.01	154,905,864	32	17,366,000	6.29	170,147,181
600,000 to 700,000	14	9,051,448	[2] 3.52	163,957,312	19	11,983,764	4.34	182,130,945
700,000 to 800,000	[2] 14	[2] 10,686,843	[2] 4.15	[2] 174,644,155	16	11,944,498	4.33	194,075,443
800,000 to 900,000	8	7,009,068	[2] 2.72	[2] 181,653,223	8	6,738,334	2.44	200,813,777
900,000 tons and over	43	75,622,832	[2] 29.39	[2] 257,276,055	45	75,166,312	27.24	275,980,089
Total	[2] 1,533	[2] 257,276,055	100.00	[2] 257,276,055	1,617	275,980,089	100.00	275,980,089

[1] Exclusive of marble, which is primarily a dimension-stone industry. Includes Hawaii and Puerto Rico
[2] Revised figure.

METHODS OF TRANSPORTATION

The only significant change in transportation methods used by the crushed-stone industries in 1952 was a slight increase in truck haulage of stone from commercial operations and a decline in transportation by rail. Waterways provide relatively minor but locally important transportation facilities.

TABLE 26.—Crushed stone sold or used in the United States [1] in 1952, by methods of transportation

Method of transportation	Commercial operations: Short tons	Commercial operations: Percent of total	Commercial and noncommercial [2] operations: Short tons	Commercial and noncommercial [2] operations: Percent of total
Truck	140,079,971	51	162,742,225	54
Rail	89,079,668	32	89,079,668	30
Waterway	25,476,939	9	25,476,939	9
Unspecified	21,492,508	8	21,492,508	7
Total	276,129,086	100	298,791,340	100

[1] Includes Alaska, Hawaii, and Puerto Rico.
[2] Entire output of noncommercial operations assumed to be moved by truck.

GRANITE

Sales of crushed and broken granite increased 10 percent in quantity and 11 percent in value in 1952 compared with 1951. Railroad ballast, riprap, and uses designated as "other" declined, but these losses were more than compensated by a large gain in sales for concrete and road metal. The average unit price advanced 1 cent per ton. North Carolina was the largest producer, followed by Georgia, South Carolina, Virginia, and California, in that order.

TABLE 27.—Granite (crushed and broken stone) sold or used by producers in the United States in 1952, by States and uses

State	Riprap		Crushed stone				Other uses[1]		Total	
			Concrete and road metal		Railroad ballast					
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
California	105,028	$73,626	(2)	(2)	(2)	(2)	453,185	$319,090	1,895,562	$1,605,562
Colorado	(2)	(2)	661	$2,381					(2)	(2)
Connecticut	(2)	(2)							(2)	(2)
Delaware			84,911	229,259			10,000	22,500	94,911	251,759
Georgia	35,383	53,403	5,231,685	8,285,436	365,313	$442,150	114,520	99,150	5,746,901	8,880,139
Idaho			23,400	22,500					23,400	22,500
Maine	(2)	(2)	(2)	(2)			1,115	2,001	6,444	11,647
Maryland	14,400	50,400	50,700	109,860					65,100	160,260
Massachusetts			541,083	959,172			14,737	57,873	555,820	1,017,045
Minnesota	(2)	(2)	114,560	151,178	500,610	553,913	(2)	(2)	815,676	747,285
Missouri	7,425	10,131							7,425	10,131
Montana	3,862	5,793	2,500	2,000					6,362	7,793
New Hampshire	2,500	1,750	1,542	2,373			180	126	4,222	4,249
New Jersey			178,972	268,458	280	420			179,252	268,878
North Carolina	(2)	(2)	6,035,726	8,459,142	(2)	(2)	(2)	(2)	6,213,434	8,949,769
North Dakota	67,064	4,968							67,064	4,968
Oklahoma	500	500							500	500
Oregon			73,143	73,143			(2)	(2)	(2)	(2)
Pennsylvania			100,487	137,289			3,051	1,526	103,538	138,815
Puerto Rico			24,500	24,500					24,500	24,500
Rhode Island	(2)	(2)	(2)	(2)			(2)	(2)	60,956	121,369
South Carolina	2,000	3,500	2,024,669	2,882,741	400,219	485,754	221,396	84,689	2,648,284	3,456,684
Tennessee			10,000	12,000					10,000	12,000
Texas	(2)	(2)							(2)	(2)
Vermont			(2)	(2)					(2)	(2)
Virginia	45,413	95,744	1,519,185	2,345,393	277,672	337,817	63,064	63,939	1,905,334	2,842,893
Washington			(2)	(2)			(2)	(2)	77,489	186,467
Wisconsin			178,750	151,250					178,750	151,250
Wyoming	79,454	87,883			634,259	608,570	43,917	32,881	757,630	729,334
Undistributed	268,852	406,659	1,378,266	1,359,566	150,292	176,585	309,574	521,984	321,451	477,169
Total	631,881	794,357	17,574,740	25,477,641	2,328,645	2,605,209	1,234,739	1,205,759	21,770,005	30,082,966
Average unit value		$1.26		$1.45		$1.12		$0.98		$1.38

[1] Includes stone used for fill material, poultry grit, road base, stone sand, and unspecified uses.
[2] Included with "Undistributed" to avoid disclosure of individual company operations.

BASALT AND RELATED ROCKS (TRAPROCK)

Commercial traprock normally includes basalt, gabbro, diorite, and other dark, igneous rocks. It is widely used for concrete aggregate, road metal, and railroad ballast, and to a lesser extent for riprap and such "other uses" as fill material, roofing granules, etc. Sales of crushed and broken traprock in 1952 were 1 percent greater in quantity and 8 percent higher in value than in 1951. Sales of material assigned to "other uses" increased greatly, while railroad ballast and riprap declined slightly in quantity but increased in value. Sales of crushed traprock for concrete aggregate and highway construction were approximately the same in quantity as in 1951 but increased 6 percent in value. The average value of traprock increased 10 cents per ton over 1951. New Jersey and Oregon were the chief producers, and Washington was next in order.

TABLE 28.—Basalt and related rocks (traprock) (crushed and broken stone) sold or used by producers in the United States in 1952, by States and uses

State	Riprap		Crushed stone				Other uses [1]		Total	
			Concrete and road metal		Railroad ballast					
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alaska			(2)	(2)					(2)	(2)
Arizona			4,050	$9,000					4,050	$9,000
California	241,178	$445,854	1,737,983	2,040,338	3,345	$4,420	12,430	$24,860	1,994,936	2,515,472
Connecticut	23,631	29,537	2,495,348	3,269,351	187,163	205,877			2,706,142	3,504,765
Hawaii	3,969	3,764	591,402	1,407,518	275	393			595,646	1,411,675
Idaho	42,000	45,000	545,563	797,973			434,000	1,090,000	1,021,563	1,932,973
Maine			168,649	369,206					168,649	369,206
Maryland	(2)	(2)	(2)	(2)	(2)	(2)			776,936	1,343,325
Massachusetts	23,075	18,093	1,963,546	2,786,016	180,380	188,687	896	2,688	2,167,897	2,995,484
Michigan			28,362	21,009					28,362	21,009
Minnesota			(2)	(2)					(2)	(2)
Montana	5,789	15,372			85,771	150,359	15,253	4,749	106,813	170,480
Nevada	3,523	880							3,523	880
New Jersey	191,381	346,661	5,171,206	9,682,868	246,320	458,810	75	187	5,608,982	10,488,526
New York			2,018,445	3,315,647	107,502	175,711			2,125,947	3,491,358
North Carolina			112,697	145,684					112,697	145,684
Oregon	61,611	73,834	4,858,234	7,114,010	178,975	170,747	12,859	16,916	5,111,679	7,375,507
Pennsylvania	(2)	(2)	1,371,728	2,199,303	604,634	940,548	(2)	(2)	2,042,283	3,690,133
Puerto Rico			(2)	(2)	(2)	(2)			(2)	(2)
Rhode Island			(2)	(2)					(2)	(2)
Texas			(2)	(2)	(2)	(2)			(2)	(2)
Virginia			697,164	1,105,059					697,164	1,105,059
Washington	155,618	172,077	2,990,618	2,933,351	509,006	518,385	87,781	24,285	3,743,023	3,648,098
Wisconsin	745	1,304	41,617	77,824	17,354	31,237	(2)	(2)	(2)	(2)
Undistributed	4,069	6,325	1,011,275	2,102,401	213,575	346,433	154,694	1,257,074	600,472	1,928,991
Total	756,589	1,158,701	25,807,887	39,376,558	2,334,300	3,191,607	717,988	2,420,759	29,616,764	46,147,625
Average unit value		$1.53		$1.53		$1.37		$3.37		$1.56

[1] Includes stone sold for fill material, roofing granules, and unspecified uses.
[2] Included with "Undistributed," to avoid disclosure of individual company operations.

MARBLE

Large quantities of waste material, consisting either of defective blocks or cuttings and spalls from marble-dressing operations, accumulate at marble quarries and mills. Some of this material is marketed as a byproduct. It is sold for a variety of uses, as indicated in a footnote to table 29. The average value varies from State to State, because in some States a large proportion of the material is marketed for the higher priced products, such as terrazzo or marble flour, whereas in others much of it is sold for concrete aggregate or other relatively low priced uses. Waste marble has virtually the same composition as limestone and is substituted for it in many applications. On this account, some of the waste marble is reported to the Bureau of Mines as limestone.

TABLE 29.—Marble (crushed and broken stone) sold by producers in the United States in 1952, by States [1]

State	Active plants	Short tons	Value	State	Active plants	Short tons	Value
Alabama	2	(2)	(2)	Texas	1	16,500	$350,000
Arkansas	1	50	$200	Utah	1	(2)	(2)
California	1	7,168	137,664	Vermont	1	4,000	3,000
Maryland	1	(2)	(2)	Virginia	1	(2)	(2)
Missouri	1	6,210	38,000	Washington	5	2,584	36,948
New Jersey	1	4,400	114,400	Undistributed		79,522	665,013
New York	1	13,182	148,486				
North Carolina	1	(2)	(2)	Total	21	148,997	1,609,135
Tennessee	3	15,381	115,424	Average unit value			$10.80

[1] Includes stone used for agriculture, asphalt filler, cast stone, composition flooring, crushed stone, magnesia, mineral food, plaster, poultry grit, roofing, stucco, terrazzo, tile, whiting (excluding marble whiting made by companies that purchase their marble), and unspecified uses.
[2] Included with "Undistributed" to avoid disclosure of individual company operations.

LIMESTONE

Limestone is widely distributed in the United States. Sales in 1952 were reported to the Bureau of Mines from 45 States and 2 Territories. Limestone has the greatest variety of uses of any rock quarried. Because of its availability and its many applications in industry, it is used more extensively than any other type of stone. In 1952 limestone (excluding that used in making cement and lime) constituted 72 percent of the total crushed and broken stone produced in the United States. Total sales were 6 percent higher than in 1951. Sales of limestone for railroad ballast, furnace flux, and miscellaneous uses declined, while gains were reported for agricultural limestone, riprap, and stone used as concrete aggregate and road metal. The average unit value increased 4 cents a ton to $1.36.

Details by States and uses are shown in table 30, and the quantities and values of limestone applied to miscellaneous uses are indicated in table 31.

A recent statistical survey, illustrated with charts, shows trends in the use of agricultural liming materials in the United States and by groups of States from 1929 to 1951.[13]

Increasing interest in agricultural limestone problems is indicated by the establishment, in 1952, of the National Agricultural Limestone Institute. It was formed by merging two earlier organizations—the

[13] Boynton, Robert S., Survey of Liming Materials Use: Rock Products, vol. 55, No. 10, October 1952, pp. 90–92.

TABLE 30.—Limestone (crushed and broken stone) sold or used by producers in the United States in 1952, by States and uses

State	Riprap		Fluxing stone		Crushed stone: Concrete and road metal		Crushed stone: Railroad ballast		Agriculture		Miscellaneous		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	36,440	$49,194	1,816,833	$2,330,467	531,508	$1,302,532			244,716	$286,358	306,532	$2,082,736	2,936,029	$6,051,287
Arizona			24,007	32,095	134,131	190,761					755	3,191	158,893	226,047
Arkansas	140,774	140,774	446,236	414,999	100,787	145,787			77,567	136,039	12,905	71,750	778,269	909,349
California	(1)	(1)	53,066	151,673	588,496	800,443	5,141	$7,917	(1)	(1)	980,783	3,017,103	1,627,992	3,979,205
Colorado			428,903	829,585	85,713	245,695					64,606	136,758	579,222	1,212,038
Connecticut			(1)	(1)	332	995			64,146	245,772	(1)	(1)	124,464	415,432
Florida					6,092,378	7,178,484	34,864	39,475	333,053	968,067	1,375,829	1,386,549	7,836,124	9,572,575
Georgia	(1)	(1)	209	657	526,221	833,835	28,700	28,700	324,294	568,023	(1)	(1)	1,218,515	3,498,420
Hawaii											105,240	121,368	105,240	121,368
Idaho			(1)	(1)	52,500	63,000					(1)	(1)	(1)	(1)
Illinois	324,124	413,333	862,992	1,193,933	15,702,331	18,929,697	1,172,642	1,214,646	3,258,578	4,208,143	1,011,819	2,338,772	22,332,486	28,298,524
Indiana	201,971	318,788	41,669	48,572	5,682,691	6,910,201	483,047	571,383	2,118,185	2,737,675	145,829	573,435	8,673,392	11,160,054
Iowa	126,363	178,941	18,740	27,711	7,919,368	9,881,910	3,500	5,250	1,760,676	2,496,307	62,695	412,670	9,891,342	13,002,789
Kansas	935,853	1,174,461			5,681,267	7,719,886	40,268	46,641	770,314	1,160,917	72,446	277,307	7,500,148	10,379,212
Kentucky	(1)	(1)			7,105,639	8,873,290	535,346	465,526	925,516	1,119,886	(1)	(1)	8,791,214	10,775,239
Louisiana											(1)	(1)	(1)	(1)
Maine	(1)	(1)							(1)	(1)	(1)	(1)	(1)	(1)
Maryland	22,070	38,600			2,276,065	3,373,269	21,778	31,142	57,903	217,429	114,357	806,630	2,492,173	4,467,070
Massachusetts	(1)	(1)	(1)	(1)	9,144	15,545			116,334	411,151	74,316	556,317	220,357	1,024,725
Michigan	55,889	89,134	10,082,920	7,614,149	3,193,750	3,433,266	169,929	209,512	722,028	921,084	3,674,922	3,379,230	17,899,438	15,646,375
Minnesota	119,051	117,592	1,500	2,625	1,142,800	1,463,133	2,000	3,500	243,988	364,821	28,769	114,447	1,538,108	2,066,118
Mississippi									90,000	103,500			90,000	103,500
Missouri	1,389,432	1,784,957	27,563	45,009	8,170,115	11,284,023	17,472	20,260	2,496,778	3,940,266	565,055	1,609,543	12,666,415	18,684,058
Montana	14,515	8,960	(1)	(1)	6,972	9,437	119	270			(1)	(1)	152,511	252,828
Nebraska	239,982	354,789			437,525	692,671			107,633	245,841	458,522	650,259	1,243,662	1,943,560
Nevada			(1)	(1)	18,813	19,390					(1)	(1)	(1)	(1)
New Jersey			6,450	14,620	27,739	61,767			119,908	403,542	154,898	947,407	308,995	1,427,336
New Mexico					2,293	1,625							2,293	1,625
New York	169,382	269,470	139,169	176,415	9,486,374	14,596,457	918,468	1,045,607	478,240	1,536,506	2,588,347	3,115,537	13,779,980	20,739,992
North Carolina					2,634,704	3,560,904	10,365	11,401	9,213	11,604			2,654,282	3,583,909
Ohio	196,067	230,799	7,357,966	7,852,092	10,981,421	12,946,509	1,660,624	1,823,223	2,369,871	3,870,535	1,822,203	3,510,959	24,388,152	30,234,117
Oklahoma	(1)	(1)	(1)	(1)	5,580,353	5,976,378	(1)	(1)	168,405	208,574	227,231	349,273	6,355,780	6,940,219
Oregon					(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Pennsylvania	187,627	321,885	8,703,922	14,186,713	9,404,087	13,168,072	197,183	274,913	1,065,358	2,733,395	1,462,423	3,225,681	21,020,600	33,910,659
Puerto Rico					596,866	1,647,265	4,328	6,059			4,636	6,586	605,830	1,659,910
Rhode Island									(1)	(1)			(1)	(1)
South Carolina					165,975	237,605			100,120	186,590			266,095	424,195
South Dakota	1,200	2,400			362,458	517,406	6,500	10,000			8,200	16,400	378,358	546,206

For footnote, see end of table.

TABLE 30.—Limestone (crushed and broken stone) sold or used by producers in the United States in 1952, by States and uses—Continued

State	Riprap		Fluxing stone		Crushed stone: Concrete and road metal		Crushed stone: Railroad ballast		Agriculture		Miscellaneous		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Tennessee	305,008	$355,354	103,434	$133,316	8,414,456	$10,263,890	554,488	$525,500	532,251	$729,036	341,086	$783,206	10,250,723	$12,790,302
Texas	115,802	143,583	307,281	325,297	3,480,954	4,109,776	953,194	855,855	89,226	71,963	351,816	521,479	5,298,273	6,027,953
Utah	(1)	(1)	504,543	595,205	(1)	(1)	(1)	(1)	----------	----------	78,515	323,649	712,325	970,162
Vermont	(1)	(1)	(1)	(1)	98,643	135,451	(1)	(1)	(1)	(1)	106,344	771,653	334,883	1,335,521
Virginia	67,743	126,896	301,030	441,501	3,765,784	4,957,557	589,916	664,616	925,392	1,552,349	1,152,855	2,453,234	6,802,720	10,196,153
Washington	(1)	(1)	(1)	(1)	(1)	(1)	----------	----------	78,000	325,051	107,323	345,384	197,900	704,817
West Virginia	----------	----------	2,968,872	3,683,777	1,027,709	1,655,694	509,276	517,482	62,345	122,026	205,645	640,280	4,773,847	6,619,259
Wisconsin	120,823	175,669	105,357	108,258	5,583,803	6,156,323	195,637	231,165	1,292,211	1,901,400	85,680	179,941	7,383,511	8,752,756
Wyoming	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	----------	----------	(1)	(1)	588,606	871,309
Undistributed	102,334	128,809	606,153	910,682	306,983	220,833	712,776	779,781	149,959	680,113	1,575,933	4,156,143	1,509,550	2,336,992
Total	4,872,450	6,424,388	34,908,815	41,119,351	127,379,148	163,580,762	8,827,561	9,389,824	21,152,208	34,463,963	19,328,515	38,884,877	216,468,697	293,863,165
Average unit value	----------	$1.32	----------	$1.18	----------	$1.28	----------	$1.06	----------	$1.63	----------	$2.01	----------	$1.36

[1] Included with "Undistributed" to avoid disclosures of individual company operations.

TABLE 31.—Limestone (crushed and broken stone) sold or used by producers in the United States [1] for miscellaneous uses, 1951–52

Use	1951		1952	
	Short tons	Value	Short tons	Value
Alkali works	7,708,686	$7,207,496	6,557,940	$6,448,388
Calcium carbide works	888,628	903,816	722,729	762,257
Coal-mine dusting	384,905	1,523,306	421,847	1,685,124
Filler (not whiting substitute):				
Asphalt	1,047,223	3,159,714	1,002,849	2,934,211
Fertilizer	630,016	1,198,395	599,856	1,165,437
Other	345,963	1,344,858	350,359	1,312,562
Filter beds	193,432	306,169	89,025	145,492
Glass factories	793,896	1,906,751	814,302	1,933,165
Limestone sand	799,980	962,244	1,697,657	2,157,633
Limestone whiting [2]	710,348	6,702,207	762,354	7,164,895
Magnesia works (dolomite) [3]	363,883	725,791	433,041	859,151
Mineral food	546,074	3,006,227	549,329	2,963,723
Mineral (rock) wool	39,412	52,675	10,811	14,119
Paper mills	445,861	943,300	359,904	820,769
Poultry grit	98,625	523,896	78,866	603,509
Refractory (dolomite)	1,112,186	1,519,831	707,741	1,047,662
Road base	1,484,602	1,309,597	1,370,970	1,244,975
Stucco, terrazzo, and artificial stone	80,244	800,266	121,192	1,085,853
Sugar factories	563,064	1,369,475	541,419	1,404,391
Other uses [4]	1,395,343	2,201,926	995,452	1,562,975
Use unspecified	806,509	1,034,891	1,140,872	1,568,586
Total	20,438,880	38,702,831	19,328,515	38,884,877

[1] Includes Hawaii and Puerto Rico.
[2] Includes stone for filler for calcimine, caulking compounds, ceramics, chewing gum, explosives, floor coverings, foundry compounds, glue, grease, insecticides, leather goods, paint, paper, phonograph records, picture-frame moldings, plastics, pottery, putty, roofing, rubber, toothpaste, wire coating, and unspecified uses. Excludes limestone whiting made by companies from purchased stone.
[3] Includes stone for refractory magnesia.
[4] Includes stone for acid neutralization, athletic-field marking, carbon dioxide, chemicals (unspecified), concrete blocks and pipes, dyes, fill material, light bulbs, motion-picture snow, oil-well drilling, patching plaster, rayons, roofing granules, spalls, and water treatment.

Agricultural Limestone Institute and the National Agricultural Limestone Association.[14]

Dolomite (calcium-magnesium carbonate) has a variety of uses, some of which differ from those for high-calcium limestone. Dead-burned dolomite is used as a refractory lining for metallurgical furnaces. Statistical data on this product (which is closely allied to lime) are given in the Lime chapter of this volume. Raw dolomite is also used as a refractory, particularly for patching furnace floors.

Sales of dolomite and its calcined products are listed by some consuming industries in table 32.

TABLE 32.—Dolomite and dolomitic lime sold or used by producers in the United States for specified purposes, 1951–52

	1951		1952	
	Short tons	Value	Short tons	Value
Dolomite for—				
Basic magnesium carbonate [1]	363,883	$725,791	433,041	$859,151
Refractory uses	1,112,186	1,519,831	707,741	1,047,662
Dolomitic lime for—				
Refractory (dead-burned dolomite)	1,966,460	26,375,313	1,928,025	26,098,455
Paper mills	46,000	584,000	40,000	488,000
Total (calculated as raw stone) [2]	5,501,000		5,077,000	

[1] Includes dolomite for refractory magnesia.
[2] 1 ton of dolomitic lime is equivalent to 2 tons of raw stone.

[14] Trauffer, Walter E., First Annual Meeting of N. A. L. I. Draws Attendance of 500: Pit and Quarry, vol. 44, No. 8, February 1952, pp. 78–85.

Table 33 shows the tonnages and values of fluxing stone sold for use in various metallurgical operations.

The statistics of limestone used in making lime and cement are given in separate chapters of the Minerals Yearbook, and therefore are not covered in the foregoing tables on limestone in this chapter. However, as a commodity review of limestone would be incomplete without inclusion of the large tonnage of limestone consumed by these industries, table 34 has been added to show the total tonnage consumed for all purposes.

TABLE 33.—Sales of fluxing limestone, 1943–47 (average) and 1948–52, by uses

Year	Blast furnaces		Open-hearth plants		Other smelters [1]		Other metallurgical [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	23, 239, 006	$18,531,329	5, 611, 730	$4,928,601	538, 796	$540, 831	214, 174	$237, 610	29, 603, 706	$24,238,371
1948	26, 339, 790	24, 721, 052	7, 873, 410	8, 695, 137	503, 490	609, 354	185, 250	224, 465	34, 901, 940	34, 250, 008
1949	23, 768, 970	24, 127, 897	5, 922, 020	6, 929, 134	728, 960	835, 962	332, 370	374, 649	30, 752, 320	32, 267, 642
1950	28, 397, 710	29, 222, 700	6, 936, 900	7, 948, 041	457, 630	587, 643	177, 580	174, 004	35, 969, 820	37, 932, 388
1951	32, 007, 284	35, 941, 217	6, 784, 102	8, 279, 021	842, 877	992, 651	295, 694	409, 236	39, 929, 957	45, 622, 125
1952	28, 158, 299	32, 857, 562	5, 629, 204	6, 879, 035	926, 063	1,142,894	195, 249	239, 860	34, 908, 815	41, 119, 351

[1] Includes flux for copper, gold,lead, zinc, and unspecified smelters.
[2] Includes flux for foundries and for cupola and electric furnaces.

TABLE 34.—Limestone sold or used for all purposes in the United States,[1] 1950–52, in short tons

Use	1950	1951	1952
Limestone (as given in this report) (approximate)	180, 919, 000	205, 480, 000	217, 255, 000
Portland and natural cement and cement rock [2]	59, 361, 000	64, 284, 000	64, 305, 000
Lime [3]	14, 980, 000	16, 511, 000	16, 146, 000
Total	255, 260, 000	286, 275, 000	297, 706, 000

[1] Includes Hawaii and Puerto Rico.
[2] Reported in terms of cement in Cement chapter of this volume.
[3] Reported in terms of lime in Lime chapter of this volume.

SANDSTONE

Sales of crushed and broken sandstone declined 2 percent in both quantity and value from the 1951 level. The average value per ton increased 1 cent to $2.10. There were declines in all categories except railroad ballast and riprap. Pennsylvania and California were the chief producers.

MISCELLANEOUS STONE

Crushed and broken stone, other than the five principal varieties already discussed, includes light-color volcanic rocks, schists, boulders from riverbeds, serpentine, chats, and flint. Sales of these varieties of stone increased 6 percent in quantity and 7 percent in value compared with 1951. The average value per ton increased 1 cent to 86 cents. California was the largest producer in 1952, followed by Oklahoma, Missouri, and Arkansas, in that order.

TABLE 35.—Sandstone (crushed and broken stone) sold or used by producers in the United States in 1952, by States and uses

State	Refractory stone (ganister)		Riprap		Crushed stone				Other uses [1]		Total	
					Concrete and road metal		Railroad ballast					
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	40,495	$360,406									40,495	$360,406
Arizona					800	$3,240					800	3,240
California	3,601	43,212	(2)	(2)	748,000	777,837	(2)	(2)	(2)	(2)	1,008,974	1,179,331
Colorado	(2)	(2)	(2)	(2)	48,422	156,892					845,292	774,012
Idaho					88,449	65,000	487,982	$410,513			576,431	475,513
Illinois	536	8,576									536	8,576
Kansas			800	$1,080	140,073	254,836	149,000	223,500	5,223	$6,267	295,096	485,683
Kentucky					25,645	38,468					25,645	38,468
Maine			1,900	3,800	114,553	264,497					116,453	268,297
Michigan					9,950	11,500					9,950	11,500
Minnesota			680	1,082							680	1,082
Missouri			100	132							100	132
Montana			(2)	(2)			380,860	345,628	(2)	(2)	424,395	361,796
New Mexico					94,866	22,399	220,485	163,608			315,351	186,007
New York			(2)	(2)	(2)	(2)					49,185	69,535
North Carolina					2,500	6,000					2,500	6,000
Ohio	81,705	892,143	(2)	(2)					(2)	(2)	138,409	1,073,760
Oklahoma			400	400							400	400
Pennsylvania	676,885	3,195,579	922	461	790,276	1,397,825	191,484	284,777	2,394	2,394	1,661,961	4,881,036
South Dakota	(2)	(2)	(2)	(2)	637,310	1,091,246	(2)	(2)	(2)	(2)	922,904	1,492,588
Texas					250,330	297,000			628,307	354,591	878,637	651,591
Utah	11,778	43,373			12,500	12,500					24,278	55,873
Virginia	(2)	(2)			(2)	(2)	(2)	(2)	(2)	(2)	160,126	388,746
Washington			360	3,650							360	3,650
West Virginia	(2)	(2)			(2)	(2)					95,595	206,854
Wisconsin	(2)	(2)	125	250	48,485	36,364			(2)	(2)	697,823	4,436,835
Wyoming			4,978	3,981							4,978	3,981
Undistributed	410,693	1,573,285	1,262,443	1,347,241	129,495	216,945	18,281	25,658	573,283	3,476,756		
Total	1,225,693	6,116,574	1,272,708	1,362,077	3,141,654	4,652,549	1,448,092	1,453,684	1,209,207	3,840,008	8,297,354	17,424,892
Average unit value		$4.99		$1.07		$1.48		$1.00		$3.18		$2.10

[1] Includes sandstone for fill material, filter stone, road base, roofing granules, spalls, stone sand, and unspecified uses.
[2] Included with "Undistributed" to avoid disclosure of individual company operations.

TABLE 36.—Miscellaneous varieties of stone (crushed and broken stone) sold or used by producers in the United States in 1952, by States and uses

State	Riprap		Crushed stone				Other uses[1]		Total	
			Concrete and road metal		Railroad ballast					
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alaska			(2)	(2)					(2)	(2)
Arizona			70,889	$113,422					70,889	$113,422
Arkansas	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	2,160,507	2,306,137
California	459,148	$646,607	5,659,741	5,622,247	429,997	$298,248	1,244,705	$1,108,910	7,793,591	7,676,012
Colorado			(2)	(2)					(2)	(2)
Georgia			14,751	3,680					14,751	3,680
Hawaii			5,108	12,258					5,108	12,258
Idaho			8,150	9,900					8,150	9,900
Iowa			630	1,050					630	1,050
Kansas [3]	(2)	(2)	222,925	110,769	(2)	(2)			984,564	360,992
Maine			5,000	4,000					5,000	4,000
Maryland	313	313							313	313
Massachusetts	20,000	25,000	296,000	423,000					316,000	448,000
Michigan			29,705	40,881					29,705	40,881
Missouri [3]			873,374	423,450	1,451,790	428,578	47,648	37,226	2,372,812	889,254
Nebraska			1,444	2,888					1,444	2,888
Nevada	(2)	(2)	(2)	(2)	(2)	(2)			(2)	(2)
New Hampshire			61,711	130,325					61,711	130,325
New Mexico			58,848	64,770			(2)	(2)	(2)	(2)
New York			(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
North Carolina	3,317	2,211	637,093	689,876					640,410	692,087
Ohio			(2)	(2)					(2)	(2)
Oklahoma [3]			474,761	227,465	2,799,247	1,284,277			3,274,008	1,511,742
Oregon	59,054	64,040	621,463	896,874	58,951	74,571	42,138	10,237	781,606	1,045,722
Pennsylvania			594,754	758,240			17,352	97,812	612,106	856,052
Puerto Rico			31,500	73,500					31,500	73,500
Rhode Island			(2)	(2)					(2)	(2)
South Carolina			460	299					460	299
South Dakota			350,000	300,000			4	30	350,004	300,030
Tennessee			8,281	12,421					8,281	12,421
Texas	(2)	(2)	(2)	(2)	(2)	(2)	1,038,828	568,467	1,265,484	739,670
Utah	115,748	97,073							115,748	97,073
Virginia			85,024	152,915					85,024	152,915
Washington	29,894	35,504	465,700	582,363					495,594	617,867
Wisconsin	(2)	(2)	(2)	(2)					106,389	77,484
Wyoming	104,802	73,878	10,551	10,388					115,353	84,266
Undistributed	452,681	471,898	1,714,273	1,813,375	1,704,485	1,293,097	107,285	130,669	782,381	968,762
Total	1,244,957	1,416,524	12,302,136	12,480,356	6,444,470	3,378,771	2,497,960	1,953,351	22,489,523	19,229,002
Average unit value		$1.14		$1.01		$0.52		$0.78		$0.86

[1] Includes stone used for agriculture, fill material, refractory, road base, roofing granules, spalls, and unspecified uses.
[2] Included with "Undistributed" to avoid disclosure of individual company operations.
[3] Chats; figures collected by Amarillo, Tex., office of the Bureau of Mines. Also includes small quantity of stone.

CONSUMPTION AND USES

As crushed stone is used principally as an aggregate in concrete, its sales tend to parallel cement shipments. This relationship is indicated in figure 3. The consumption of both crushed stone and cement is governed to a marked degree by the volume of new construction. As indicated in the figure, sales of both these commodities have increased more rapidly than new construction during 1951 and 1952. The area of concrete pavements has made substantial gains since 1945, but its advances have not kept pace with those of crushed stone.

As indicated in figure 4, sales of both fluxing limestone and refractory stone declined in consonance with the moderate recession in metallurgical activity.

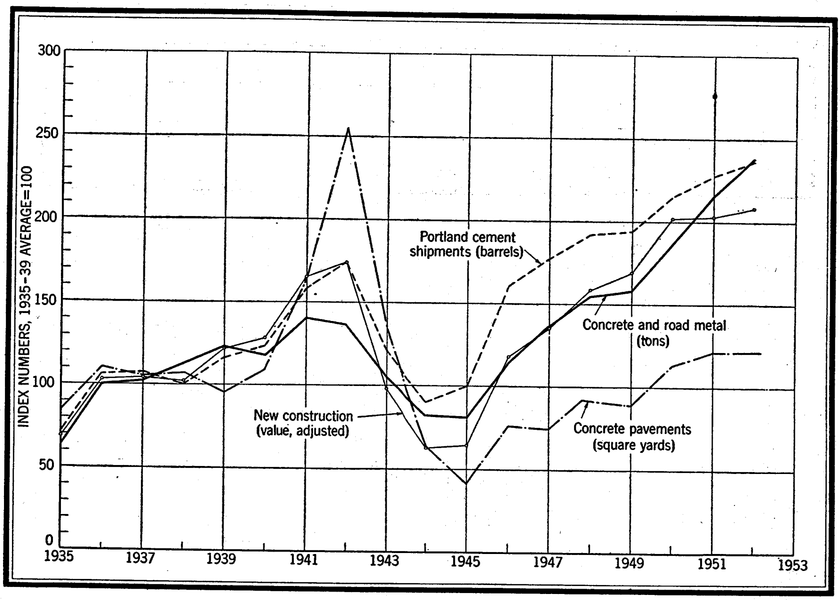

FIGURE 3.—Crushed-stone aggregates (concrete and road metal) sold or used in the United States compared with shipments of portland cement, total new construction (value), and concrete pavements (contract awards, square yards), 1935–52. Data on construction and concrete pavements from Survey of Current Business, U. S. Department of Commerce. Construction value adjusted to 1947–49 prices.

TECHNOLOGY

A comprehensive series of articles on the theory and practice of rock crushing, begun in June 1950 and suspended with publication of part VII in June 1951, was resumed in July 1952 and continued throughout the year. The recent articles relate to the action, capacity, reduction ratio, power requirements, and other features of crusher rolls and hammer mills. They discuss the performance of crushing units, and the principles underlying the proper selection of equipment for efficient practice.[15]

[15] McGrew, Brownell, Crushing Practice and Theory; pt. VIII, Crushing Rolls and Their Uses: Rock Products, vol. 55, No. 7, July 1952, pp. 65–68, 102; pt. IX, Special Types of Roll Crushers: No. 8, August 1952, pp. 164–165, 168, 188; pt. X, Characteristics and Performance of Hammer Mills: No. 9, September 1952, pp. 67–69; pt. XI, Crusher Product Curves and Tables: No. 10, October 1952, pp. 107–109, 156; pt. XII, Selecting the Primary Crusher: No. 11, November 1952, pp. 79–81; pt. XIII, Selection of Quarry Equipment for Efficient Crushing Practice: No. 12, December 1952, pp. 91–93.

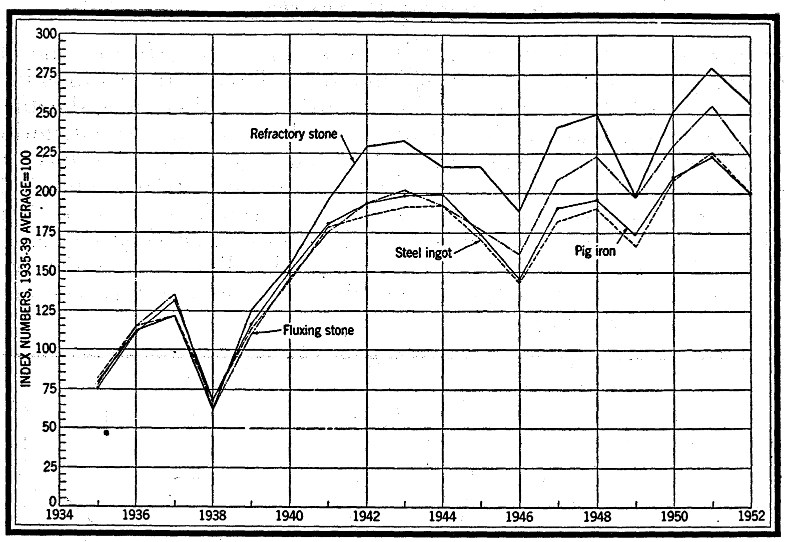

FIGURE 4.—Sales (tons) of fluxing stone and refractory stone (including that used in making dead-burned dolomite) compared with production of steel ingot and pig iron, 1935–52. Statistics of steel-ingot production compiled by American Iron and Steel Institute.

Methods have been worked out for calculating the power requirement for crushing rock to specified sizes. The power needed for grinding can also be determined mathematically, but both power requirements and costs vary with grinding processes. For instance, dry grinding requires one-third more power than wet grinding, but the metal wear per ton of finished product in dry grinding is only one-fifth of that which results when the wet process is used.[16]

Methods of determining the shapes of aggregate particles, and the effect on concrete of flaky, elongated, and angular particles have been described.[17]

The seismograph is now finding wider use. With introduction to the quarry industry about 1945 of the split-second delay detonation, now known as millisecond timing, many new problems arose in blasting efficiency, and it is claimed that the seismograph is a useful tool in working out the details of these problems.[18]

Substitution of rotary for churn drills in sinking blastholes up to 7⅝ inches in diameter is now finding favor. Drilling speeds up to 50 feet per hour in ordinary limestone and 30 to 35 feet per hour in hard, cherty limestone have been attained. The bits are operated dry; the cuttings are blown out with compressed air forced through the drill stem at a velocity of 3,000 feet per minute. Drilling rates are three or more times as fast as those attained with churn drills, and costs compare favorably with those involved in churn-drill operation. Rotary drills are not, at this stage, adapted to all kinds of rock.[19]

[16] Bond, Fred C., Crushing and Grinding Calculations: Pit and Quarry, vol. 45, No. 5, November 1952, pp. 118–119, 124.

[17] Mercer, L. Boyd, Aggregate Particle Determination: Pit and Quarry, vol. 44, No. 11, June 1952, pp. 111–112.

[18] Jenkins, Jules E., Economic Contributions of the Seismograph to the Quarry Industry: Rock Products, vol. 55, No. 1, January 1952, pp. 148–151, 182.

[19] Mining World, Rotary Blast-Hole Drilling Now Feasible in Igneous Rock: Vol. 14, No. 10, September 1952, pp. 42–43.

A notable example of a modern trend in quarrying is discontinuance of an overhead cableway serving a deep quarry and establishment of primary crushing and storage at the quarry floor. Belt conveyors elevate the crusher product to a sizing plant at the surface. Such a transformation has recently been accomplished at a large granite quarry near Columbia, S. C.[20]

A modern plant design for quarrying and sizing quartzite aggregate recently has been described.[21]

A portable crushing, screening, and washing plant capable of producing 200 tons per hour has been designed and built in accordance with specifications of the Corps of Engineers. A demonstration run was conducted at Minneapolis, Minn., in 1952. Most of the units were mounted on pneumatic tires for quick relocation. It was claimed that the entire plant could be dismantled and loaded on 11 flatcars in about 5 hours.[22]

The economy in time and cost of using diesel-electric locomotives instead of steam-powered locomotives in mines and quarries has been described.[23]

Since 1944 the Federal Bureau of Mines has been conducting experimental work at the Government-operated oil-shale mine at Rifle, Colo., to develop low-cost underground mining methods. Recently compiled cost data for 1950 show that, on the basis of a daily output of 19,700 tons, the direct cost of mining, conveying, and crushing was 29 cents a ton. The total cost to surge pile was 42.6 cents per ton, which included management, depreciation, taxes, and insurance, but did not include depletion, interest on investment, profit, or expenditures for offsite facilities. A detailed discussion of methods and equipment has been published.[24]

The finer agricultural limestone is ground the more rapidly it becomes available for soil neutralization or for supplying calcium and magnesium as plant food. However, it is claimed by some authorities that a minus-100-mesh material may not give best results, that a slower delivery from larger particles will preserve a certain degree of acidity in the soil which is essential to assimilation by the plant of phosphorus, iron, and manganese, which are insoluble in alkaline salts. Accordingly, a 10-mesh mill-run limestone is recommended. The entire question of "agstone" specifications is worthy of careful study.[25]

Limestone fines recovered by wet processes are generally regarded as undesirable for agricultural use because of the difficult drying problem. At one plant in Missouri, limestone tailings from a lead-zinc ore-treating mill are conveyed to a disposal area by pipeline. Here the material is allowed to drain and air-dry before loading by clamshell into gondola cars. This method of recovering agricultural limestone is regarded as satisfactory.[26]

---

20 Avery, William M., Weston and Brooker Expands: Pit and Quarry, vol. 44, No. 12, June 1952, pp. 96-108.

21 Rock Products, Producing Aggregates for Atomic Energy Construction Project: Vol. 55, No. 7, July 1952, pp. 74-75.

22 Connolly, J. M., Big Portable Rock-Crushing Plant Produces Over 200 Tons per Hour: Eng. News Record, vol. 149, No. 13, Nov. 6, 1952, pp. 136-140.

23 Jacobs, G. W., Diesel-Electric Locomotives for Quarry Operations: Rock Products, vol. 55, No. 9, September 1952, pp. 92-94.

24 Lenhart, Walter B., Low-Cost Underground Mining Methods Developed for Blasting and Handling Large Tonnages: Rock Products, vol. 55, No. 3, March 1952, pp. 80-87, 107.

25 Nordberg, Bror, What Is Best Fineness for Agricultural Limestone?: Rock Products, vol. 55, No. 4, April 1952, p. 79. Agronomists' Views on Specifications: Rock Products, vol. 55, No. 4, April 1952, pp. 120-122, 152.

26 Lenhart, Walter B., Producing Agstone by Wet Processes: Rock Products, vol. 55, No. 6, June 1952, pp. 98-100, 156-157.

The principles underlying successful froth flotation as a means of removing impurities from mineral products have been covered in two recent articles.[27]

The depth, burden, spacing, and diameter of quarry blastholes, and the size of the explosive charge to be used have been described in detail. Formulas have been worked out to determine their interrelationship from the standpoint of low cost and effective blasting.[28]

A timing device for millisecond-delay blasting has been described in detail, with many illustrations, by its inventor.[29]

One blasting authority claims that, contrary to early practice, the lateral spacing of blastholes should be greater than the burden (distance from the face). A modern drilling pattern for 6-inch holes is 17 to 20 feet burden and 20 to 23 feet spacing. This pattern is especially desirable when short-interval delay firing is followed. The latter method has decided advantages, but if the delay interval is too long the danger of missed and cutoff holes is increased. Devices for promoting greater accuracy in the delay interval are being sought. It is important that the drill-hole pattern, and the size and nature of the charge be adjusted to give adequate fragmentation.[30]

An innovation in Great Britain, of considerable interest to crushed-stone producers, is replacement of standard well drills by machines that use articulated steel rods equipped with 1⅝-inch drill bits. It is recorded that in one quarry in Scotland a hole 86 feet deep was drilled with this equipment in less than 3½ hours. Such blastholes, when spaced more closely than those made with churn drills, gave excellent fragmentation. Better fragmentation, less "scatter," and reduced vibration resulted when millisecond-delay-action detonators were used.[31]

WORLD REVIEW

The stone quarries of Great Britain have been operating almost at capacity. Labor shortage has been acute at times because the quarry industries have to compete with other trades where work is less strenuous. The shortage has been offset to some extent by a rapid development of mechanization.

Extensive building activity, involving wide use of stone products, has been noted in Stockholm, Sweden; Milan, Italy; and in Germany. The disposal of rubble resulting from bombing in Germany created so difficult a problem at some cities that facilities were created for converting the rubble into aggregate to be used in rebuilding. The city of Frankfurt am Main has established an elaborate crushing and screening plant for such a purpose.[32]

Large deposits of dolomite have been discovered in Jamaica as a result of recent surveys. A Canadian refractory company is planning development work.[33] A subsidiary of a British refractory company

---

27 Gisler, H. J., Factors Affecting Flotation, part I: Pit and Quarry, vol. 44, No. 9, March 1952, pp. 121–125, 131; part II, No. 10, April 1952, pp. 109–112.

28 Westwater, R., The Blasting of Stone in Quarries: Quarry Managers' Jour. (London), vol. 36, No. 6, December 1952, pp. 346–359.

29 Walker, F. J., The Millisecond-Delay Timer: Quarry Managers' Jour. (London), vol. 35, No. 7, January 1952, pp. 373–380.

30 Whitney, F. R., The Modern Trend in Quarry Blasting: Quarry Managers' Jour. (London), vol. 35, No. 7, January 1952, pp. 393–401.

31 Stone Trades Journal (London), Problems of Stone Trade Outlined in H. M. Inspector's Report: Vol. 71, No. 7, July 1952, pp. 65–68.

32 Anderegg, F. O., Developments in Rock Products and Concrete Industries in Europe: Rock Products, vol. 55, No. 5, May 1952, pp. 70–72.

33 Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 4, October 1952, p. 29.

has been organized to manufacture dolomite refractories at Dundas, Ontario, Canada. A proposed $2 million plant may be in operation in 1954.[34]

The growing need for cement in India has led to a survey for available limestone suitable for cement manufacture. Limestones of satisfactory quality do not appear to be abundant, hence beneficiation processes, such as froth flotation, may become necessary.

FOREIGN TRADE [35]

Importations of stone into the United States in 1952 declined 3 percent in value compared with 1951. Increases were recorded for marble slabs and tile, dressed granite, and whiting, but imports of most of the other types declined.

A new export classification appeared in 1952, namely "crushed, ground, or broken" stone. Inclusion of this classification with the items formerly reported brings total export value of stone in 1952 to a figure approaching $3,400,000.

TABLE 37.—Stone and whiting imported for consumption in the United States, 1951–52, by classes

[U. S. Department of Commerce]

Class	1951		1952	
	Quantity	Value	Quantity	Value
Marble, breccia, and onyx:				
Sawed or dressed, over 2 inches thick...cubic feet..	1,960	$13,729	1,330	$7,041
In blocks, rough, etc...do....	175,106	805,453	157,873	827,903
Slabs or paving tiles...superficial feet..	647,780	436,702	673,890	472,290
All other manufactures	-----------	419,844	-----------	553,311
Total	-----------	1,675,728	-----------	1,860,545
Granite:				
Dressed...cubic feet..	[1] 33,630	[1] 237,093	40,424	387,176
Rough...do....	85,665	306,861	44,562	156,139
Paving blocks, wholly or partly manufactured number..	[1] 439	[1] 4,184	611	13,991
Total	-----------	[1] 548,138	-----------	557,306
Quartzite...short tons..	275,778	786,523	184,467	627,616
Travertine stone...cubic feet..	63,466	106,110	40,921	134,190
Stone (other):				
Dressed	-----------	293,262	-----------	74,537
Rough (monumental or building stone)..cubic feet..	4,385	22,942	3,284	7,261
Rough (other)...short tons..	67,273	193,969	66,191	197,734
Marble chip or granito...do....	16,517	158,020	13,607	137,675
Crushed or ground, n. s. p. f.	-----------	2,263	-----------	9,982
Total	-----------	670,456	-----------	427,189
Whiting:				
Chalk or whiting, precipitated...short tons..	1,029	48,708	1,374	58,762
Whiting, dry, ground, or bolted...do....	9,407	121,512	12,286	182,860
Whiting, ground in oil (putty)...do....	3	587	24	6,591
Total	-----------	170,807	-----------	248,213
Grand total	-----------	[1] 3,957,762	-----------	3,855,059

[1] Revised figure.

[34] Rock Products, Canadian Dolomite Plant: Vol. 56, No. 1, January 1953, p. 180.
[35] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 38.—Stone exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Marble and other building and monumental stone		Crushed, ground or broken				Other manufactures of stone (value)
			Stone		Limestone		
	Cubic feet	Value	Short tons	Value	Short tons	Value	
1948	345,697	$584,050	(1)	(1)	(1)	(1)	$430,862
1949	211,334	523,171	(1)	(1)	(1)	(1)	436,705
1950	142,955	378,645	(1)	(1)	(1)	(1)	338,207
1951	230,239	585,499	(1)	(1)	(1)	(1)	271,461
1952	277,551	648,833	126,123	$1,631,358	803,029	$789,733	314,502

[1] Not separately classified before January 1, 1952.

Strontium

By Joseph C. Arundale [1] and Flora B. Mentch [2]

PRODUCTION of strontium minerals in the United States for several years has been sporadic and small. However, the United States is the world's largest producer of strontium compounds; but the raw material, largely in the form of celestite, is imported from United Kingdom and Mexico.

DOMESTIC PRODUCTION

Domestic occurrences of strontium minerals are known in California, Washington, Texas, Arizona, Arkansas, Tennessee, Ohio, Michigan, and other States. Small tonnages have been produced from these deposits, but recent production has been confined to California and Washington, largely for local use. Considerable crude ore has been mined in the past from several deposits, principally in Texas, for use as an oil-well drilling mud admixture, but when the royalty on the use of barite for this purpose ceased upon expiration of the patent, this practice was largely discontinued. During World War II some of the Texas celestite was concentrated for chemical use. However, when high-grade foreign celestite was again available, consumers reverted to imported supplies. Virtually all United States requirements for strontium minerals now are supplied from foreign sources.

CONSUMPTION AND USES

The bulk of the strontium minerals consumed is converted to various strontium compounds. These compounds are made by E. I. du Pont de Nemours & Co., Wilmington, Del.; Foote Mineral Co., Philadelphia, Pa.; and Barium Products, Ltd., Modesto, Calif. Small quantities of strontium hydride are made by Metal Hydrides, Inc., Beverly, Mass.

A very small quantity of strontium metal was produced by King Laboratories, Inc., Syracuse, N. Y., and by Cooper Metallurgical Associates, Cleveland, Ohio.

Strontium compounds impart a characteristic brilliant red to a flame and this property is utilized in several pyrotechnical applications. Tracer bullets fired from machine-guns contain a charge of strontium nitrate and peroxide, which is ignited by the propellant and burns brightly during flight. The flame permits the gunner to judge the accuracy of his aim. Marine distress-signal equipment consists of a pistol and red parachute flares or rockets. Similar red flares may be dropped from aircraft. The military also uses various types of red flares for tactical signaling. The familiar red color of some fireworks and pyrotechnical exhibitions is produced by strontium

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.

compounds. Railroads for many years have used red flares and fusees as emergency signals. Many State laws require that trucks carry similar fusees to warn of danger when for any reason they must stop on a highway.

These compounds also are used in ceramics, medicine, and other minor applications. Strontium metal and some of its alloys are used principally as "getters" for extracting the last traces of gases from electronic tubes.

PRICES

According to Oil, Paint and Drug Reporter, the price of strontium sulfate (celestite), air floated, 90-percent grade, 325-mesh, bags, works, was quoted at $56.70–$66.15 per short ton. Strontium carbonate, 92-percent grade, drums, early in 1952 was quoted at 20½-24½ cents per pound, increased to 25–30 cents in June, and dropped to 23 cents per pound in September. Strontium chloride, technical, barrels, in January was quoted at 22–24 cents per pound and by the end of the year at 24–26 cents per pound. Strontium nitrate, barrels, carlots, works, was 10¼ cents per pound at the beginning of the year and 10¼–11 cents per pound at the end of the year.

FOREIGN TRADE [3]

For several years imports of strontium minerals have come largely from United Kingdom and Mexico. A large tonnage was received as a result of a preclusive buying agreement with Spain. However, the last of these shipments was made in 1949.

TECHNOLOGY

A patent was issued on the use of strontium chromate as a corrosion inhibitor in refrigeration systems that utilize an aqueous ammonia solution as the refrigerant.[4]

TABLE 1.—Strontium minerals [1] imported for consumption in the United States, 1950–52, by countries, in short tons

[U. S. Department of Commerce]

Country	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Canada			38	$382	59	$607
Mexico	1,975	$23,910	2,034	23,730	1,297	16,870
United Kingdom	6,655	118,303	11,972	280,392	8,161	168,849
Total	8,630	142,213	14,044	304,504	9,517	186,326

[1] Strontianite or mineral strontium carbonate and celestite or mineral strontium sulfate.

One firm offered pilot-plant quantities of strontium hydrate. It was said that a variety of strontium greases with useful properties could be produced with strontium hydrate and various soaps. These

[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

[4] Widell, Nils Erik (assigned to Aktiebolaget Elektrolux, Stockholm, Sweden), Corrosion Inhibitor in Absorption Refrigeration System: U. S. Patent 2,580,984, Jan. 1, 1952.

properties were listed as: Resistance to change in consistency while being heated and cooled in service, resistance to water and the leaching action of hydrocarbons, protective action against moisture or salt-spray corrosion, resistance to oxidation or breakdown upon exposure to elevated temperatures, and stability of structure when subjected to mechanical working.

Strontium napthenate and a number of other soaps of this type are useful stabilizers for many vinyl plastics. Coal tar, resin, and long-chain aliphatic acids can be reacted with strontium hydrate to form such stabilizers. The strontium hydrate may also find use in the refining of special carbohydratelike materials.[5]

Several investigators have reported favorable response of plants to the application of strontium. In a study reported in 1952 a strontium chloride spray was applied to peach trees that exhibited chlorosis. The results indicate that such a spray has value. Studies have indicated that strontium takes the place of calcium when insufficient quantities of the latter element are present. However, the failure of calcium in both the spray and soil to correct chlorosis raised the question in the researchers' minds as to whether strontium in lime or gypsum applied to the soil accounts in part for the response of plants.[6]

Cement chemists have been interested in the possibility of producing compounds of strontium and silicon analogous to the calcium silicates, which are the main compounds in portland cement. Such compounds might be expected to yield valuable information on the general theory of cementing action. Tristrontium silicate reportedly was prepared by heating strontium carbonate and finely ground quartz at 1,500° C., in a platinum boat. The combination was accelerated by a steam atmosphere. After about 10 hours of heating time the preparation appeared to be homogeneous. Attempts were then made to obtain good crystals of the compounds. Mixtures of tristrontium silicate powder, strontium chloride, and strontium carbonate were heated and cooled slowly. Tristrontium silicate crystals and distrontium silicate needles were formed. These were separated after the mass had been gently broken up in alcohol. The experiments showed that strontium compounds lacked the property of hardening under water, but the possibility remains that hardening may take place in sulfate solutions.[7]

Scarcity of lead in time of emergency and the move to eliminate lead as a health hazard has focused the attention of many researchers on the development of low-lead and leadless ceramic glazes. A strontia glaze in which lithia replaced part of the alkali content produced a satisfactory leadless glaze and was used in several plants during the latter years of World War II when the use of lead was restricted. Since the war these leadless glazes, although not entirely abandoned, have been used by plants only for specific purposes. Leadless glazes have three advantages: (1) They do not flow like lead glazes and therefore produce cleaner cut lines for sharp underglaze decorations; (2) they are satisfactory in certain open-fire conditions where lead glazes

[5] Chemical Engineering, vol. 59, No. 3, March 1952, pp. 198, 200.
[6] Wolf, Benjamin, and Cesare, S. J., Response of Field-Grown Peaches to Strontium Sprays: Science, vol. 115, No. 2996, May 30, 1952, pp. 606-607.
[7] Nurse, R. W., Tristrontium Silicate—A New Compound: Jour. Appl. Chem., vol. 2, pt. 5, May 1952, pp. 244-246.

scum; and (3) those high in strontia produce desirable effects on certain colors. Their main disadvantage is inability to flow, resulting in the need for more careful application. During the year one laboratory conducted research on the replacement of strontia for lead in cone 06 lead glaze. The results of this research showed that strontia can be used as a lead replacement in this glaze. It will produce a more viscous glaze but will have a beneficial effect on certain ceramic colors. The effect of strontia on a series of standard glaze stains was summarized by Marquis.[8]

Installation of a new device for automatically controlling the uniformity of the rubber coating on cord or fabric used in making tires, V-belts, and other products was announced. An electronic control system utilizes beta rays from a small capsule of strontium 90, an atomic byproduct. The electronic control system automatically adjusts the machinery that applies the rubber coating.[9] The manufacturing firm stated that the system can be adapted to metal coating and metal rolling operations.

WORLD REVIEW

Although United Kingdom and Mexico in the order named are the world's principal producers of strontium minerals, production has also been reported in recent years from Tunisia (strontianite and celestite), Pakistan (celestite), Italy (strontianite and celestite), Germany, and Canada.

[8] Marquis, John, Recent Glaze and Color Developments: Am. Ceram. Soc. Bull., May 1952, pp. 161–164.
[9] Steel, vol. 131, No. 6, Aug. 11, 1952, p. 87.

Sulfur and Pyrites

By G. W. Josephson [1] and Flora B. Mentch [2]

DURING 1952 the sulfur industry emerged from the stringent supply situation that had developed in 1950. Production of sulfur by the Frasch process increased slightly, and progress was made in the direction of developing additional Frasch mines. The prospective development of major Frasch sulfur production in Mexico was particularly noteworthy.

TABLE 1.—Salient statistics of the sulfur industry in the United States, 1943–47 (average) and 1948–52, in long tons

	1943–47 (average)	1948	1949	1950	1951	1952
Native sulfur:						
Production (from Frasch mines)	3, 562, 198	4, 869, 210	4, 745, 014	5, 192, 184	5, 278, 249	5, 293, 145
Apparent sales	3, 910, 888	5, 015, 230	4, 870, 723	5, 636, 959	5, 095, 347	5, 061, 722
Imports	3, 354	38	32	25	[1] 2, 376	4, 863
Exports:						
Crude	943, 580	1, 262, 913	1, 430, 916	1, 440, 996	1, 287, 773	1, 304, 154
Treated	35, 564	32, 630	30, 135	37, 526	24, 044	34, 213
Apparent consumption	2, 935, 098	3, 719, 725	3, 409, 704	4, 158, 462	[1] 3, 785, 906	3, 728, 218
Producers' stocks at end of year	3, 941, 328	3, 225, 014	3, 099, 305	2, 654, 530	2, 837, 432	3, 068, 855
Pyrites:						
Production	813, 507	928, 531	888, 388	931, 163	1, 017, 769	994, 342
Imports	186, 605	107, 411	120, 937	208, 766	221, 487	296, 047
Recovery as byproduct:						
Production of byproduct sulfuric acid (basis, 100 percent) at Cu, Zn, and Pb plants	739, 089	572, 719	511, 854	661, 529	736, 672	774, 177
Production of recovered elemental sulfur (basis 100 percent S)	25, 560	44, 369	56, 781	142, 475	184, 013	251, 198
Other byproduct sulfur compounds (basis, 100 percent S)	19, 572	25, 792	37, 935	41, 963	59, 613	66, 512

[1] Revised figure.

Output from byproduct-sulfur projects, principally involving the purification of natural and refinery gas, continued to increase. Although these projects were relatively small in size, they were numerous and promised to contribute hundreds of thousands of tons annually in the future.

Demand for sulfur both in the United States and the world at large did not come up to expectations, and therefore production and demand were reasonably balanced. Consequently, the first steps in the relaxation of governmental controls over this commodity were taken before the end of the year.

DOMESTIC PRODUCTION

NATIVE SULFUR

The development of new sulfur-production capacity was assisted by the Government through the Defense Minerals Exploration Administration, the Defense Materials Procurement Agency, the Petroleum Administration for Defense, the National Production Authority, the Defense Production Administration, and other agencies. On January 10, 1952, the Defense Production Administration announced

[1] Chief, Construction and Chemical Materials Branch.
[2] Statistical assistant.

that the expansion goal for sulfur in all forms was 8,400,000 long tons by 1955. At the end of the year, this goal was being reconsidered with a view to downward revision. Exploration programs were supported by the Defense Minerals Exploration Administration through loans covering 50 percent of the cost. The accelerated tax amortization provided by the defense legislation encouraged numerous sulfur-expansion projects, and funds for development loans were available.

Native sulfur production reached a new record in 1952, when output exceeded that of the previous year by less than 0.5 percent. As shown in the accompanying tables, virtually all of the United States production of native sulfur is by the Frasch process, by which sulfur is melted underground with hot water and pumped from wells. A very small tonnage is produced by other methods from surface or shallow deposits.

TABLE 2.—Production of sulfur and sulfur-containing raw materials by producers in the United States, 1951–52, in long tons

	1951		1952	
	Gross weight	Sulfur content	Gross weight	Sulfur content
Native sulfur or sulfur ore:				
From Frasch-process mines	5, 278, 249	5, 278, 249	5, 293, 145	5, 293, 145
From other mines	3, 945	1, 365	8, 536	2, 197
Total native sulfur	5, 282, 194	5, 279, 614	5, 301, 681	5, 295, 342
Recovered elemental sulfur:				
Brimstone	182, 495	181, 935	250, 428	249, 388
Paste	4, 614	2, 078	3, 859	1, 810
Total recovered elemental sulfur	187, 109	184, 013	254, 287	251, 198
Pyrites (including coal brasses)	1, 017, 769	432, 819	994, 342	418, 100
Byproduct sulfuric acid (basis, 100 percent) produced at Cu, Zn, and Pb plants	736, 672	240, 800	774, 177	253, 000
Other byproduct sulfur compounds [1]	70, 257	59, 613	77, 307	66, 512
Total equivalent sulfur		6, 196, 859		6, 284, 152

[1] Hydrogen sulfide and liquid sulfur dioxide. In addition, a quantity of acid sludge is converted to H_2SO_4 but is excluded from the above figures.

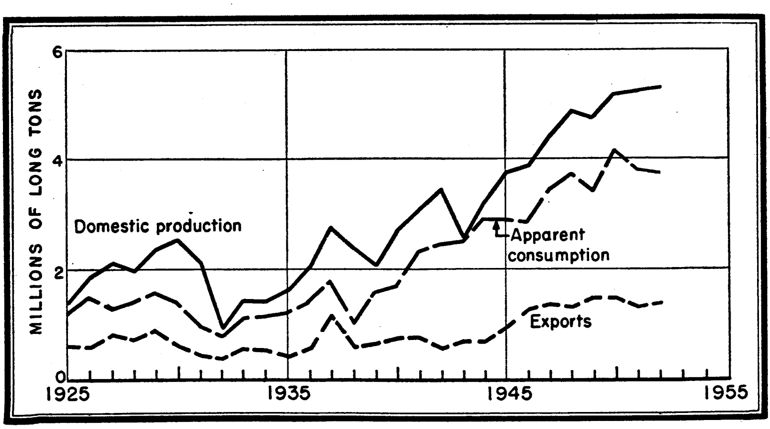

FIGURE 1.—Domestic production, apparent consumption, and exports of native sulfur, 1925–52, in long tons.

TABLE 3.—Sulfur produced and shipped from Frasch mines in the United States, 1943–47 (average) and 1948–52

Year	Produced (long tons)			Shipped	
	Texas	Louisiana	Total	Long tons	Approximate value
1943–47 (average)	2,799,457	762,741	3,562,198	3,852,507	$63,240,000
1948	3,867,545	1,001,665	4,869,210	4,978,912	89,600,000
1949	3,610,829	1,134,185	4,745,014	4,789,311	86,200,000
1950	3,949,164	1,243,020	5,192,184	5,504,714	104,000,000
1951	3,966,956	1,311,293	5,278,249	4,988,101	107,300,000
1952	3,784,595	1,508,550	5,293,145	5,141,392	110,925,000

Of the total output of native sulfur, about 71 percent was produced in Texas and 29 percent in Louisiana and small tonnages in California, Wyoming, Nevada, and Utah.

The rate of output was high between April and August (a peak of 477,939 long tons was reached in the month of July) but was lower in the last quarter.

Texas Gulf Sulphur Co. produced sulfur in Texas from the Boling dome, Wharton County, and Moss Bluff dome, Liberty County; and in May the company began mining at the Spindletop dome. Equipment for the expansion of production capacity was being installed at Moss Bluff.

The principal mines of Freeport Sulphur Co. were the Grande Ecaille in Plaquemines Parish, La., and Hoskins Mound, Brazoria County, Tex. In November production was begun by the company at the Bay Ste. Elaine dome in Louisiana. Output from this mine was expected to be relatively small, but it attracted a great deal of interest because of the unique equipment that was designed and installed for its operation. The installation is outlined in the Technology section of this chapter. Freeport Sulphur Co. also was proceeding with the development of the Garden Island Bay dome[3] and Chacahoula dome in Louisiana and Nash dome in Texas.

The mines of the Jefferson Lake Sulphur Co. were at Starks dome, Calcasieu Parish, La.; at Clemens dome, Brazoria County, Tex.; and at Long Point dome, Fort Bend County, Tex. The company explored the Black Bayou dome, Cameron Parish, La. Three of the 12 test wells drilled showed sulfur, but in quantities insufficient to justify an attempt to develop the property commercially. Exploration was discontinued.[4]

Duval Sulphur & Potash Co. produced sulfur at Orchard dome, Fort Bend County, Tex.

The sulfur shortage engendered unusual interest in the surface or shallow deposits of elemental sulfur, which cannot be mined by the Frasch process. New mining and processing facilities were installed at several localities. The Wyoming Gulf Sulphur Corp. operated a plant at Cody, Wyo., for a short period.[5]

The Continental Sulphur & Phosphate Corp. exploration program in the Sunlight Valley area, Park County, Wyo., resulted in a certified

[3] Chemical and Engineering News, Construction Continues Apace on New Sulfur Plant: Vol. 30, No. 43, Oct. 27, 1952, pp. 4486–4487.

[4] Jefferson Lake Sulphur Co., New Orleans, Report for the Nine Months Ended Sept. 30, 1952, 3 pp.

[5] Quinn, James E., and Frye, G. C., Wyoming-Gulf Sulphur Corp.: Pit and Quarry, vol. 45, No. 4, October 1952, pp. 91–95.
Mining World, Nation's Newest Sulphur Producer: Vol. 14, No. 6, May 1952, pp. 18–20.

TABLE 4.—Sulfur ore (10–70 percent S) produced and shipped for agricultural use in the United States, 1943–47 (average) and 1948–52, in long tons [1]

Year	Produced (long tons)	Shipped	
		Long tons	Value
1943–47 (average)	3,563	3,295	$41,598
1948	1,832	1,700	30,220
1949	5,678	5,392	101,991
1950	3,327	3,247	60,115
1951	3,945	3,945	75,609
1952 (estimate)	8,536	4,686	91,310

[1] California, Colorado (1948–49 only), Nevada, Texas (1948 only), Utah (1952 only), and Wyoming (except 1948).

discovery of sulfur under its contract with the Defense Minerals Exploration Administration.

Western Sulphur Industries and its predecessor companies constructed a sulfur-beneficiating plant at Sulphurdale, Utah. It operated the plant for a period in 1952.

The Black Rock Desert Mineral Co. was reported to be producing agricultural sulfur at Sulphur, Nev., about 60 miles west of Winnemucca.

The Inyo Soil Sulphur Co. produced sulfur at the Crater mine in Inyo County, Calif.

The Fraction No. 1 mine in Inyo County, Calif., was leased by Mrs. G. L. Ott, owner, to the Rimas Mining Corp., and some sulfur was shipped.

Anaconda Copper Mining Co., which acquired the Leviathan mine, Alpine County, Calif., in October 1951, did not produce any sulfur from it during 1952 but prepared the property for production. Sulfur ore from this property was to be used at the new copper operation of the company at Yerington, Nev.

Development of the Canary Hill mine at Chalk Mountain, Lake County, was undertaken by the Chemi-Cal Sales Corp.[6]

Usually the non-Frasch sulfur operations serve the soil sulfur market, but in 1952 several of them attempted to compete in other markets as well. A combination of operational difficulties, price problems, and declining demand frustrated these efforts in most instances.

RECOVERED ELEMENTAL SULFUR

In addition to the sulfur produced in the United States at Frasch mines, primary elemental sulfur also has been produced for many years from a variety of coal and petroleum gases; but the quantity was small until recently. The need for removal of sulfur from industrial gases to improve their utility as fuel or to reduce air pollution encouraged this type of sulfur production, but the greatest impetus was given by the shortage.[7] Many companies, particularly those in the petroleum industry that consume sulfur, saw an opportunity to improve their individual supply positions by installing equipment to recover sulfur from their waste gases. As a result, a large number (about 40) of such projects were initiated. In 1952 this expansion program resulted in a 35-percent increase in recovered-sulfur output.

[6] Mineral Information Service, California Department of Natural Resources, Division of Mines, New Sulfur-Mining Operation in Lake County: Vol. 5, No. 4, Apr. 1, 1952, p. 4.
[7] Chemical Engineering, Sulphur From H_2S: Vol. 59, No. 10, October 1952, pp. 210–213.

PYRITES

As pyrites is the traditional alternate for Frasch sulfur, this material naturally got much attention during the shortage. Two factors, however, discouraged large-scale expansion of pyrites production in the United States. First, the price structure of the sulfur industry would not permit profitable production and use of pyrites at most locations; and second, announcement of a number of new Frasch-sulfur developments further discouraged the industry, which is well aware of the competitive advantages of Frasch sulfur.

Expansion of pyrite utilization, therefore, did not develop on a large scale. Domestic production in 1952 actually was lower than in 1951. A large fraction of the total was captive tonnage. Producers reported that in 1952 they consumed 778,370 long tons of pyrites and sold 195,654 long tons.

In the eastern part of the United States, a number of major pyrite mines were in operation in 1952. The Tennessee Copper Co. was the largest producer, with mines at Copperhill, Polk County, Tenn. This company consumed its entire output. The General Chemical Division of Allied Chemical & Dye Corp. produced a substantial tonnage of pyrites at the Gossan mine in Virginia and used it in making sulfuric acid at its plant in Pulaski. In Lebanon County, Pa., the Bethlehem Cornwall Corp. recovered pyrites at its concentrating plant. In New York, the St. Joseph Lead Co. produced pyrites from the Balmat mine in St. Lawrence County.

New pyrite-processing facilities were put into operation in New England. The Vermont Copper Co. concentrated pyrites from the Elizabeth mine in Orange County, Vt., for sale to the Brown Paper Co. of Berlin, N. H. The Brown Co. had installed a Fluosolids pyrite-

TABLE 5.—Pyrites (ores and concentrates) produced in the United States, 1943–47 (average) and 1948–52

Year	Quantity: Gross weight (long tons)	Quantity: Sulfur content (percent)	Value	Year	Quantity: Gross weight (long tons)	Quantity: Sulfur content (percent)	Value
1943–47 (average)	813, 507	41. 7	$3, 088, 000	1950	931, 163	42. 2	$4, 059, 000
1948	928, 531	41. 8	3, 950, 000	1951	1, 017, 769	42. 5	4, 656, 000
1949	888, 388	42. 6	3, 904, 000	1952	994, 342	42. 1	4, 947, 000

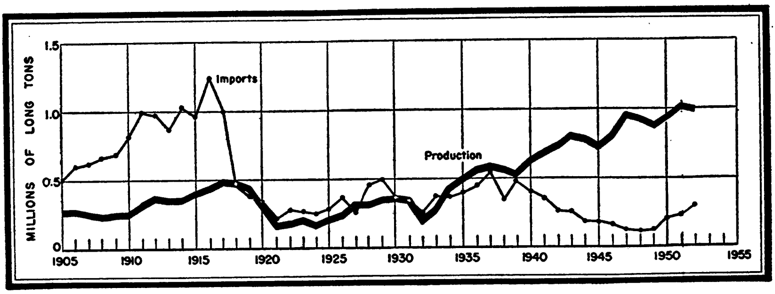

FIGURE 2.—Domestic production and imports of pyrites, 1905–52.

burning unit in its papermill in Berlin to permit the use of pyrites as a sulfur raw material. In 1952, 17,892 long tons of pyrites was sold by the Vermont Copper Co.

Allied Chemical & Dye Corp. acquired the Katahdin pyrrhotite deposit in Maine.[8]

Although large quantities of pyrites are available from midwestern coal mines, little is recovered.[9] The only tonnage reported in 1952 was from the Talleydale mine, Snow Hill Coal Corp., Vigo County, Ind.

In the West a substantial tonnage of pyrites was produced by the Mountain Copper Co., Ltd., at the Hornet mine in Shasta County, Calif. In Colorado the Rico Argentine Mining Co. recovered pyrites from the Mountain Springs mine in Dolores County near Rico and Climax Molybdenum Co. from its operations in Lake County. Byproduct pyrites was recovered by the Anaconda Copper Mining Co. at its copper-plant operations in Deer Lodge County, Mont.

In 1952 Tennessee was the largest producing State, followed by California, Virginia, and Montana, in that order.

BYPRODUCT SULFURIC ACID

As large volumes of sulfur-bearing gases are evolved at metal sulfide smelters, creating an air-pollution problem in the vicinity, many smelters have installed equipment advantageous to recover sulfur in the form of acid for sale in the available markets. It has not been possible to develop fully the acid-production potential of all smelters because markets capable of consuming the product have not been within economic shipping distance. The output of acid by smelters during the last 5 years is shown in table 6. Demand for smelter acid was high in 1952; consequently, output was 5 percent greater than in 1951.

During 1952 smelter-acid expansion programs were being conducted by American Smelting & Refining Co., American Zinc, Lead & Smelting Co., Sullivan Mining Co., and Eagle Picher Co. These expansions, when completed, would add about 170,000 tons of equivalent sulfur to the total capacity.

TABLE 6.—Byproduct sulfuric acid [1] (basis, 100 percent) produced at copper, zinc, and lead plants in the United States, 1943–47 (average) and 1948–52, in short tons

	1943–47 (average)	1948	1949	1950	1951	1952
Copper plants [2]	209,961	111,967	96,344	131,342	189,125	202,364
Zinc plants	617,819	529,478	476,932	609,571	635,948	664,714
Total	827,780	641,445	573,276	740,913	825,073	867,078

[1] Includes acid from foreign materials.
[2] Includes acid produced at a lead smelter. Excludes acid made from pyrites concentrates in Montana and Tennessee.

[8] Chemical and Engineering News, vol. 30, No. 14, Apr. 7, 1952, p. 1396.
[9] Chemical and Engineering News, Coal Can Be Utilized as Source of Sulfur: Vol. 30, No. 24, June 16, 1952, p. 2510.

OTHER BYPRODUCT SULFUR COMPOUNDS

In addition to the sulfur recovered from industrial gases in the form of elemental sulfur, a relatively small quantity was also recovered in the form of sulfur dioxide and hydrogen sulfide. The output of this material is shown in table 1.

CONSUMPTION AND USES

The demand for sulfur, which had been most insistent in 1951, tapered off in 1952, and a more normal atmosphere prevailed in the industry. Consumption, partly because of Government control measures and partly because of modification in the industrial requirements, was approximately the same in 1952 as in 1951. Owing to the complexity of the consumption pattern and difficulties of collecting accurate information, the availability of sulfur-consumption statistics varies greatly from year to year. Available statistics compiled by the National Production Authority and Chemical Engineering magazine for recent years are presented in this chapter. As over three-fourths of the sulfur consumed in the United States is used in making sulfuric acid, the output of that commodity, as reported by the Bureau of the Census is shown in table 9.

TABLE 7.—Apparent consumption of native sulfur in the United States, 1943–47 (average) and 1948–52, in long tons

	1943–47 (average)	1948	1949	1950	1951	1952
Apparent sales to consumers [1]	3, 910, 888	5, 015, 230	4, 870, 723	5, 636, 959	5, 095, 347	5, 061, 722
Imports	3, 354	38	32	25	[2] 2, 376	4, 863
Total	3, 914, 242	5, 015, 268	4, 870, 755	5, 636, 984	[2] 5, 097, 723	5, 066, 585
Exports:						
Crude	943, 580	1, 262, 913	1, 430, 916	1, 440, 996	1, 287, 773	1, 304, 154
Refined	35, 564	32, 630	30, 135	37, 526	24, 044	34, 213
Total	979, 144	1, 295, 543	1, 461, 051	1, 478, 522	1, 311, 817	1, 338, 367
Apparent consumption	2, 935, 098	3, 719, 725	3, 409, 704	4, 158, 462	[2] 3, 785, 906	3, 728, 218

[1] Production adjusted for net change in stocks during the year.
[2] Revised figure.

TABLE 8.—Apparent consumption of sulfur in all forms in the United States, 1943–47 (average) and 1948–52, in long tons [1]

	1943–47 (average)	1948	1949	1950	1951	1952
Native sulfur	2, 935, 100	3, 719, 700	3, 409, 700	4, 158, 500	3, 785, 900	3, 728, 200
Recovered sulfur shipments	20, 100	54, 300	42, 300	78, 600	193, 800	224, 500
Pyrites:						
Domestic production	339, 100	388, 400	378, 500	392, 800	432, 800	418, 100
Imports	89, 600	51, 600	58, 000	100, 200	106, 300	142, 000
Total pyrites	428, 700	440, 000	436, 500	493, 000	539, 100	560, 100
Smelter acid production	248, 000	187, 000	167, 000	216, 000	240, 800	253, 000
Other production [2]	19, 580	25, 800	37, 900	42, 000	59, 600	66, 500
Total	3, 651, 500	4, 426, 800	4, 093, 400	[2] 4, 988, 100	4, 819, 200	4, 832, 300

[1] Crude sulfur or sulfur content.
[2] 1948–49, hydrogen sulfide; 1950–52, hydrogen sulfide and liquid sulfur dioxide. In addition, a quantity of acid sludge is converted to H_2SO_4 but is excluded from the above figures.

TABLE 9.—Production of new sulfuric acid (100 percent H_2SO_4), by geographical divisions and States, 1948–52, in short tons

[U. S. Department of Commerce]

Division and State	1948	1949	1950	1951	1952
New England [1]	188,243	158,675	201,281	210,324	172,157
Middle Atlantic:					
Pennsylvania	735,467	619,923	772,103	808,334	747,226
New York and New Jersey	1,311,898	1,136,654	1,357,087	1,348,451	1,343,165
Total Middle Atlantic	2,047,365	1,756,577	2,129,190	2,156,785	2,090,391
North Central:					
Illinois	964,596	868,235	993,759	1,073,223	1,059,602
Indiana	429,025	415,766	464,680	464,896	433,150
Michigan	(2)	(2)	(2)	(2)	196,120
Ohio	665,478	617,673	672,190	654,321	624,184
Other [3]	555,344	618,032	741,998	798,472	522,963
Total North Central	2,614,443	2,519,706	2,872,627	2,990,912	2,836,019
South:					
Alabama	307,393	309,385	290,494	298,404	290,139
Florida	370,078	459,369	526,273	535,719	740,199
Georgia	218,463	232,005	223,949	247,307	239,833
North Carolina	155,159	163,446	159,466	160,087	159,469
South Carolina	212,704	204,203	188,993	206,779	197,323
Virginia	540,502	486,720	560,644	549,918	550,742
Kentucky and Tennessee	774,042	795,728	853,475	835,310	841,555
Texas	613,447	880,330	972,260	947,916	1,086,957
Delaware and Maryland	(2)	(2)	1,354,643	1,340,009	1,221,445
Louisiana	(2)	(2)	(2)	435,335	505,768
Other [4]	1,958,879	2,050,983	980,179	489,988	459,972
Total South	5,150,667	5,582,169	6,110,376	6,046,772	6,293,402
West [5]	736,217	709,849	829,317	984,075	951,928
Total United States	10,736,935	10,726,976	12,142,791	12,388,868	12,343,897

[1] Includes data for plants in Connecticut, Maine, Massachusetts, and Rhode Island.
[2] Included with "Other."
[3] Includes data for plants in Iowa (1949–52 only), Kansas (1950–52 only), Michigan, (except 1952), Missouri, and Wisconsin.
[4] Includes data for plants in Arkansas, Delaware (1948–49 only), Louisiana (1949–50 only), Maryland (1948–49 only), Mississippi, Oklahoma, and West Virginia.
[5] Includes data for plants in Arizona, California, Colorado, Montana, Utah, Washington, and Wyoming.

TABLE 10.—Sulfur consumed in nonacid uses in the United States, 1950–51, in thousands of long tons

[U. S. Department of Commerce, National Production Authority]

Use	1950	1951	Use	1950	1951
Carbon disulfide	191	216	Miscellaneous	63	63
Pulp and paper	402	387			
Crude ground	291	270	Total	1,042	1,030
Other chemicals	95	94			

TABLE 11.—Estimates of principal nonacid uses of sulfur in the United States, 1951–52, in thousands of long tons

[Chemical Engineering]

Use	1951 (revised)	1952 (preliminary)	Use	1951 (revised)	1952 (preliminary)
Wood pulp	391	380	Rubber	75	75
Carbon bisulfide	214	200	Other	137	130
Other chemicals, dyes	100	90			
Insecticides, fungicides	135	105	Total	1,052	980

As the accompanying tables show, the pattern of consumption did not change greatly for most applications during the past year. Somewhat greater emphasis on consumption in fertilizer was noted. At the same time, there was a noteworthy move toward actual commercial production of superphosphates by methods that would substitute nitrogen compounds for sulfuric acid. Proponents of these nitrogenous phosphates claimed that they could be produced at costs that would make them competitive with the usual types of superphosphates and that handling problems had been reasonably well solved. The industry did not expect these processes to reduce the market for sulfur in fertilizer production in the near future, but the development is important because fertilizer is the largest single sulfur market.

The market for sulfur continued to grow in 1952, as a number of new acid-producing facilities and other sulfur-consuming units were being built.

The competitive position of the various sulfur raw materials for the manufacture of sulfuric acid received a great deal of attention in 1952. and some data were published.[10]

TABLE 12.—Sulfuric acid [1] (basic, 100 percent) consumed in the United States, 1950–51, by industries, in thousands of short tons

[U. S. Department of Commerce, National Production Authority]

Industry	1950	1951	Industry	1950	1951
Fertilizers:			Rayon and cellulose film	669	685
Superphosphate	3,790	3,943	Synthetic detergents	201	218
Ammonium sulfate	1,510	1,156	Dyes	195	201
Chemicals	2,072	2,507	Textile finishing	37	31
Petroleum and its products	1,679	1,868	Miscellaneous	1,284	1,495
Pigments (Pb, Zn, and Ti)	1,325	1,332			
Iron and steel	1,026	952	Total	13,999	14,632
Other metallurgical	211	244			

[1] Includes virgin, fortified, and spent acid. Fortified and spent acids totaled 2,006,000 short tons in 1950 and 2,433,000 tons in 1951.

TABLE 13.—Estimates of United States use of sulfuric acid [1] (basis, 100 percent), 1951–52, in thousands of short tons

[Chemical Engineering]

Industry	1951 (revised)	1952 (preliminary)	Industry	1951 (revised)	1952 (preliminary)
Fertilizers:			Iron and steel	1,080	960
Superphosphate	3,900	4,150	Other metallurgical	200	200
Ammonium sulfate	1,500	1,450	Industrial explosives	110	110
Chemicals	3,800	3,680	Textile finishing	40	30
Petroleum refining	1,550	1,550	Miscellaneous	380	370
Paints and pigments	1,250	1,250			
Rayon and film	710	700	Total	14,520	14,450

[1] Recycled acid, including reused, concentrated, fortified, and reconstituted acid is estimated at about 2,130,000 short tons in each of 1951 and 1952.

[10] Chemical Week, What Price Sulfuric?: Vol. 71, No. 10, Sept. 6, 1952, pp. 42, 44–47; Jones, William P., Economic Aspects of Sulphuric Acid Manufacture: Min. Eng., vol. 4, No. 10, October 1952, pp. 957–960.

During the early part of 1952 sulfur consumption was limited by the provisions of National Production Authority Order M-69. Effective January 1, 1952, consumers were restricted to the use of 90 percent of their use during the calendar year 1950. Inventory was limited to 25 days supply.[11]

On February 28, 1952, the order was amended to require filing of certain reports by suppliers and consumers.[12]

The inventory restriction was relaxed on August 19, 1952, to permit a consumer to hold a 60-day supply.[13]

Actual consumption fell below the authorized use during the first 8 months of 1952; consequently, the limitations on use and inventory under Order M-69 were removed on November 5, 1952.[14]

Sulfuric acid was placed under NPA Order M-94 on January 1, 1952, to insure fulfillment of defense needs and provide for distribution among civilian users as equitably as possible.[15] The supply situation eased by the middle of the year, and on August 18, 1952, the order was revoked.

STOCKS

As table 1 shows, producers' stocks of Frasch sulfur increased less than 1 percent (231,423 long tons) in 1952. On December 31 producers held 2,830,014 long tons at the mines and 238,841 tons elsewhere. This industry stock constituted a 7-month supply at the 1952 rate of sales. In view of past industry practice, this was considered to be lower than desirable, and further rebuilding of inventories was anticipated.

There also was a moderate increase in stocks of recovered sulfur in 1952. At the end of January—the first month for which these statistics were collected—the industry held 79,565 long tons of recovered sulfur and at the end of the year 94,662.

No statistics on pyrites stocks are available.

PRICES

In 1952 domestic sulfur prices were under the control of the Office of Price Stabilization. Frasch-sulfur prices were frozen at those of the 1950 base period. These ranged from $21 to $24 f. o. b. mines for domestic consumption and from about $25 to $27 at the port for export. Prices of recovered sulfur and native sulfur produced by non-Frasch methods were either controlled at the 1950 base level or, in the case of most of the new producers, established at local levels that made them competitive with Frasch sulfur when transportation factors were taken into consideration. Prices of elemental sulfur in the international market were reported to have ranged in some instances between $100 and $200 a ton, but the trend was sharply down by the end of the year.

---

[11] NPA, Sulfur: Order M-69, as amended Dec. 29, 1951 (effective Jan. 1, 1952), 2 pp.
[12] NPA, Sulfur: Order M-69, as amended Feb. 28, 1952, 2 pp.
[13] NPA, Sulfur: Order M-69, as amended Aug. 19, 1952, 2 pp.
[14] NPA, Sulfur: Order M-69, revocation, Nov. 5, 1952, 1 p.
[15] NPA, Sulfuric Acid: Order M-94, Dec. 29, 1951 (effective Jan. 1, 1952), 2 pp.

Numerous requests for price relief were submitted to the Office of Price Stabilization, particularly by new producers. On July 1, 1952, OPS issued Supplementary Regulation 3 of Ceiling Price Regulation 61. This permitted ceiling prices for non-Frasch native sulfur to be established at the average total cost plus a reasonable profit margin for sales in the export market only.

Prices of pyrites vary greatly from place to place, principally because of the importance of the transportation factor in the delivered cost. Trade journals quoted only nominal prices in 1952. For example, E&MJ Metal and Mineral Markets quoted domestic and Canadian pyrites per long ton at $9 to $11 f. o. b. point of shipment.

The f. o. b. mine valuations attributed to output by domestic producers ranged from $2.75 to $7.84 a long ton. The average value of all domestic output was $4.98, and the average value of the tonnage sold was $6.21.

There was a strong upward pressure on pyrites prices during the year; this is reflected by the fact that the average value of imports increased from $2.06 in 1951 to $2.98 in 1952.

FOREIGN TRADE [16]

Foreign demand for United States Frasch sulfur apparently tapered off somewhat in 1952. Exports remained under Government control throughout the year and the sulfur committee of the International Materials Conference periodically reviewed the status of supply and demand. Exports from the United States were maintained at a level slightly higher than in the previous year.

The high prices that prevailed in the international sulfur market stimulated development of production capacity in a number of foreign countries, and much of this tonnage entered international trade. However, considerable time is required for constructing new facilities, and consequently the quantities involved in 1952 were relatively small. A discouraging factor for this type of project was the softening of sulfur prices during the latter part of the year, when it became apparent that demands in most foreign countries were being reasonably well satisfied from the available sources.

The primary effort made during the year by both the Government agencies and producers was to supply sulfur-consuming countries throughout the world more or less in proportion to historical requirements and also to provide adequately for the requirements of the industries contributing most directly to defense.

The shortage and defense considerations set in motion some developments that may have considerable effect on the pattern of foreign trade in future years. For example, a number of countries are emphasizing the use of a greater proportion of domestic raw materials such as gypsum, pyrites, and spent oxides. The development of elemental sulfur production in Mexico and possibly other countries also may broaden the base of world sulfur supply considerably.

Whereas the United States imported only a negligible quantity of elemental sulfur, it consumed a large tonnage of pyrites obtained from Canada. Sulfur prices were too low to justify major conversion

[16] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

by consumers from elemental sulfur to pyrites raw material. However, some conversions were feasible economically. Imports of pyrites from eastern Canadian sources into the United States increased by about one-third in 1952.

Exports of pyrites are not separately classified in the foreign trade statistics of the U. S. Department of Commerce.

TABLE 14.—Sulfur imported into and exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Imports for consumption				Exports			
	Ore		In any form, n. e. s.		Crude		Crushed, ground, refined, sublimed, and flowers	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
1948	----------	----------	38	$13,299	1,262,913	$26,779,444	32,630	$1,774,358
1949	5	$89	27	5,768	1,430,916	30,489,876	30,135	1,682,965
1950	----------	----------	25	6,172	1,440,996	30,950,531	37,526	2,249,311
1951	[1] 1,875	[1] 94,496	[1] 501	[1] 63,131	1,287,773	31,760,539	24,044	1,947,860
1952	4,829	98,581	34	7,545	1,304,154	33,515,359	34,213	2,451,132

[1] Revised figure.

TABLE 15.—Sulfur exported from the United States, 1951–52, by countries of destination

[U. S. Department of Commerce]

Country	Crude				Crushed, ground, refined, sublimed, and flowers			
	1951		1952		1951		1952	
	Long tons	Value	Long tons	Value	Pounds	Value	Pounds	Value
North America:								
Canada	334,146	$7,891,831	370,192	$9,261,956	7,853,485	$308,270	7,440,553	$274,183
Central America	139	3,850	----------	----------	640,908	28,881	921,059	40,949
Mexico	957	26,147	----------	----------	10,665,295	355,794	8,403,865	219,312
West Indies	25,900	646,939	34,128	882,276	408,454	17,964	340,704	12,952
Total North America	361,142	8,568,767	404,320	10,144,232	19,568,142	710,909	17,106,181	547,396
South America:								
Argentina	4,800	119,500	2,500	64,613	790,306	32,961	212,170	39,111
Brazil	40,879	1,057,726	50,158	1,380,441	4,823,414	215,813	8,046,221	349,114
Colombia	557	16,153	----------	----------	340,477	17,687	281,516	14,138
Ecuador	72	2,772	72	2,780	11,000	484	53,954	3,058
Peru	9	640	1	109	1,112,396	31,732	4,742,878	141,467
Uruguay	1,200	30,000	3,700	96,353	----------	----------	73,600	2,164
Venezuela	27	1,031	58	2,430	79,030	10,278	279,895	16,529
Other South America	139	3,850	72	1,990	68,143	6,503	10,400	1,288
Total South America	47,683	1,231,672	56,561	1,548,716	7,224,766	315,458	13,700,634	566,869
Europe:								
Austria	13,900	361,800	14,900	398,766	----------	----------	----------	----------
Belgium-Luxembourg	54,300	1,371,880	39,700	1,039,268	460,344	13,952	959,492	24,513
France	73,555	1,914,185	52,095	1,362,123	----------	----------	----------	----------
Germany	21,538	555,438	24,000	633,550	55,000	11,735	37,530	7,578
Greece	----------	----------	----------	----------	14,178,914	382,538	19,615,584	495,778
Ireland	----------	----------	----------	----------	263,200	10,058	447,613	17,361
Netherlands	975	24,605	450	11,408	491,492	14,010	527,292	16,946

TABLE 15.—Sulfur exported from the United States, 1951–52, by countries of destination—Continued

[U. S. Department of Commerce]

Country	Crude				Crushed, ground, refined, sublimed, and flowers			
	1951		1952		1951		1952	
	Long tons	Value	Long tons	Value	Pounds	Value	Pounds	Value
Europe—Continued								
Norway					67,440	$6,607	87,483	$2,564
Portugal	194	$5,593			12,600	2,959	5,000	780
Sweden	2,850	74,490			37,500	8,300	24,350	5,164
Switzerland	19,300	496,005	19,000	$492,375	371,360	31,144	612,514	29,418
Turkey					548,344	13,063		
United Kingdom	424,007	10,332,658	377,884	9,570,107	88,250	6,955		
Yugoslavia					2,204,000	55,000	6,535,740	156,999
Other Europe	4,000	100,000			14,500	3,337	32,400	6,650
Total Europe	614,619	15,236,654	528,029	13,507,597	18,792,944	559,658	28,884,998	763,751
Asia:								
Ceylon					8,700	652	29,190	2,455
Hong Kong					1,500	135		
India	33,357	867,372	52,069	1,379,703	3,885,464	164,668	6,946,082	227,632
Indonesia	7,920	193,084	7,534	190,706	1,185,420	39,898	2,737,602	94,561
Israel	4,000	105,000	3,100	83,700	833,000	21,877	3,121,185	78,464
Lebanon	71	3,287	40	1,546			436,920	9,800
Pakistan	423	11,688	497	14,113			215,480	7,322
Philippines					132,320	6,050	133,724	7,270
Syria					349,797	7,643	645,961	15,753
Other Asia	2,664	109,289	2,259	64,887	26,720	4,399	124,220	7,132
Total Asia	48,435	1,289,720	65,499	1,734,655	6,422,921	245,322	14,390,364	450,389
Africa:								
Algeria	11,275	290,695	6,430	163,001				
Belgian Congo							221,660	7,756
British East Africa	100	2,765	190	5,380			87,948	3,040
Egypt	3,225	87,285	2,091	69,265	835,846	21,078	1,588,416	39,590
French Morocco	3,125	93,750	2,870	73,405				
Mozambique	99	2,750	149	4,148				
Tunisia	2,000	50,350	5,000	130,000				
Union of South Africa	58,600	1,433,050	65,200	1,732,830	652,080	71,068	380,166	53,303
Total Africa	78,424	1,960,645	81,930	2,178,029	1,487,926	92,146	2,278,190	103,689
Oceania:								
Australia	70,735	1,791,391	98,665	2,594,592	75,400	7,512	113,440	12,150
New Zealand	66,735	1,681,690	69,150	1,807,538	285,678	16,855	163,235	6,888
Total Oceania	137,470	3,473,081	167,815	4,402,130	361,078	24,367	276,675	19,038
Grand total	1,287,773	31,760,539	1,304,154	33,515,359	53,857,777	1,947,860	76,637,042	2,451,132

TABLE 16.—Pyrites, containing more than 25 percent sulfur, imported for consumption in the United States, 1948–52, by countries

[U. S. Department of Commerce]

Country	1948		1949		1950		1951		1952	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
Australia					22	$242				
Canada	75,248	$169,551	107,951	$215,290	208,725	411,823	221,487	$457,365	295,820	$865,547
Malta, Gozo, Cyprus					19	57				
Portugal									227	16,267
Spain	32,163	89,994	12,986	36,331						
Total	107,411	259,545	120,937	251,621	208,766	412,122	221,487	457,365	296,047	881,814

TABLE 17.—Pyrites, containing more than 25 percent sulfur, imported for consumption in the United States, 1948–52, by customs districts, in long tons

[U. S. Department of Commerce]

Customs district	1948	1949	1950	1951	1952
Buffalo	66,385	106,862	208,569	221,391	295,626
Chicago			36		
Connecticut	37				
Duluth and Superior				46	
Michigan			5		
New York			41		227
Philadelphia	40,989	14,075			
Rochester				50	
St. Lawrence					194
Vermont			115		
Total	107,411	120,937	208,766	221,487	296,047

TECHNOLOGY

One of the most interesting projects from the technologic standpoint in 1952 was the Freeport Sulphur Co. installation at Bay Ste. Elaine dome in Louisiana. This deposit, which is about 160 miles southwest of New Orleans, is covered by salt marsh and water. The nearest source of fresh water is about 35 miles away. Standard Frasch mining practice requires the use of fresh water. The deposit is relatively small and so isolated that it can be reached for commercial operation only by boat.

To solve the many problems involved, the company designed a mining plant capable of using sea water. The water is heated by direct contact with flue and combustion gases to eliminate oxygen, followed by final heating with steam in tubular heat exchangers. The heat exchangers are constructed of corrosion-resistant alloys and the steel-surface pipelines are protected by cement lining. Chemical treatment of the sea water can also be used. This plant was mounted on a barge 40 feet wide, 200 feet long, and 12 feet deep. The barge was towed to the mine site and partly sunk in place so that the elevation of the deck is about 6½ feet above the mean water level.

The plant was designed for production from 6 wells simultaneously; annual capacity was rated at 100,000 long tons of sulfur.

As construction of storage facilities at the site was impractical, provision was made for the transportation of sulfur as produced in two 1,000-ton insulated tank barges to the storage area of the company at Port Sulphur, 75 miles away.[17]

Until recently, sulfuric acid was the only economic outlet from sulfur compounds derived from the smelter gases at Copper Cliff, Ontario. Experimental production of liquid sulfur dioxide from dilute smelter gases several years ago had shown that the costs of production are too high to compete with elemental sulfur from other sources. However, when a new flash-roasting process was developed, which produced a gas containing 75 percent or more sulfur dioxide, the concentration costs of this gas were so much lower that competitive production appeared to be feasible. A plant was built by Canadian

[17] Price, K. T., Freeport Mines Sulphur by Boat: Eng. and Min. Jour., vol. 153, No. 12, December 1952, pp. 98–102; Bartlett, Z. W., Lee, C. O., and Feierabend, R. H., Development and Operation of Sulphur Deposits in the Louisiana Marshes: Min. Eng., vol. 4, No. 8, August 1952, pp. 775–783.

Industries, Ltd., at this site for the production of 90,000 tons of liquid sulfur dioxide a year. Smelter gas is dried with sulfuric acid, compressed, and cooled. In cooling, sulfur dioxide condenses as a liquid. The remaining gas is compressed further and passed through an oil separator and a second liquefier. The unliquefied portion of the sulfur dioxide, after the second step, is fed to the acid plant for conversion to sulfuric acid. Economic success of the project is said to depend upon close integration of the process with the acid plant. Liquid sulfur dioxide from this new unit is to be used almost entirely by sulfite pulp mills in Ontario and Quebec. The utility of liquid sulfur dioxide in pulp production was demonstrated on a trial basis in 1947 by the Abitibi Power & Paper Co. at Fort William, Ontario. The liquid sulfur dioxide is shipped from the plant to the sulfite mills in a fleet of 55-ton tank cars.[18]

Increasing quantities of sulfur are being moved from the mine in molten condition relatively long distances. The transportation practice of the new mines of the Freeport Sulphur Co. at Garden Island Bay and Bay Ste. Elaine domes are good examples. This technique is also being utilized for shipping sulfur to consuming plants in a few instances.[19]

The fluosolids calcining process is finding wider use in the sulfur industry.[20] In burning pyrites the process can produce a gas containing 12 to 15 percent sulfur dioxide.

RESERVES

A fundamental question in the industry is the magnitude of reserves of native sulfur that can be mined by the Frasch process. An important factor in this regard is the exploration being carried on in the Tehauntepec Peninsula of Mexico. Companies interested in commercial development of these deposits announced plans for the construction of facilities that may produce well over 500,000 tons a year. This would indicate the existence of reserves totaling many million tons. Definite information on the magnitude of these reserves has not been made available, but it is evident that Mexico may add materially to the known commercial reserves of Frasch sulfur in the near future.

After reviewing the sulfur situation, the President's Materials Policy Commission published estimates of reserves and concluded that Frasch reserves probably are not large enough to supply the growing requirements for many years and by 1975 other sulfur minerals would become increasingly important sources of supply.

Information on reserves of sulfides in Australia and Bolivia is contained in the World Review section of this chapter.

WORLD REVIEW

Australia.—In 1952 Australia was making an effort to convert its sulfur-consuming industry from imported elemental sulfur to the use

[18] Allgood, R. W., Sulphuric Acid and Liquid Sulphur Dioxide Manufactured from Smelter Gases at Copper Cliff, Ontario: Canadian Min. and Met. Bull., vol. 45, No. 479, March 1952, pp. 153–155.
[19] Chemical Engineering, Recovered Sulphur Shipped Molten From Extraction Unit: Vol. 59, No. 10, October 1952, p. 246.
[20] Copeland, G. G., New FluoSolids Experience: Min. Cong. Jour., vol. 38, No. 3, March 1952, pp. 42–44, 54.

of domestic supplies of pyrites and other sulfides. Numerous instances of projects that were contributing to this program appeared in the trade press.[21]

In the latter part of the year, however, the easing of the sulfur supply situation raised fundamental questions concerning the economic problems involved in continuation of the conversion program. In many instances the acid manufacturer using Australian pyrites would be at a cost disadvantage to the acid producer using imported sulfur. A tariff board was investigating the problem and the industry anticipated that governmental decisions concerning the degree of protection to be given the consumer of domestic pyrites would soon be forthcoming.[22]

The Australian Government issued a comprehensive bulletin on sulfur resources.[23] This publication mentions that the largest deposits of sulfide minerals are found at Mount Isa and Mount Morgan, in Queensland, Broken Hill and Captain's Flat in New South Wales, Mount Lyell and Read-Rosebery in Tasmania, Nairne in South Australia, and Norseman in Western Australia. Reserves in the deposits are estimated as follows:

	Tons
Pyrite and pyrrhotite bodies	7, 921, 000
Pyrite concentrates from mixed sulfide bodies	4, 234, 000
Zinc concentrates	4, 213, 000
Lead concentrates	2, 052, 000
Total	18, 420, 000

Of this total, about 14,932,000 tons is considered to be available for making acid. This is considered sufficient to supply Australian needs for about 33 years.

Bolivia.—Bolivia continued to produce a small quantity of sulfur. No major construction program was announced, but it was reported that the Bolivian Government signed a contract for developing Bolivian sulfur deposits. Reserves in the Department of Potosi in southwestern Bolivia were estimated at about 5,000,000 tons assaying more than 60 percent sulfur. However, the altitude (5,970 meters), the extreme cold, and winds made mining very difficult. The sulfur is carried from the mines by llamas to a camp at an elevation of 5,000 meters, where a small beneficiation plant is operated.[24]

Canada.—As Canada is a large consumer of sulfur and has substantial reserves of sulfur-bearing materials capable of being developed commercially, the sulfur shortage stimulated a great deal of activity in that country. The commercial developments included a variety of operations. Canadian Industries, Ltd., began producing liquid sulfuric acid at Copper Cliff, Ontario, from smelter gases of the Inter-

21 Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 4, October 1952, pp. 36–42;
Chemical Engineering and Mining Review, New Sulphuric Acid Plant at Port Adelaide, South Australia: Vol. 44, No. 11, Aug. 11, 1952, pp. 417–418;
Mining Journal (London), The Australian Sulphur Industry: Vol. 238, No. 6083, Mar. 21, 1952, p. 291;
Mining World, vol. 14, No. 9, August 1952, p. 67;
Mining World, vol. 14, No. 11, October 1952, p. 62.

22 Fertiliser and Feeding Stuffs Journal, Australia's Sulphur Policy: Vol. 39, No. 1, Jan. 7, 1953, pp. 25–26;
Industrial and Mining Standard (Melbourne), vol. 107, No. 2725, Aug. 31, 1952, p. 3.

23 Nye, P. B., and Mead, G. F., Australian Resources of Sulphur-Bearing Minerals: Bureau of Mineral Resources, Geology, and Geophysics, Bull. 5, 1952, 76 pp.

24 Engineering and Mining Journal, vol. 153, No. 11, November 1952, p. 138;
Mining World, vol. 14, No. 12, November 1952, p. 59.

national Nickel Co. Capacity of this facility is 45,000 tons of sulfur equivalent per year.[25]

At the Jumping Pound, Alberta, natural-gas field, the Shell Oil Co. began production of elemental sulfur. The facility has a capacity of 10,000 tons of elemental sulfur per year recovered from processing of sour natural gas. Natural gas at this location contains about 3½ percent hydrogen sulfide by volume.[26]

On a site near the Turner Valley, Alberta, plant of the Royalite Oil Co., Ltd., this firm constructed an elemental sulfur refinery having a daily capacity of 30 long tons. Turner Valley gas contains about 2 percent hydrogen sulfide. Sulfur from these sources is to be marketed principally in the pulp and paper industry of the Pacific coast area and possibly in other markets as far away as the north central United States.[27]

Large reserves of sour gas estimated to contain about 8 percent hydrogen sulfide are reported to have been established in the Pincher Creek gas field of Alberta.

No commercial deposits of native sulfur that can be mined by the Frasch method have been reported in Canada; however, sulfur showings have been noted. In 1952 Sunbeam Sulphur, Ltd., a subsidiary of Dominion Tar & Chemical Co., Ltd., was drilling two wells near wells in which sulfur had previously been noted. The site is in the Chisholm area on the Peace River Railroad about 100 miles north of Edmonton. In one well, the sulfur was found at a depth of 3,040 feet and in the other about 10 miles away it showed up at 3,500 feet.

Noranda Mines, Ltd., continued to make progress toward commercial development of a process wherein elemental sulfur will be recovered in the burning of pyrites under controlled conditions. It was reported that an agreement had been contracted between this company and North American Cyanamid, Ltd., for the construction of a $4,000,000 plant.[28]

A comprehensive survey of the sulfur situation in Canada was published.[29]

Chile.—World shortages of sulfur usually stimulate production from the relatively high cost native sulfur operations in Chile.

After World War II the Chilean sulfur industry declined, but the sulfur shortage transformed its outlook. Prices soared, and production facilities were rehabilitated and expanded. Chilean sulfur deposits, which extend from the northern tip of the country to the Province of Atacama, a distance of about 600 miles, have been estimated by a sulfur producers' association to contain as much as 400 million metric tons of ore. Other estimates of small areas have indicated tonnages over 20 million tons. Although this estimate may

---

[25] Allgood, R. W., Sulphuric Acid and Liquid Sulphur Dioxide Manufactured from Smelter Gases at Copper Cliff, Ontario: Canadian Min. and Met. Bull., vol. 45, No. 479, March 1952, pp. 153–155.

[26] Canadian Chemical Processing, Liquid Sulphur Dioxide for Sulphite Mills: Vol. 36, No. 3, March 1952, pp. 54, 56, 57;
Mining Journal (London), Canada's First Sulphur From Petroleum Plant: Vol. 239, No. 6103, Aug. 8, 1952, p. 150;
The Precambrian, Sulphur Production to Start With New $50,000 Plant at Jumping Pound, Alta.: Vol. 25, No. 2, February 1952, p. 24.

[27] Canadian Chemical Processing, New Sulphur Recovery Plant: Vol. 36, No. 3, March 1952, pp. 59–60;
McGuffin, G. A., Sulphur Recovery from Turner Valley Gas: Canadian Min. and Met. Bull., vol. 45, No. 479, March 1952, pp. 156–159.

[28] Canadian Mining Journal, vol. 73, No. 12, December 1952, p. 114.

[29] Janes, T. H., Sulphur and Pyrites in Canada: Department of Mines and Technical Surveys, Ottawa, 32 pp.

not be fully verified by exploration evidence, the sulfur reserves of Chile in any case apparently are large.

Much of the mining was done by open pits, but shallow underground mining is practiced also. Most of the caliche (sulfur ore) is hand drilled and blasted. The ore is shoveled into wheelbarrows or hide baskets. Narrow-gage cars are used to transport the sulfur out of the mine. In some instances, the ore is broken into pieces about 8 inches in size and hand-picked. Weather and the physical difficulties of working at very high altitude are adverse factors. The workers are generally paid on a piecework or contract basis. Animals, aerial tramways, trucks, and rail cars are used to convey the mined sulfur to the refineries. Refining is commonly done at a nearby settlement or at some convenient location near the volcano from which the sulfur is obtained. The product normally assays about 95 percent sulfur but some sublimed sulfur of very high purity is also produced.

A detailed description of the practices and current status of the Chilean industry was published in 1952.[30]

Ecuador.—The Tixan sulfur mine in Ecuador is one of the most favorably located in South America as the deposit is at a relatively low elevation—about 8,500 feet—and transportation is easily available. In 1952 the Ecuadoran Mining Co., a subsidiary of Chemical Plants Corp., operated this mine under a contract with the Ecuadoran Minister of Social Welfare. Output in 1952 exceeded 2,000 tons. Other sulfur deposits in Ecuador also attracted attention. Concessions have been granted to develop sulfur in the Galapagos Islands. Reports were also current of the granting of concessions to develop sulfur deposits at Otavalo. Although there was considerable activity and interest in sulfur in Ecuador, the only company actively in production was the Ecuadoran Mining Corp.[31]

Iraq.—Interest in a concession to extract sulfur from waste gases produced in the Iraqi oil fields was reported in 1952. Both American and British companies were investigating the prospects of commercial production.[32]

Italy.—Production of elemental sulfur in Italy continued to increase in 1952; however, in the latter part of the year the shortage had eased so much that marketing of the exportable surplus became exceedingly difficult at prevailing prices. The Italian industry is conscious of the need for developing cheaper production methods that would make the product more nearly competitive with Frasch sulfur, and substantial Government funds were made available for improvement in production facilities and for exploration of deposits. A number of ways of improving practices, including the adoption of more modern underground mining methods and beneficiation through froth flotation, were in progress, but no major advances can be reported for 1952.[33]

Japan.—Production of sulfur in Japan in 1952 increased about 25 percent over the previous year. Sulfur is mined in Japan by numerous companies, the largest of which is the Matsuo Mining Co., Ltd., which accounts for about 30 percent of the output. Second in

---

[30] Rudolph, William E., Sulphur in Chile: Geog. Rev., October 1952, pp. 562–590.
[31] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 6, December 1952, pp. 36–37.
Mining Engineering, vol. 4, No. 9, September 1952, p. 847.
[32] Chemical Age, Race for Sulphur Rights: Vol. 66, No. 1716, May 31, 1952, p. 847.
[33] Mining World, vol. 14, No. 7, June 1952, p. 58.

rank is the Hokkaido Sulphur Co., Ltd., which supplies approximately 20 percent.

Most of the sulfur-mining companies are relatively small and many of them are in part supported with loans or investments by consuming companies. Sulfur price controls were lifted in 1951 and consequently the export prices thereafter reflected world demand. Prices ranging from about $105 to $148 per long ton were reported, and occasionally rumors of even higher figures were heard.[34]

Mexico.—Mexico was a center of world interest in 1952 owing to the growing possibility that it will become the first producer of Frasch sulfur outside of the United States. Domes in Mexico have been explored over a period of years, and finally arrangements for their development were crystallizing. As construction of Frasch-mining facilities requires investment of considerable capital and these deposits have locations disadvantages, financing the development work presented a problem. To assist expansion of low-cost sulfur-production capacity, the Export-Import Bank agreed to participate in financing two projects.

In 1951 the Mexican Gulf Sulphur Co. was the first company to obtain a loan from the Export-Import Bank for construction of a plant at the San Cristobal dome. Construction of the facility was begun by an American construction company. This dome was expected to be in production in the latter part of 1953. Its capacity was estimated between 150,000 and 200,000 long tons a year.

Pan American Sulphur Co. was the second firm to initiate a construction program. A $3,664,000 loan was obtained from the Export-Import Bank for constructing a plant at the Jaltipan dome. This company had explored the deposit extensively and expected to be able to produce from 350,000 to 500,000 long tons of sulfur annually. Construction of this facility was scheduled to begin in 1953 and to be completed in the latter part of 1954.

In addition to these actual development projects, further exploration activities were being pressed as rapidly as possible by a number of organizations. For example, the Texas Gulf Sulphur Co. conducted a major exploration program, but the company did not announce any discoveries.

Surface sulfur deposits also were being investigated during the year. It was reported that a concession was awarded on a volcanic sulfur deposit on the Island of Socorro off the northwest coast of Mexico. Reserves were estimated at 800,000 tons.[35]

Efforts were being made to develop surface sulfur production south of San Felipe on the Gulf of California.[36]

It was reported that the Huaxcama mines of Negociacion Minera de Azufre, S. A., were producing about 50 metric tons of elemental sulfur per day in the latter part of 1951 and in 1952 output was being increased.[37]

During 1952 actual production of native sulfur in Mexico was small as shown in table 18. However, a larger quantity—approxi-

---

[34] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 5, November 1952, pp. 39–41.
[35] Mining World, vol. 14, No. 12, November 1952, p. 73.
[36] Pit and Quarry, vol. 45, No. 5, November 1952, p. 81.
[37] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 1, July 1952, pp. 43–45.

mately 37,000 metric tons—was produced by Petroleos Mexicanos from a gas-cleaning plant at the Poza Rica oil fields.[38]

Norway.—At Skorovas, in northern Norway, a new pyrite mine was started in 1952. Capacity of this mine is about 150,000 tons per year. The deposit is estimated to contain 7,500,000 tons. Heavy-medium concentration is used, and much of the product contains 1.5 percent copper.[39]

Peru.—A number of organizations investigated Peruvian sulfur deposits in 1952. For example, an American firm sent a technologist to study its holdings in the Sechura Desert in northern Peru. Actual production in 1952 was twice as high as in 1951 but, as shown in table 18, the total tonnage was still relatively insignificant.[40]

TABLE 18.—World production of native sulfur, by countries,[1] 1948–52, in long tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
North America:					
Mexico	2,100	(3)	(3)	11,375	11,784
United States	4,869,210	4,745,014	5,192,184	5,278,249	5,293,145
South America:					
Argentina	8,388	10,048	7,622	7,560	[4] 8,000
Bolivia (exports)	2,685	4,398	4,307	9,100	5,497
Chile	13,124	7,599	22,065	29,672	[4] 36,000
Colombia	592	793	1,461	2,479	2,974
Ecuador	43	16	27	1	2,353
Peru	971	248	98	2,251	5,066
Europe:					
France (content of ore)	6,648	5,201	5,629	5,460	[4] 12,000
Italy (crude) [5]	170,904	198,274	209,767	197,382	232,706
Spain	2,500	5,000	6,800	6,700	4,800
Asia:					
Japan	40,120	61,414	90,940	139,364	173,615
Taiwan (Formosa)	1,578	362	2,657	2,732	5,001
Turkey (refined)	2,556	3,046	5,911	7,275	7,948
Total (estimate)	5,300,000	5,200,000	5,700,000	5,800,000	6,000,000

[1] Native sulfur believed to be also produced in China (continental) and U. S. S. R., but complete data are not available; estimates by senior author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous sulfur chapters.
[3] Data not available; estimate by authors of chapter included in total.
[4] Estimate.
[5] In addition the following tonnages of ground sulfur rock (30 percent S) were produced and used as an insecticide: 1948, 15,176 tons; 1949, 19,213 tons; 1950, 15,778 tons; 1951, 22,120 tons, 1952, 21,482 tons.

The Tutupaca mines near Tacna were purchased by a Canadian-American group and British investors made an advance to Cia. Azufrera Peruana in southern Peru, against a 10,000 ton delivery.[41]

Philippine Islands.—Efforts to develop fertilizer production capacity in the Philippines at the Maria Cristina project of the National Power Corp. in Mindanao led to exploration of local sulfur resources. In 1951 an engineer of the Federal Bureau of Mines studied the potential resources in the Philippines for the Economic Cooperation Administration. He found that one fumerole deposit of crude sulfur might be a commercial source but that the most promising sources of sulfur were pyrites deposits. Pyrites may be obtained as a by-

[38] Chemical Age (London), Sulphur from Mexico: Vol. 67, No. 1736, Oct. 18, 1952, p. 546.
[39] Chemical Age (London), vol. 67, No. 1743, Dec. 6, 1952, p. 777.
[40] Foreign Commerce Weekly, U. S. Company Investigates Sulfur Holdings in Peru: Vol. 47, No. 7, May 19, 1952, p. 19.
[41] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 1, July 1952, pp. 43–45.

342070—55——64

TABLE 19.—World production of pyrites (including cupreous pyrites), by countries,[1] 1948–52, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1948		1949		1950		1951		1952	
	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content
North America:										
Canada	166,985	79,039	227,227	106,667	283,597	136,519	403,648	195,373	503,784	239,189
United States	943,434	394,583	905,746	385,518	946,108	399,092	1,034,104	439,766	1,010,301	424,850
South America: Brazil	3,600	[3] 1,500	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Europe:										
Austria	7,871	2,942	11,624	4,064	12,489	3,133	9,756	2,645	8,034	2,297
Czechoslovakia	3,195	[3] 1,200	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Finland	177,512	79,170	180,040	80,409	162,050	70,107	232,546	98,557	249,813	[3] 111,400
France	181,683	82,238	205,393	85,270	247,642	108,962	280,600	[3] 124,000	294,000	[3] 130,000
Germany, West	383,100	153,245	431,963	173,582	525,196	191,525	533,180	194,598	525,252	190,800
Greece	16,236	[3] 7,800	15,785	[3] 7,600	87,678	[3] 42,000	180,120	[3] 88,200	201,238	[3] 98,600
Italy	836,245	381,579	864,185	393,723	900,912	[3] 414,420	898,186	[3] 404,100	1,141,454	[3] 513,600
Norway	735,021	314,940	744,762	317,920	748,793	317,866	696,217	313,300	714,000	309,876
Poland	58,100	[3] 25,000	81,000	[3] 36,000	(4)	(4)	(4)	(4)	(4)	(4)
Portugal	561,136	[3] 252,500	622,925	[3] 280,300	613,522	276,085	729,611	328,325	758,927	341,517
Rumania	(4)	(4)	[3] 5,000	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Spain	1,463,912	[3] 702,700	1,559,044	[3] 748,300	1,653,699	[3] 794,000	2,004,126	[3] 962,000	2,140,680	[3] 1,027,000
Sweden	392,033	181,987	424,007	205,085	406,809	202,301	406,934	202,397	[3] 360,000	[3] 173,000
United Kingdom	10,800	[3] 4,300	17,191	[3] 6,900	13,501	[3] 5,400	13,501	[3] 5,400	(4)	(4)
Yugoslavia	300,006	[3] 135,900	244,775	[3] 110,800	117,167	[3] 53,000	153,779	[3] 69,600	188,129	84,866
Asia:										
China	42,907	19,300	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Cyprus	589,772	283,091	942,808	452,548	829,889	398,347	959,838	460,722	1,072,968	515,025
Japan	1,138,782	489,676	1,542,360	663,200	1,928,750	786,930	2,250,784	904,815	2,628,357	1,053,971
Taiwan (Formosa)	------	------	------	------	------	------	6,728	2,153	33,232	10,634
Africa:										
Algeria	35,900	14,468	32,705	13,150	25,075	10,532	31,450	13,838	25,175	11,077
French Morocco	70	34	202	95	1,473	692	1,949	877	2,025	871
Southern Rhodesia	13,224	[3] 5,500	16,968	6,787	13,810	5,524	28,269	12,156	19,053	8,193
Tunisia	2,851	1,297	2,925	1,400	1,150	[3] 500	------	------	------	------
Union of South Africa	35,992	15,456	35,527	15,274	36,026	15,623	33,378	14,474	34,327	14,782
Australia	90,848	42,230	87,923	41,021	113,973	53,887	153,818	72,589	201,973	95,070
Total (estimate)	9,900,000	4,000,000	11,100,000	4,600,000	11,800,000	5,000,000	13,200,000	5,500,000	14,200,000	6,000,000

[1] In addition to countries listed, East Germany, Kenya, Korea, and U. S. S. R., produce or have produced pyrites, but production data are not available; estimates by senior author of chapter included in total.

[2] This table incorporates a number of revisions of data published in previous pyrite chapters.

[3] Estimate.

[4] Data not available; estimate by authors of chapter included in total.

product of metal-mining operations. Ample reserves appear to be available for a 10-year period and probably for a longer period.

In 1952 it was reported that a contract was signed by the National Power Corp. and the Camiguin Mining Co. whereby the latter firm would supply 10,000 metric tons of sulfur over a 4-year period beginning in March 1953.[42]

Sweden.—Elemental sulfur production capacity in Sweden was being expanded in 1952. Output, which totaled about 14,000 long tons in 1950, was reported to have increased to about 28,000 tons by end of 1953. The sulfur was produced by the Swedish Shale Oil Co.[43]

United Kingdom.—A number of firms interested in maintaining adequate supplies of sulfur established an organization called the Sulphur Exploration Syndicate. This organization carried on surveys in various areas.[44]

An important aspect of the British sulfur program was installation of additional capacity to produce sulfuric acid from anhydrite. At Whitehaven, Cumberland, England, a new plant to produce sulfuric acid and cement was being constructed. The anhydrite was to be obtained from two thick seams under the St. Bees Headland adjacent to the site. Exploration has revealed enough anhydrite for 50 years' requirements.[45]

Venezuela.—The Venezuelan Sulphur Corp. was exploring its deposit near El Pilar, known as the Costa More 1–4 concessions. Tests on samples are said to have indicated a high sulfur content and the company expressed an intention to construct a refinery at Carupano, Estado Sucre.[46]

---

[42] Mining World, vol. 14, No. 11, October 1952, p. 61.
[43] Mining World, vol. 14, No. 8, July 1952, p. 64.
[44] Chemical Engineering and Mining Review, Sulphur News: Vol. 44, No. 6, Mar. 10, 1952, p. 239.
[45] Mining World, New Sulphuric Acid Plant for English Chemical Firm: Vol. 14, No. 8, July 1952, p. 62.
[46] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 4, October 1952, p. 46.

Talc, Pyrophyllite, and Ground Soapstone

By Donald R. Irving [1] and Frances P. Uswald [2]

DECREASES from the record highs of 1951 in the combined mine production of talc, pyrophyllite, and ground soapstone and the quantity of these commodities sold by producers were recorded in 1952. The combined value of talc, pyrophyllite, and ground soapstone sold by producers increased slightly to a new high. Imports were about the same in quantity and somewhat higher in value; exports were about the same in quantity but lower in value.

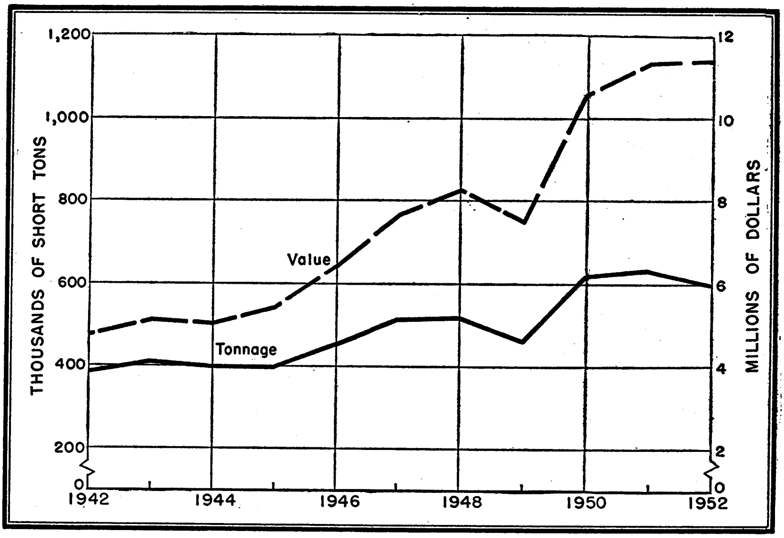

FIGURE 1.—Sales of domestic talc, pyrophyllite, and ground soapstone, 1942–52.

GOVERNMENT PROGRAM UNDER THE DEFENSE PRODUCTION ACT OF 1950

The Defense Minerals Exploration Administration executed a contract on October 24, 1951, with the Hitchcock Corp., Murphy, N. C., to explore for block steatite talc on the property of the Nancy Jordan and Carolina mines, Cherokee County, N. C. (Docket 1198, Contract IDM–E194). The contract was for an expenditure not to exceed $32,519, with the Government's share 90 percent of the total, or a maximum of $29,267. The contract remained in force on December 31, 1952.

[1] Commodity-industry analyst.
[2] Statistical clerk.

TABLE 1.—Salient statistics of talc, pyrophyllite, and ground soapstone in the United States, 1951–52

	1951		1952	
	Short tons	Value	Short tons	Value
Mined	640,456	(1)	600,908	(1)
Sold by producers:				
Crude to consumers [2]	20,166	$211,241	19,029	$203,895
Sawed and manufactured	1,097	375,141	976	309,271
Ground [2] [3]	614,805	10,736,448	573,142	10,834,151
Total sales	636,068	11,322,830	593,147	11,347,317
Imports for consumption: [4]				
Crude and unground	109	20,326	284	57,991
Cut and sawed	127	42,033	64	18,900
Ground, washed, or pulverized	20,404	631,707	19,954	649,955
Total imports	20,640	694,066	20,302	726,846
Exports:				
Talc, steatite, soapstone, and pyrophyllite, crude and ground [5]	23,009	[6] 705,806	23,223	757,516
Powder-talcum (in packages), face, and compact	(1)	1,463,010	(1)	1,244,801
Total exports		2,168,816		2,002,317

[1] Figure not available.
[2] Revised figures owing to changes in classification.
[3] Includes some crushed material.
[4] Exclusive of "Manufactures, n. s. p. f. (not specifically provided for), except toilet preparations," as follows: 1951: $2,178; 1952: $1,922. Quantities not available.
[5] Includes "Manufactures, n. e. s."
[6] Revised figure.

TABLE 2.—Talc, pyrophyllite,[1] and ground soapstone sold by producers in the United States, 1943–47 (average) and 1948–52, by classes

Year	Crude [2]			Sawed and manufactured		
	Short tons	Value at shipping point		Short tons	Value at shipping point	
		Total	Average		Total	Average
1943–47 (average)	11,383	$86,152	$7.57	1,023	$238,192	$232.84
1948	15,936	138,956	8.72	920	227,963	247.79
1949	15,731	170,414	10.83	636	253,704	398.91
1950	18,805	186,120	9.90	805	312,776	388.54
1951	20,166	211,241	10.48	1,097	375,141	341.97
1952	19,029	203,895	10.71	976	309,271	316.88

Year	Ground [2]			Total		
	Short tons	Value at shipping point		Short tons	Value at shipping point	
		Total	Average		Total	Average
1943–47 (average)	424,249	$5,610,443	$13.22	436,655	$5,934,787	$13.59
1948	501,890	7,898,444	15.75	518,746	8,265,363	15.93
1949	[3] 445,529	[3] 7,099,360	[3] 15.93	461,896	7,523,478	16.29
1950	[3] 601,140	[3] 10,121,847	[3] 16.84	620,750	10,620,743	17.11
1951	[3] 614,805	[3] 10,736,448	[3] 17.46	636,068	11,322,830	17.80
1952	[3] 573,142	[3] 10,834,151	[3] 18.90	593,147	11,347,317	19.13

[1] Includes pinite 1944, 1947, and 1948.
[2] Revised figures owing to changes in classification.
[3] Includes some crushed material.

DOMESTIC PRODUCTION

Mine production of talc, pyrophyllite, and ground soapstone decreased 6 percent in quantity in 1952 from the record high production of 1951, according to reports by producers (table 1). The quantity of these commodities sold by producers decreased 7 percent but increased slightly in value to a new high (table 2).

Most of the talc, pyrophyllite, and soapstone is ground by the producers before it enters the trade, although some consumers buy crude material and grind it to the desired specifications in their own mills. Some producers sell crude material to grinders. The figures in table 2 have been revised to show the proportion of material that enters the trade in crude and ground form rather than the proportion of each grade sold by the primary producers, as was done in previous years.

Pyrophyllite production and sales in 1952 were 5 percent greater in quantity than in 1951, a record high, but the value was 5 percent less (table 3).

As in 1951, New York, California, and North Carolina ranked first, second, and third, respectively, in production and sales of talc, pyrophyllite, and ground soapstone in 1952. Pyrophyllite was reported from North Carolina, the major producing State, and California (table 4). North Carolina was the only State reporting an

TABLE 3.—Pyrophyllite [1] produced and sold by producers in the United States, 1943–47 (average), and 1948–52

Year	Production (short tons)	Sales					
		Crude		Ground		Total	
		Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	83,076	6,850	$47,488	74,404	$725,332	81,254	$772,820
1948	107,885	5,175	25,766	102,152	1,313,266	107,327	1,339,032
1949	90,920	5,927	31,489	82,934	1,070,838	88,861	1,102,327
1950	116,800	5,690	30,016	112,119	1,504,141	117,809	1,534,157
1951	120,031	4,446	23,741	114,398	1,664,058	118,844	1,687,799
1952	125,496	4,720	29,922	119,767	1,569,471	124,487	1,599,393

[1] Exclusive of pinite.

TABLE 4.—Talc, pyrophyllite, and ground soapstone sold by producers in the United States, 1950–52, by State of origin

State	1950		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
California	109,747	$2,069,211	126,784	$2,269,771	120,574	$2,868,255
Georgia	70,749	774,148	77,895	823,133	56,491	653,144
Maryland and Virginia	41,206	355,075	45,399	431,579	37,755	356,274
Nevada	8,581	170,736	6,919	152,878	(1)	(1)
New York	163,974	4,039,973	152,652	4,170,987	149,837	4,069,771
North Carolina	116,895	1,855,163	113,950	1,982,927	115,481	1,771,518
Texas	(1)	(1)	(1)	(1)	17,800	216,569
Vermont	72,135	906,396	78,694	998,792	71,027	926,646
Other States [2]	37,463	450,041	33,775	492,763	24,182	485,140
Total	620,750	10,620,743	636,068	11,322,830	593,147	11,347,317

[1] Included with "Other States."
Includes Montana, Washington, and States indicated by footnote 1.

increase in production of talc, pyrophyllite, and ground soapstone in 1952.

CONSUMPTION AND USES

Sales to 6 industries—ceramics, paint, insecticides, rubber, roofing, and paper—consumed 84 percent of the domestic production of talc, pyrophyllite, and ground soapstone in 1952, according to reports from producers, and ranked in the same order as in 1951 (table 5).

TABLE 5.—Talc, pyrophyllite, and ground soapstone sold by producers in the United States, 1950–52, by uses [1]

Use	1950		1951		1952	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Ceramics	148,500	24	170,521	27	143,161	24
Paint	145,000	23	122,557	19	125,126	21
Insecticides	77,000	12	90,418	14	87,361	15
Rubber	75,900	12	70,970	11	64,476	11
Roofing	55,400	9	64,768	10	49,561	8
Paper	29,600	5	27,974	5	26,327	4
Toilet preparations	11,700	2	7,946	1	8,811	2
Foundry facings	7,800	1	7,986	1	7,279	1
Crayons	600	(2)	738	(2)	703	(2)
Other uses [3]	48,000	8	56,675	9	67,924	12
Unclassified	21,250	4	15,515	3	12,418	2
Total	620,750	100	636,068	100	593,147	100

[1] Partly estimated (1950–51).
[2] Less than 0.5 percent.
[3] Refractory, textile, asphalt filler, plaster, and miscellaneous other uses.

PRICES

Table 6 shows the prices of ground talc and pyrophyllite at the beginning of 1951 and 1952 and at the end of the latter year, as quoted by the Oil, Paint and Drug Reporter.

TABLE 6.—Prices quoted on talc and pyrophyllite, carlots, 1951–52, per short ton

[Oil, Paint and Drug Reporter]

Mineral and grade	Jan. 8, 1951	Jan. 7, 1952	Dec. 29, 1952
GROUND TALC (BAGGED)			
Domestic, f. o. b., works:			
Ordinary:			
California	$25.00–$35.00	$25.00–$35.00	$25.00–$35.00
Vermont	14.00	14.00	14.00
Fibrous (New York):			
Off color	24.00	25.00–30.00	25.00–30.00
325-mesh:			
98.5–99.5 percent	25.00	(1)	(1)
99.5 percent	(1)	27.00	27.00
99.95 percent, micronized	(1)	(1)	36.00
Imported (Canadian), f. o. b. mines	12.50–35.00	15.25–35.00	15.25–35.00
PYROPHYLLITE			
Standard, bulk, mines: [2]			
200-mesh	11.00–11.50	12.50	12.50
230-mesh	12.00–12.50	13.50	13.50
325-mesh	15.75	16.75	16.75
No. 3: 200-mesh, bulk, mines [2]	9.50	11.00	11.00
Insecticide grade: 200-mesh, bags, mines	12.00–12.50	13.50–14.00	13.00–13.50
Rubber grade: 140-mesh, bags, mines	10.00–10.50	13.50	11.50–12.00

[1] Not quoted.
[2] In paper bags, $3 to $3.50 per ton extra.

The trend in the average value per ton of domestic talc, pyrophyllite, and soapstone sold by producers continued upward, as shown in table 2.

FOREIGN TRADE [3]

Imports.—A 2-percent decrease in quantity and a 5-percent increase in value were reported in 1952 from 1951 for the total of unmanufactured talc, steatite or soapstone, and French chalk imported for consumption in the United States. Imports of manufactures (not specifically provided for except toilet preparations) declined 12 percent. Detailed data on imports are given in table 7.

Exports.—Crude and ground talc, steatite, soapstone, and pyrophyllite exports showed a slight increase in quantity and decreased 5 percent in value in 1952 from 1951. Exports of manufactures increased 150 percent in quantity and 135 percent in value during the same period. The value of exports of "powders—talcum (in packages), face and compact" was $218,000 less than in 1951.

TABLE 7.—Talc, steatite or soapstone, and French chalk imported for consumption in the United States, by classes in 1948–50, and by classes and countries in 1951–52

[U. S. Department of Commerce]

Country	Crude and unground		Ground, washed, powdered, or pulverized except toilet preparations		Cut and sawed		Total unmanufactured		Manufactures n. s. p. f., except toilet preparations (value)
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	
1948	85	$4,835	18,194	$484,857	98	$29,133	18,377	$518,825	$14,772
1949	47	4,981	18,648	537,061	121	35,072	18,816	577,114	9,012
1950	177	10,052	23,054	637,262	156	44,364	23,387	691,678	7,574
1951									
Canada			3,484	43,402	1	628	3,485	44,030	99
China			(1)	241			(1)	241	2,045
Egypt			55	3,600			55	3,600	
France			1,855	35,645	12	7,888	1,867	43,533	
Germany									5
Hong Kong			(1)	26			(1)	26	18
India	75	10,834	832	28,938			907	39,772	
Italy	34	9,492	14,178	519,855	98	28,469	14,310	557,816	
Japan					3	1,476	3	1,476	
Norway					13	3,572	13	3,572	
United Kingdom									11
Total	109	20,326	20,404	631,707	127	42,033	20,640	694,066	2,178
1952									
Canada	20	275	3,204	44,673	15	1,564	3,239	46,512	71
China									509
France			1,566	38,979	12	3,201	1,578	42,180	3
Germany, West									804
India	113	14,908	546	31,967			659	46,875	
Italy	151	42,808	14,638	534,336	9	4,220	14,798	581,364	198
Japan					16	6,451	16	6,451	
Netherlands									24
Norway					12	3,464	12	3,464	
Peru									3
Switzerland									256
United Kingdom									54
Total	284	57,991	19,954	649,955	64	18,900	20,302	726,846	1,922

[1] Less than 1 ton.

[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 8.—Talc, pyrophyllite, and talcum powders exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Talc, steatite, soapstone, and pyrophyllite				Powders—talcum (in packages), face and compact (value)
	Crude and ground		Manufactures, n. e. s.		
	Short tons	Value	Short tons	Value	
1948	16,327	$432,176	(1)	(1)	$2,228,956
1949	15,840	439,686	1	$455	1,636,505
1950	20,593	560,752	51	25,492	1,233,609
1951	22,903	645,217	106	[2] 60,589	1,463,010
1952	22,958	615,160	265	142,356	1,244,801

[1] Not separately classified before January 1949.
[2] Revised figure.

TECHNOLOGY

The development of cordierite bodies using talc and clay was discussed.[4] The history of the use of talc in porcelain body formulas was reported.[5] The use of talc in paint, storage battery cases, high-frequency electronic insulators, and other ceramic bodies was described in several articles.[6] A study was made of the hydrothermal synthesis of talc and serpentine from mixtures of MgO and SiO_2 heated with water in an autoclave.[7] The properties of Indian talcs were determined and used as a basis of classification.[8] The beneficiation of low-grade pyrophyllite by elutriation to remove quartz, pyrite, and gypsum was described. The washed product contained 87.8 percent pyrophyllite, 7.2 percent diaspore, 2.1 percent halloysite, and 1.1 percent gypsum.[9]

WORLD REVIEW

The production of talc, pyrophyllite, and soapstone, 1948–52, by countries, is shown in table 9. The world production decreased 11 percent in 1952 from the record high of 1951. Countries from which substantially lower production was reported, in addition to the United States, were Japan, France, and Austria.

Austria.—Talc exports for 1951–52, by country of destination, are given in table 10. Imports were 50 metric tons valued at 117,000

[4] Gaskins, W. W., How to Develop Cordierite in a Gas Heater's Backwall Radiant: Ceram. Ind., vol. 58, No. 3, March 1952, p. 85.
Hughan, R. R., Cordierite Saggers of Increased Durability from Australian Talc and Clays: Australian Jour. Appl. Sci., vol. 3, No. 2, June 1952, pp. 173–192.
[5] Gaskins, W. W., Historical Background Development on Use of Talc in Ceramic Bodies: Am. Ceram. Soc. Bull., vol. 31, No. 10, October 1952, pp. 392–395.
[6] Lamar, R. S., California Talc in Paint Industry: California Jour. Mines and Geol., vol. 48, No. 3, July 1952, pp. 189–199.
Haskell, D., Mineral Needs and Problems of Lead-Acid Storage Battery Industry in California: Californi Jour. Mines and Geol., vol. 48, No. 1, January 1952, pp. 9–28.
Roy, S. B., and Varshney, Y. P., Use of Talc in Ceramic Industry: Statesman (Calcutta), Glass and Ceramic Survey, Jan. 7, 1952, p. 4.
Alderman, A. R., Mount Fitton (South Australia) Talc as a Possible Source of Forsterite Refractories Univ. Adelaide, Sir Douglas Mawson Anniversary Volume, 1952, 6 pp.
[7] Kiyoura, Raisaku, Ito, Yoshitaka, and Masumizo, Masauki, Hydrothermal Reaction of Silicate II, Hydrothermal Synthesis of Talc and Serpentine: Jour. Ceram. Assoc. Japan, vol. 60, No. 673, 1952, pp. 264–266; Ceram. Abs., January 1953, p. 17.
[8] Ram, Atma, Banerjee, J. C., Roy, S. B., and Varshney, Y. P., Studies on Indian Talcs: I, General, Chemical, and Mineralogical Characteristics: Proc. Indian Sci. Cong., 39th Cong., pt. 3, 1952, p. 126.
[9] Bishop, G. J., III, Pyrophyllite in Refractory Enamels: Am. Ceram. Soc. Bull., vol. 31, No. 12, Dec. 15, 1952, pp. 493–496.

schillings, from Switzerland.[10] (Rate of exchange: 1951–52, inclusive, 21 to 26 schillings equaled $US1.)

Australia.—The talc deposits of South Australia were reported to contain ample reserves to supply Australian requirements for many years and to warrant development of an export trade in the higher grades of talc.[11]

Canada.—According to the official preliminary estimates, Canada produced 12,639 short tons of talc (value $C150,695) and 13,409 tons of soapstone (value $C146,821) in 1952, compared with final revised 1951 figures of 13,698 tons of talc (value $C160,540) and 11,148 tons of soapstone (value $C123,084).[12] Imports of talc and soapstone in 1952 were given as 8,749 tons (value $C276,496) and exports of talc 3,435 tons (value $C44,925). In 1951, the value of the Canadian dollar ranged from $US0.95 to $US0.98; in 1952, the value ranged from $US0.99 to $US1.04.

TABLE 9.—World production of talc, pyrophyllite, and soapstone, by countries,[1] 1948–52, in metric tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
North America:					
Canada (shipments)	26,109	24,423	29,578	22,540	23,504
United States	[3] 479,484	416,709	559,440	581,009	545,132
South America:					
Argentina [4]	(5)	(5)	(5)	15,000	16,000
Brazil	9,881	17,782	12,632	11,304	(5)
Chile	270	110	142	25	(5)
Uruguay	2,984	660	681	959	679
Europe:					
Austria	47,510	56,050	58,681	72,784	50,822
Finland	237	(5)	4,000	----------	----------
France	91,520	100,055	95,500	120,000	95,400
Germany, West	28,214	30,968	13,314	19,500	10,653
Greece	1,800	1,700	2,500	2,623	1,200
Italy	70,430	61,462	67,616	75,827	80,336
Norway	57,226	53,993	64,099	60,000	[4] 60,000
Portugal	21	3	2	1	(5)
Spain [6]	29,984	38,208	25,131	36,034	27,859
Sweden	11,703	11,293	13,843	13,332	(5)
United Kingdom	4,000	2,616	1,727	2,540	(5)
Asia:					
Afghanistan	----------	100	75	840	800
India	18,386	21,535	25,894	32,314	(5)
Japan	243,737	262,433	283,566	400,626	318,386
Korea, Republic of	72	2,773	(5)	3,208	3,964
Taiwan (Formosa)	----------	76	700	2,057	1,093
Africa:					
Egypt	5,521	5,573	3,731	3,754	4,903
Kenya	322	590	334	337	235
Union of South Africa	4,897	5,386	3,978	5,663	8,674
Australia	6,199	8,717	9,851	13,359	7,772
Total (estimate) [1]	1,300,000	1,300,000	1,425,000	1,650,000	1,475,000

[1] In addition to countries listed, talc or pyrophyllite is reported in China, Rumania, and U. S. S. R., but data on production are not available; estimates have been included in total.
[2] This table incorporates a number of revisions of data published in previous talc chapters.
[3] Includes some pinite.
[4] Estimate.
[5] Data not available; estimate by senior author of chapter included in total.
[6] Includes steatite as follows: 1948: 18,627; 1949: 20,880; 1950: 13,702; 1951: 22,628; 1952: 18,412.

[10] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 5, May 1952, p. 46; vol. 37, No. 4, October 1953, p. 71.
[11] Chemical Engineering and Mining Review, vol. 44, No. 11, Aug. 11, 1952, p. 425.
[12] Canada, Department of Trade and Commerce, Dominion Bureau of Statistics, Preliminary Rept. on Mineral Production—1952: Prep. in Min., Met., and Chem. Sec., Industry and Merchandising Div., Dominion Bureau of Statistics, Ottawa, Canada, pp. 6–7.

TABLE 10.—Talc exports from Austria, by countries of destination, 1951-52, in metric tons

Country of destination	1951		1952	
	Metric tons	Value,[1] 1,000 schillings	Metric tons	Value,[1] 1,000 schillings
Argentina	35	37	----------	----------
Belgium-Luxembourg	938	335	661	232
Czechoslovakia	92	44	----------	----------
Denmark	----------	----------	25	10
France	901	317	668	315
Germany: East	3,618	2,458	1,536	1,351
West	15,642	7,134	12,192	6,234
Great Britain	403	109	527	173
Hungary	3,668	2,595	3,095	2,416
Italy	21	4	48	20
Netherlands	1,449	548	1,994	890
Poland	6,916	4,046	8,812	4,404
Sweden	15	11	----------	----------
Switzerland	1,756	712	1,264	576
Trieste	----------	----------	24	10
Yugoslavia	92	156	86	171
Total	35,546	18,506	30,932	16,802

[1] Rate of exchange: 1951-52, incl., 21 to 26 schillings equaled $US1.

Source: Statistik des Aussenhandel Osterreichs, 1952, Vienna.

TABLE 11.—Consumption of ground talc and soapstone in Canada, 1948-50, by use and by Province in short tons

	1948	1949	1950
USE			
Roofing	7,696	8,595	9,739
Paints	6,041	5,378	9,023
Insecticides and miscellaneous chemicals	2,461	4,674	6,006
Rubber	3,125	3,002	3,290
Pulp and paper	3,722	3,827	1,634
Toilet and medicinal preparations	1,242	864	861
Clay products	1,127	882	716
Textiles	[1] 150	484	571
Electrical apparatus	658	815	475
Soaps and cleaning preparations	310	215	159
Iron foundries	[1] 106	110	110
Coal tar distillation	----------	----------	98
Tanneries	[1] 50	50	50
Polishes	14	----------	25
Prepared foundry facings	70	846	21
Linoleum	6	5	----------
Adhesives	4	----------	----------
Total	26,782	29,747	32,778
PROVINCE			
Ontario	15,911	18,511	19,562
Quebec	8,334	8,433	8,735
Manitoba	1,493	1,729	3,184
British Columbia	487	416	622
New Brunswick	292	381	421
Nova Scotia	56	[2] 151	127
Alberta	96	66	103
Saskatchewan	113	60	24
Total	26,782	29,747	32,778

[1] Partly estimated.
[2] Includes Newfoundland.

The Canadian talc and soapstone industry in 1951 was described as follows: [13]

Talc and soapstone shipped by producers in 1951 amounted to 24,846 tons valued at $283,624, compared with 32,604 tons worth $364,995 in 1950. Most of the production in Ontario was high grade milled talc. The output from Quebec included crayons, blocks, and ground soapstone. Operations in British Columbia were for experimental test purposes.

The industry employed 50 persons to whom $109,522 were paid in salaries and wages. Fuel cost $5,945 and 1,267,218 k.w.h. of electricity were purchased for $19,529.

Imported talc and soapstone amounted to 9,283 tons valued at $306,277. During 1951 there were 3,743 tons of talc valued at $48,857 exported from Canada.

Talc and pyrophyllite occurrences in British Columbia were described.[14]

France.—Open-pit mining methods at Luzenac talc mines were described, and analyses of the product were given.[15]

Netherlands.—Imports of talc and soapstone, 1951–52 including ground, by country of origin, are given in table 12.[16]

Republic of Korea.—According to a despatch from the American Embassy in Pusan, talc exports from Korea in 1952 totaled 7,965 metric tons, valued at $US246,192. Exports to Japan were 6,330 metric tons, valued at $US183,320.

TABLE 12.—Imports of talc and soapstone into the Netherlands, 1951–52, by country of origin, in metric tons

Country of origin	1951		1952	
	Metric tons	Value, 1,000 guilders [1]	Metric tons	Value, 1,000 guilders [1]
Austria	1,414	135	1,985	231
Egypt	200	71		
France	1,479	291	1,106	227
Germany, West	144	14		
India	399	77	130	30
Italy	141	32	412	87
Norway	7,985	768	5,706	605
Others	6	4	396	32
Total	11,768	1,392	9,735	1,212

[1] 1 guilder equals about $US0.263.

[13] Canada, Department of Trade and Commerce, Dominion Bureau of Statistics, The Talc and Soapstone Industry, 1951: Industry and Merchandising Div., Min., Met., and Chem. Sec., Ottawa, Canada, 1952, 5 pp.

[14] Cummings, J. M., and McCammon, J. W., Clay and Shale Deposits of British Columbia: British Columbia Dept. Mines, Bull. 30, 1952, 64 pp.

[15] Vie, Georges, Mining of Talc at Mines of Luzenac: Echo des mines et de la metallurgie, No. 3443, April 1952, pp. 257–259.

[16] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 5, May 1953, p. 54.

Tin

By Abbott Renick[1] and John B. Umhau[2]

THE TIN INDUSTRY in 1952 was characterized by resumption of private importation of tin, termination of the Reconstruction Finance Corporation's tin-purchase program, stable tin prices, resumption of purchases of tin for the National Strategic Stockpile, and nationalization of the three principal tin-mining companies in Bolivia.

Effective August 1, 1952, an amendment to National Production Authority Order M–8 permitted resumption of private importation of tin; and when this prohibition against free trading was removed the RFC price became, in effect, the ceiling price. For the remainder of the year, spot grade A tin sold at $1.215, or slightly below. The Preparedness Subcommittee of the Senate Armed Services Committee released a supplemental report on tin which criticized tin producers and claimed that, by following the policy it recommended on price, the United States would save at least one-half billion dollars.

In Bolivia, a decree signed on October 31, 1952, nationalized operations of the three principal tin-mining companies. The properties were placed under control of the Corporacion Minera Boliviana, the Government mining corporation created by decree shortly before nationalization.

In January 1952, the Reconstruction Finance Corporation entered into a purchase agreement with the United Kingdom for the supply of 20,000 long tons of tin, delivery to be completed by the end of the year. In mid-March the RFC consummated a 3-year contract with Indonesia providing for the supply of 18,000 tons a year, at a price of $1.18 per pound at ports of shipments for the first 2 years of the contract, although the price for the third year was left open to negotiation. A week later the Belgian Congo contracted to supply 7,000 tons over a 2-year period (1952–53), with an option to supply 75 percent of any increased production up to a further 2,000 tons. Approximately 2,000 tons of the quantity delivered was to be in the form of concentrates. The price was $1.2075 a pound of tin delivered at American ports. In January 1952, the United States price was raised from $1.03 to $1.215 and remained virtually unchanged for the next 12 months.

The Preparedness Investigating Subcommittee of the Committee on Armed Services, United States Senate, conducted a comprehensive investigation on tin, culminating in a report issued March 5, 1951; on July 17, 1952, the committee issued a supplemental report, the second on this subject.[3] The first report recommended that tin

[1] Commodity-industry analyst.
[2] Statistical assistant.
[3] Preparedness Subcommittee of the Committee on Armed Services, U. S. Senate, Investigation of the Preparedness Program, 6th Rept., Tin: 82d Cong., 1st sess., 1951, p. 48, and U. S. Senate, Supplemental Report on Tin: 82 Cong., 2d sess., 1952, 12 pp.

purchasing be centralized in a single Government department and that stockpiling be suspended until prices decreased to a reasonable level. The committee concluded that, in case of war, sufficient tin stocks were on hand to satisfy United States requirements if stringent control and conservation measures were put into effect. The recommendations of the supplemental report on tin were:

1. That our responsible officials initiate a study to determine the best allocation of recently acquired tin supplies among our various defense and industrial needs, with particular consideration to be given to our tin stockpile.
2. That officials engaged in procuring raw materials abroad study the history of the tin negotiations carefully as a guide to the conduct of negotiations for other materials.
3. That in all future contracts the most-favored-nation clause be eliminated.

The Bolivian mining industry's traditional problems were overshadowed in 1952 by the revolutionary ascent to power of the National Revolutionary Movement (MNR party) and the new Government's subsequent nationalization of the bulk of the mining industry. The properties of the three largest mining groups—Patiño, Hochschild, and Aramayo—were expropriated by a Supreme Decree of October 31. The operation of these properties, which normally provide approximately 70 percent of Bolivian tin production, was charged to the Corporacion Minera de Bolivia (CMB), a state entity established for this purpose just before nationalization. Presaging the October 31 expropriation was a Government decree of June 2, which nationalized all mineral exports by making the Banco Minero de Bolivia the sole purchaser of production.

World mine production of tin totaled 173,000 long tons in 1952—the highest since 1941—but was only 3,000 tons (2 percent) greater than in 1951. Had it not been for a 4,000-ton increase in Indonesia—the only major producer to show an increase—there would have been a small world decline. In Malaya, production remained virtually unchanged from 1951. World smelter production totaled 171,000 long tons, a 1-percent increase over the 1951 output of 169,000 long tons. During the 3 years 1950–52, world mine production exceeded world consumption by about 46,000 long tons.

Consumption of tin in 1952 in the United States, under Government control, decreased 17 percent from 1951; consumption of primary tin decreased 20 percent and of secondary 11 percent. Domestic smelter output, all from the Government-owned smelter at Texas City, decreased 9,000 long tons (28 percent) from 1951 owing to a shortage of tin concentrates and complete suspension of operations resulting from a 76-day labor strike. Secondary tin production was 6 percent less than in 1951.

Metal imports increased 185 percent and represented 75 percent of the total tin imported. Receipts of concentrates, in terms of metal, decreased 11 percent from 1951. The decrease was due chiefly to decreased receipts from Indonesia. Imports of tin in concentrates from Bolivia decreased 3 percent. In 1952, imports of tin in concentrates and tin metal into the United States were augmented by 7,600 long tons (gross weight—chief value, tin) of tin alloys, mainly from the Netherlands in the form of a 94-percent tin alloy. This material was not under formal quantitative allocation control.

The total stocks of tin in the United States and in transit as of December 31, 1952, were 62,000 long tons, exclusive of the National Strategic Stockpile. As a reserve for civilian deficiency, the RFC on December 31, 1951, held 13,000 long tons of pig tin. On December 31, 1952, tin concentrate and other tin-bearing materials held by the RFC contained an estimated total tin content of 25,000 long tons. As of December 31, tin stocks held by industry were 24,000 long tons.

During 1952 domestic tin prices were virtually stable. The RFC maintained the selling price at $1.03 a pound from August 1, 1951, to January 21, 1952. As a consequence of the United Kingdom tin-purchase agreement, announced on January 18, 1952, the price was increased to $1.215 on January 22, at which the RFC price for resale was maintained until the end of the year. The annual average for 1952 was $1.2044 per pound.

There was no formal meeting of the International Tin Study Group in 1952.

Major progress was made during the year in the accumulation of tin for the National Strategic Stockpile.

The Defense Minerals Exploration Administration, acting under authority of the Defense Production Act of 1950, as amended, provided exploration assistance amounting to 90 percent of costs to approved tin-exploration projects. The following applicants were awarded contracts with DMEA from the beginning of the program to the end of 1952:

State or Territory contractor	Project location	Value	
		Total	Government participation
Alaska:			
Zenda Gold Mining Co.	Seward Peninsula	$120,000.00	$108,000.00
United States Tin Corp.	do	226,000.00	203,400.00
Purkeypile, I. W.	do	18,000.00	16,200.00
South Dakota: Keenan Properties	Lawrence County	48,931.00	44,037.90

TABLE 1.—Salient statistics of tin in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Production—						
From domestic mines [1] long tons	2.5	4.7	68.4	94.1	88.0	98.7
From domestic smelters [2] do	33,930	36,703	35,834	33,118	31,852	22,805
From secondary sources do	29,160	26,900	22,230	31,680	30,745	28,800
Consumption:						
Primary	54,969	59,863	47,163	71,191	56,884	45,323
Secondary	29,616	30,925	25,243	33,273	31,285	27,950
Imports for consumption:						
Metal do	14,842	49,196	60,224	82,838	[3] 28,255	80,543
Ore (tin content) do	31,673	37,492	38,311	25,960	[3] 29,621	26,491
Exports (domestic and foreign) do	959	91	154	799	1,513	380
Monthly price of Straits tin at New York:						
Highest cents per pound	64.00	103.00	103.00	163.50	184.00	121.50
Lowest do	55.60	94.00	77.50	74.125	103.00	103.00
Average do	57.70	99.25	99.316	95.557	128.31	120.44
World mine production long tons	106,600	[3] 154,000	161,800	[3] 169,600	[3] 169,900	173,200

[1] Includes Alaska.
[2] Including tin content of ores used direct to make alloys.
[3] Revised figure.

GOVERNMENT CONTROLS

The supply of tin reached virtual balance with defense and essential civilian demand in 1952. Curbs on the use of tin were relaxed progressively by National Production Authority, by amendments to control orders. The overall use quota of 90 percent of base period consumption, however, was retained throughout 1952.

NPA Order M–8 was amended April 9 to require more precise certification concerning the permitted uses of pig tin, mainly applying to smaller users that had been disregarding the limitation restricting their quarterly use to 90 percent of the base period. Effective July 21, limited use of tin was authorized for costume jewelry and other uses that had been banned, and 40 percent solder was permitted without certification. Effective August 1, private firms could resume importing tin from suppliers of their own choosing. Domestic use remained under control, but consumers could receive allocations for 3-month periods, rather than month-by-month as before. The RFC, sole importer into the United States from March 12, 1951, continued to buy foreign tin under existing contracts and to make tin available to industry in accordance with NPA allocation. On August 25, the Defense Production Administration moved tin from List I (materials in short supply) to List II (materials in approximate balance). Beginning September 23, the use of body solder in the production of automobiles and trucks was permitted. Announcement was made December 30 of an amendment to M–8 removing allocation controls over pig tin, effective January 1, 1953.

NPA Order M–24, controlling the use of tinplate and terneplate, was amended March 4 to establish and permit utilization of three new classifications of irregular or offgrade tinplate and terneplate that had been accumulating in the hands of distributors and mills. These were unmended menders, unassorted temper tinplate, and other coated secondaries. On August 12, restrictions on the use of tin-mill accumulation of secondaries were removed, and coating weight of terneplate for roofing purposes was liberalized. On September 12, restrictions on the end use of terneplate were removed, although its status as a controlled material was continued to permit wider use to counteract a sluggish movement of existing stocks. The requirement that secondary tin only was to be used to make terne metal was continued, however.

NPA Order M–25 restricted the uses of cans and set down specifications for can materials according to products packed. Effective January 1, 1952, can users were allowed to adjust their bases for the first three quarters of 1952 without applying to NPA. This gave packers an opportunity to spread production equally over all quarters of the year. On January 22, M–25 was completely revised to supersede previous issues and amendments. The revised order increased the quantity of cans used for some packs and permitted increased weight of tin coatings in packing some items.

An amendment to M–25, March 13, redefined tinplate and permitted canners and packers to use any quantity of secondary tin mill plate without having material charged against their quotas. On May 14, retroactive to April 1, increased use of cans was allowed by packers whose needs had increased, to take advantage of surplus allotments of packers who had not used permitted quotas. On June 30, to cushion the impact of the steel strike, direction 4 to M-25 required can manufacturers to schedule operations to give preference to orders for cans for packing perishable food products. This was revoked effective October 14. On October 2, freer use of tinplate was permitted, and all restrictions on terneplate were removed in the manufacture of cans. On August 15, M-25 was amended to remove restrictions on secondaries of tinplate in can production.

Amendment 1, Controlled Materials Plan Regulation I, December 24, 1952, removed from the controlled-material category mill accumulation plate, unassorted temper tinplate, unmended menders, waste-waste, and other coated secondaries as defined in NPA Order M-24. Under CMP, allotments of tinplate and terneplate were made to can manufacturers for the production of cans.

Effective August 21, the Office of Price Stabilization, by amendment 13 to Ceiling Price Regulation 31, made it clear that tin was no longer excluded from the list. Being covered by a Government purchase program, tin had been excepted from the regulation.

On February 14, 1952, NPA Order M-98 was issued to assure an adequate supply of shredded used cans to copper producers who precipitate copper from water containing copper sulfate in or about copper mines. Used-can collectors in certain California and Arizona counties had to dispose of their cans to shredding plants in those counties or to copper producers engaged in precipitating copper. Shredding-plant operators had to deliver their products only to copper producers engaged in precipitating copper.

DOMESTIC PRODUCTION

MINE OUTPUT

Domestic mine production of tin was again insignificant in terms of United States demand. Only 100 long tons of tin was produced in 1952 compared with 90 in 1951. As usual, Alaska was the principal producer. Mining in Alaska in 1952 was confined mainly to placer deposits of the Northern Tin Co., Inc., on Buck Creek and lode mining by the United States Tin Corp. at Lost River on Seward Peninsula. The Climax Molybdenum Corp., Climax, Colo., and the Foote Mineral Co., Kings Mountain, N. C., recovered very small quantities of tin as a byproduct of mining for molybdenum and spodumene, respectively.

The production of lode tin by the United States Tin Corp., in 1952 was the first from this source in Alaska since 1905. It was made possible by Government financial assistance through a Defense Minerals Procurement Agency purchase "floor-price" type of contract; the authorized advance amounted to $1,301,000[4] as of August 31, 1952. The quantities involved under the contract were 800 short tons of tin and 450 short tons of tungsten concentrates. The effective date of the contract was March 23, 1951, and the approximate term of the contract was 4¾ years.

In 1952 the Defense Minerals Exploration Administration executed a tin-exploration contract for a total estimated expenditure of $18,000

[4] Committee on Interior and Insular Affairs, U. S. Senate, Defense Minerals Policy: 82d Cong., 2d sess., hearings on Dec. 12, 1951, at Butte, Mont., pp. 222-223.

with I. W. and S. E. Purkeypile, Fort Gibbon Mining District, Alaska; Government participation amounted to $16,200. The contract was completed without the discovery of tin reserves of commercial or long-range interest. The exploration contracts of 1951 included one with the Zenda Gold Mining Co. in Alaska (Government participation $54,000, total contract $60,000) and one with the Keenan Properties in South Dakota (Government participation $90,000, total contract $100,000).

At the end of 1952 amended contracts with the Keenan Properties reduced the total thereof to $48,931, of which Government participation was $44,037.90; and with the Zenda Gold Mining Co. increased the amount to $120,000, of which Government participation was $108,000. There was negotiated also in 1952 a DMEA contract with the United States Tin Corp. for exploration to a total of $226,000 (Government participation $203,000).

TABLE 2.—Mine production of tin (content) in the United States, 1943–47 (average) and 1948–52, by States, in long tons

Year	Alaska	South Dakota	Colorado	Other States	Total	
					Long tons	Value
1943–47 (average)	.3	(1)	(1)	1.0	2.5	$3,040
1948	[2] 4.7	(2)			4.7	10,380
1949	51.6		16.8		68.4	152,210
1950	79.5		14.6		94.1	201,446
1951	68.6		18.8	.6	88.0	252,920
1952	81.9		12.5	4.3	98.7	266,280

[1] Included in total.
[2] A very small quantity from South Dakota is included with Alaska.

SMELTER OUTPUT

Domestic tin-smelter production was 22,800 long tons in 1952 compared with 31,900 tons in 1951. In 1952 all of the production came from the Government-owned Longhorn smelter at Texas City, as no privately owned smelter was in operation in the United States. The output of the smelter was the smallest since 1943 due to a shortage of concentrates in the first part of the year and virtual stoppage of all production during June, July, and August by a strike (which began on June 3 and was settled with workers returning to their jobs on August 19). A large influx of concentrates in the latter half contributed to a very high production rate, and in November output reached 4,000 long tons of 3-Star metal, the highest recorded by the plant for any month.

In addition to Longhorn tin, the smelter produced 252 long tons gross weight of Copan alloy (213 tons, tin content) in 1952, against 700 tons (592 tons tin content) in 1951. According to the RFC, during the 6 months ended December 31, 1952, production at the smelter aggregated 13,640 long tons of tin (13,590 of 3-Star and 50 of Copan) at a cost of $37 million.

The Longhorn smelter received 51,500 long tons of concentrates, containing 24,800 tons of tin, in 1952 compared with 57,700 tons, containing 28,600 tons of tin, in 1951.

TABLE 3.—Production of Longhorn tin at the Texas City smelter, by months, 1943–47 (average) and 1948–52, in long tons

Month	1943–47 (average)	1948	1949	1950	1951	1952
January	2,943	3,172	3,257	2,627	3,211	1,802
February	2,911	2,800	3,254	2,362	3,096	1,800
March	2,814	2,602	3,104	2,729	3,123	1,800
April	2,756	2,906	2,851	2,484	3,058	1,800
May	2,780	3,310	3,007	2,852	3,059	1,800
June	2,801	3,651	3,006	2,204	2,655	-------
July	2,744	3,509	2,910	2,256	2,406	-------
August	2,544	3,509	3,005	2,396	2,505	50
September	2,706	2,859	2,910	2,805	2,155	2,450
October	2,890	2,300	2,964	3,209	2,055	3,364
November	2,876	2,907	2,994	3,207	1,806	4,020
December	2,974	3,153	2,791	3,005	1,805	3,706
Total	33,739	36,678	36,053	32,136	30,934	22,592

Bolivia continued to be the main source of supply, but in 1952 receipts from that source were the smallest since the smelter began operating in 1942. Bolivia supplied only 140 tons of tin in concentrates in the first half and 11,200 tons in the latter half of 1952. Procurement of concentrates from Thailand was increased in 1952 to the highest rate ever reached, and contracts involving 4,800 tons of contained tin were negotiated. Receipts from Portugal, a minor supplier, were the largest ever recorded from that source. Table 4 shows a breakdown of receipts by countries and grades of concentrate in 1951 and 1952.

TABLE 4.—Tin concentrates received at Longhorn smelter, 1951–52[1]

Countries	1951				1952			
	Concentrates received (long tons)	Content		Percent of tin content of receipts	Concentrates received (long tons)	Content		Percent of tin content of receipts
		Long tons	Percent tin			Long tons	Percent tin	
Bolivia	36,234	12,995	35.87	45.43	32,756	11,332	34.60	45.61
Indonesia	15,025	10,956	72.92	38.30	9,644	7,034	72.94	28.31
Thailand	4,169	3,091	74.14	10.81	5,014	3,701	73.81	14.90
Belgian Congo	1,733	1,294	74.67	4.52	1,763	1,293	73.34	5.20
Miscellaneous	516	270	52.33	.94	2,312	1,487	64.32	5.98
Total	57,677	28,606	49.60	100.00	51,489	24,847	48.26	100.00

[1] Source: Reconstruction Finance Corporation.

New agreements made by RFC with Indonesia and the African Metals Corp. (Belgian Congo), effective March 1, 1952, assured delivery of tin in concentrates for 2 years or until March 1, 1954. Yearly deliveries from these 2 sources were expected to aggregate 10,000 tons of tin content (8,000 Indonesia and 2,000 Belgian Congo). Contracts with these suppliers, which expired December 31, 1951, provided for yearly deliveries at the rate of 9,000 and 1,500 tons of tin content, respectively. During 1952 RFC procured approximately 21,000 long tons of tin in concentrates from Bolivia through short-term purchases, as negotiations for a long-term contract were unsuccessful. In the first half of 1952 spot purchase contracts were made for an estimated 15,000 long tons of tin contained in concentrates accumulated in Peruvian and Chilean ports. By June 30, 11,816 long tons of concentrates had been delivered. On September 29, 6,000 to 7,000 long tons of tin in concentrates was contracted for in the same manner.

In 1952 the smelter treated 45,365 tons of concentrates, comprising 28,912 tons of Bolivian, with an average grade of 35.24 percent, and 16,453 tons of alluvial, with an average grade of 72.87 percent.

RFC assets of property, plant, and equipment under the tin program, excluding inventories of refined tin, tin ore, byproducts, and operating and other supplies, were valued at $12,708,023, less accrued depreciation of $4,024,780, or $8,683,243 as of June 30, 1952. The payroll at the smelter normally numbers about 900. As of June 30, 1952, this was reduced to 279 as a result of the strike, but at the end of 1952 there were 851 employees.

Since its inception the Texas City smelter has been operated by the Tin Processing Corp. (a Delaware corporation and a subsidiary of N. V. Billiton Maatschappij) as an independent contractor under an operating agreement with RFC. In conjunction with this arrangement, RFC purchases all concentrates, pays all operating costs, and sells the resulting tin. The contract with the firm was extended to June 30, 1953.

SECONDARY TIN

Recovery of secondary tin decreased 6 percent in quantity and 12 percent in value in 1952 compared with 1951. Most of the tin recovered was contained in copper-, tin-, and lead-base alloys and chemical compounds. Only 10 percent of the total was recovered in the form of metallic tin, and most of this was accomplished by the detinning plants.

In 1952 about 70 percent less tin in tin- and lead-base scrap went into brass and bronze than in 1951, whereas the tin composition of lead- and tin-alloy products (mainly solder) increased 30 percent. The recoverable tin content of copper-base scrap decreased 1,600 long tons, while tin recovered from scrap processed in brass and bronze decreased 4,000 long tons. The total tonnage of recoverable tin from white metal scrap processed declined only 230 long tons, but tin in old tin-base scrap increased 650 long tons. The tin recovered from scrap processed in all categories of white metal increased 2,700 long tons, of which nearly 90 percent was in solder.

TABLE 5.—Secondary tin recovered in the United States, 1943–47 (average) and 1948–52, in long tons

Year	Tin recovered at detinning plants			Tin recovered from all sources			
	As metal	In chemicals	Total	As metal	In alloys and chemicals	Total: Long tons	Total: Value
1943–47 (average)	3,120	320	3,440	3,460	25,700	29,160	$37,363,504
1948	2,930	340	3,270	3,100	23,800	26,900	59,796,140
1949	2,850	410	3,260	3,170	19,060	22,230	49,461,354
1950	3,300	575	3,875	3,615	28,065	31,680	67,809,158
1951	3,150	415	3,565	3,300	27,445	30,745	88,363,153
1952	2,640	310	2,950	2,860	25,940	28,800	77,710,297

Detinning plants treated 439,000 long tons of tin-plate clippings in 1952—9 percent less than the 481,000 tons processed in 1951, the peak year. In addition, old cans processed increased 17 percent to 25,900 long tons in 1952, compared with 22,000 tons in 1951; this was a small figure, however, compared with the record use of 176,000 tons in 1943. In total, from new and old material this industry recovered 3,000 long tons of tin. Tin recovered from tin-plate clippings in 1952 was 2,800 tons, 19 percent less than 1951, while that from old cans—200 tons (mostly in the form of pig tin)—increased 11 percent. For additional data concerning the secondary tin industry, see the Secondary Metals, Nonferrous, chapter of this volume.

CONSUMPTION BY USES

Total domestic consumption of tin was 17 percent less in 1952 than in 1951. The use of primary tin decreased 20 percent and of secondary 11 percent. The tin content of manufactured products was 73,000 long tons in 1952 (45,000 tons of primary and 28,000 of secondary) compared with 88,000 tons in 1951 (57,000 of primary and 31,000 of secondary). The tinplate and terneplate industry decreased its use of tin 11 percent, while the total quantity used by all other industries decreased 20 percent.

Five items—tinplate and terneplate, solder, bronze and brass, babbitt, and tinning—accounted for most of the tin consumed in 1952 and 1951. Tinplate and terneplate, the largest consumers of primary tin, took 60 and 54 percent, respectively, of the totals for 1952 and 1951. A prolonged steel strike interrupted operations of most of the tinplate mills in June and July 1952; thereafter their average monthly usage increased, and during the last 5 months of 1952 it was 17 percent above the average monthly rate for all of 1951. Tonnagewise the use of primary tin for solder decreased more than any other item. Solder required 5,400 tons less primary tin than in 1951, mainly because of substitution of 2,700 tons of tin in imported tin-base alloys and because of the larger tonnage of secondary tin used. Solder was the only item in this group to report increased usage of secondary tin in 1952. Primary tin for babbitt declined 525 tons, mainly through substitution of 360 tons of tin in imported alloys. Tinning declined 14 percent. In respect to total tin used, bronze maintained its position as the second largest consumer, but its total use decreased 3,390 tons (primary 1,226 and secondary 2,164). This does not include 1,970 tons of tin in imported tin-base alloys used for making bronze and brass in 1952.

About 58 percent of the tin used to make tinplate in 1952 was for hot-dipped plate and 42 percent for electrolytic. Hot-dipped tinplate production, however, represented only 33 percent and electrolytic 67 percent of the total output in 1952. Electrolytic tinplate requires considerably less tin per unit of product than hot dipped. Production of tinplate by electrolytic lines was 4 percent below the high record established in 1951. Hot-dipped tinplate production declined 16 percent and was the smallest tonnage recorded since 1932. Terneplate production required 24 percent less tin in 1952 than in 1951. Short-terne output increased 8 percent, whereas long-terne output decreased 24 percent.

Net industrial receipts of tin in 1952 were 79,110 long tons (3 percent less than in 1951), of which 62 percent was primary pig tin. Receipts of primary tin were virtually unchanged; however, other materials decreased 7 percent. (Receipts of 5,460 tons of tin in 1952 in imported tin-base alloys are not included in these figures.) "Straits" resumed its long-time position as the principal brand of tin and constituted nearly one-half of the primary receipts of 1952, against one-fourth in 1951. The principal brand acquired in 1951 was Longhorn, produced by the Government-owned tin smelter at Texas City, Tex., but in 1952 Longhorn ranked second and supplied industry with only 30 percent of its needs. Other brands received in 1952 included Netherlands 9 percent, English 7 percent, Belgian 3 percent, and miscellaneous the remaining 4 percent.

TABLE 6.—Consumption of primary and secondary tin in the United States, 1943–47 (average) and 1948–52, in long tons

	1943–47 (average)	1948	1949	1950	1951	1952
Stocks on hand Jan. 1 [1]	31,773	25,743	27,070	24,621	31,856	20,764
Net receipts during year:						
Primary	53,404	62,119	47,782	79,992	48,298	48,657
Secondary	2,939	3,004	2,606	3,371	3,273	2,338
Terne	280	681	470	997	594	622
Scrap	27,988	29,840	22,193	30,839	28,974	27,493
Total receipts	84,611	95,644	73,051	115,199	81,139	79,110
Available	116,384	121,387	100,121	139,820	112,995	99,874
Stocks on hand Dec. 31 [1]	28,152	27,070	24,621	31,856	20,764	22,826
Total processed during year	88,232	94,317	75,500	107,964	92,231	77,048
Intercompany transactions in scrap	2,676	2,535	2,167	2,168	2,726	2,397
Total consumed in manufacturing	85,556	91,782	73,333	105,796	89,505	74,651
Plant losses	971	994	927	1,332	1,336	1,378
Tin content of manufactured products	84,585	90,788	72,406	104,464	88,169	73,273
Primary	54,969	59,863	47,163	71,191	56,884	45,323
Secondary	29,616	30,925	25,243	33,273	31,285	27,950

[1] Stocks shown exclude tin in transit or in other warehouses on Jan. 1, as follows: 1947, 1,000 tons; 1948, 940 tons; 1949, 328 tons; 1950, 61 tons; 1951, 1,355 tons; 1952, 971 tons; and 1953, 525 tons.

TABLE 7.—Consumer receipts of primary tin, by brands, 1939–52, in long tons

	Banka	Chinese	English	Katanga	Longhorn	Straits	Others	Total
1939	3,540	3,407	8,347	1,902		48,677	4,859	70,732
1940	6,333	3,154	3,034	530		82,980	2,094	98,125
1941	5,238	4,594	3,783	6,589		88,213	5,864	114,281
1942	2,899	1,428	177	3,334	[1] 1,238	21,105	2,945	33,126
1943	4,524	1,700	189	14,983	12,600	5,951	601	40,548
1944	6,717	1,730	53	13,182	25,540	7,560	541	55,323
1945	857	2,303	(2)	6,935	39,575	4,157	836	54,663
1946	588	1,000	(2)	677	48,745	1,244	4,349	56,603
1947	2,856	636	(2)	2,884	37,657	11,144	4,705	59,882
1948	2,888	962	(2)	7,752	24,664	20,492	5,361	62,119
1949	3,491	3,310	(2)	8,435	13,369	14,874	4,303	47,782
1950	1,273	1,500	5,172	5,661	4,912	54,350	7,124	79,992
1951	6,159	352	1,406	4,602	20,263	12,163	3,353	48,298
1952	4,208	(2)	3,279	1,573	14,694	23,010	1,893	48,657

[1] First shipments made in June 1942.
[2] Included in others not separately reported.

TABLE 8.—Consumption of tin in the United States, 1950–52, by finished products, in long tons of contained tin

Product	1950			1951			1952 [1]		
	Primary	Secondary	Total	Primary	Secondary	Total	Primary	Secondary	Total
Tinplate	35,380	--------	35,380	30,522	--------	30,522	[2]27,316	--------	[2]27,316
Terneplate	349	603	952	84	683	767	85	[3]495	[3]580
Solder	18,343	9,117	27,460	13,066	6,744	19,810	7,678	7,545	15,223
Babbitt	3,501	2,908	6,409	2,493	3,360	5,853	1,968	2,277	4,245
Bronze and brass	4,178	16,416	20,594	4,838	16,934	21,772	3,612	14,770	18,382
Collapsible tubes and foil	1,438	228	1,666	832	208	1,040	604	104	708
Tinning	2,797	179	2,976	2,431	277	2,708	2,095	221	2,316
Pipe and tubing	383	57	440	133	94	227	139	18	157
Type metal	184	1,796	1,980	120	1,694	1,814	86	1,567	1,653
Bar tin	1,194	240	1,434	875	54	929	642	36	678
Miscellaneous alloys	1,543	164	1,707	844	183	[4]1,027	485	244	[4]729
White metal	693	524	1,217	134	146	280	81	39	120
Chemicals (other than oxide)	869	847	1,716	95	707	802	414	596	1,010
Tin oxide				279	119	398			
Miscellaneous	339	194	533	138	82	220	118	38	156
Total	71,191	33,273	104,464	56,884	31,285	88,169	45,323	27,950	73,273

[1] Excludes 5,180 long tons of tin contained in imported tin-base alloys—of which 2,700 tons was used for solder, 1,970 tons for bronze and brass, 360 tons for babbitt, and 150 tons for other products.
[2] Includes small tonnage of secondary pig tin and tin acquired in chemicals.
[3] Includes small tonnage of imported tinbase alloy.
[4] Includes 592 tons of tin in Copan produced in 1951, and 213 in 1952.

TABLE 9.—Tin content of tinplate and terneplate produced in the United States, 1943–47 (average) and 1948–52

Year	Total tinplate (all forms)			Tinplate (hot dipped)			Tinplate (electrolytic)			Tinplate waste-waste, strips, cobbles, etc.		
	Gross weight (short tons)	Tin content (long tons)	Pounds of tin per short ton of plate	Gross weight (short tons)	Tin content (long tons)	Pounds of tin per short ton of plate	Gross weight (short tons)	Tin content (long tons)	Pounds of tin per short ton of plate	Gross weight (short tons)	Tin content (long tons)	Pounds of tin per short ton of plate
1943–47 (average)	2,728,899	25,976	21.6	1,752,416	20,790	26.6	889,876	4,494	11.6	86,607	692	18.3
1948	3,914,323	31,503	18.0	1,848,373	22,028	26.7	1,918,708	8,518	9.9	147,242	957	14.6
1949	3,863,801	29,617	17.2	1,648,001	19,613	26.7	2,030,567	8,814	9.7	185,233	1,190	14.4
1950	4,767,274	35,380	16.6	1,845,009	21,875	26.6	2,693,777	12,110	10.1	228,488	1,395	13.7
1951	4,591,431	30,522	14.9	1,557,006	17,789	25.6	2,832,044	11,595	9.2	202,381	1,138	12.6
1952	4,249,393	[1]27,316	14.4	1,308,173	15,012	25.7	2,712,657	11,022	9.1	228,563	1,282	12.6
	Total terneplate			Short ternes			Long ternes			Terneplate waste-waste		
1943–47 (average)	284,025	572	4.5	130,369	297	5.1	149,254	267	4.0	4,402	9	5.3
1948	324,088	672	4.6	181,141	388	4.8	137,045	272	4.4	5,902	12	4.6
1949	239,641	626	5.9	81,682	177	4.9	150,143	435	6.5	7,816	14	4.0
1950	274,963	952	7.8	60,952	188	6.9	209,223	753	8.1	4,788	11	5.1
1951	273,244	[2]767	6.3	52,614	201	8.6	216,069	555	5.8	4,561	11	5.1
1952	225,679	[3]580	5.8	56,961	225	8.8	165,260	347	4.7	3,458	8	5.5

[1] Includes small tonnage of secondary pig tin and tin acquired in chemicals.
[2] Total includes 84 long tons of pig tin.
[3] Total includes 85 long tons of pig tin.

STOCKS

Consumers' stocks (including pig tin in transit in the United States) increased 16 percent in 1952; however, except for 1951, stocks of virgin pig tin at consumers' plants at the end of 1952 were the lowest since 1936.

RFC reported tin stocks available for industry requirements as 7,000 long tons at the beginning of the year and 14,600 tons at the end of 1952. Stocks of concentrates contained an estimated total of 11,878 tons of tin at the beginning of the year and 25,209 tons of tin at the end of the year.

The National Strategic Stockpile objective for tin was not completed. Nevertheless, inventories had reached a level according to the Munitions Board that could meet the needs of war without serious danger to national security; consequently, tin was listed in the category of materials, the acquisition of which was no longer of the highest urgency.[5]

General Services Administration made a special inspection in cooperation with the Tin Research Institute of all tin in the stockpile for evidence of tin disease which may attack the high-purity grades under certain climatic conditions.[6]

TABLE 10.—Stocks of virgin pig tin in the United States, Dec. 31, 1948–52, in long tons [1]

	1948	1949	1950	1951	1952
At consumers' plants	14,349	13,771	20,576	10,043	11,819
At other warehouses and in transit	328	61	1,355	971	525
Held by jobbers	100	292	384	82	531
Total consumers' stocks	14,777	14,124	22,315	11,096	12,875
Afloat to United States (estimated)	25	8,500	3,500	895	5,300
Total stocks [1]	14,802	22,624	25,815	11,991	18,175

[1] Excludes Government purchases delivered for stockpiling or at Texas City smelter. Also excludes tin in process and secondary pig tin.

PRICES

Tin prices were much steadier in 1952 than in other recent years The average price of Straits tin for prompt delivery in New York in 1952 was $1.2044 or 6 percent below that in 1951, which had been the highest annual price on record. On January 22, 1952, RFC announced that, effective that day, its selling price for tin metal was $1.215, at which level the RFC price for resale remained for the rest of 1952. This was the first upturn in price since August 1, 1951. The new price was a result of the United States-United Kingdom mutual assistance agreement under which the United States became obligated to buy 20,000 long tons of Straits tin or its equivalent at $1.18 f. o. b. port of shipment. This ended the lengthy price controversy between the main producing countries and the United States and set the pattern for the long-term contracts between Belgian Congo and Indonesia producers for large supplies of tin. The RFC price averaged $1.205

[5] Munitions Board, Stockpile Report to the Congress, Covering the Period From July 1 to Dec. 31, 1952: Feb. 15, 1953, p. 3.

[6] Work cited in footnote 5, p. 15.

for 1952. The RFC was the sole importer of tin from March 12, 1951, until resumption of private importing for resale was permitted on August 1, 1952, when the outside market reopened. The outside market for prompt tin was nominal until August 11, and the price quoted first was $1.21 a pound. The 5-month average from August through December was $1.21305. The monthly average price on the open market ranged from $1.21152 in August to $1.21472 in December 1952. The lowest price for the year on the outside market was $1.2075 on October 15. RFC monthly sales contracts with industry averaged less than half the tonnage of tin in the last 5 months compared with the first 7 months of 1952.

Effective September 12, 1952, the Office of Price Stabilization established a ceiling price on tin of $1.215 a pound f. o. b. New York.

TABLE 11.—Monthly prices of Straits tin for prompt delivery in New York, 1951–52, in cents per pound [1]

Month	1951			1952						
				RFC			Open market			Average RFC open market
	High	Low	Average	High	Low	Average	High	Low	Average	
January	[2] 184.00	150.00	171.716	121.50	103.00	109.73				109.73
February	183.00	181.50	182.681	121.50	121.50	121.50				121.50
March	[3] 181.75	134.00	145.464	121.50	121.50	121.50				121.50
April	150.50	142.00	145.827	121.50	121.50	121.50				121.50
May	142.00	139.00	139.955	121.50	121.50	121.50				121.50
June	136.00	106.00	118.048	121.50	121.50	121.50				121.50
July	106.00	106.00	106.000	121.50	121.50	121.50				121.50
August	103.00	103.00	103.000	121.50	121.50	121.50	121.375	120.750	[4] 121.15	[5] 121.15
September	103.00	103.00	103.000	121.50	121.50	121.50	121.500	121.250	121.38	121.38
October	103.00	103.00	103.000	121.50	121.50	121.50	121.500	120.750	121.23	121.23
November	103.00	103.00	103.000	121.50	121.50	121.50	121.375	121.125	121.27	121.27
December	103.00	103.00	103.000	121.50	121 50	121.50	121.500	121.375	121.47	121.47
Total	184.00	103.00	128.308	121.50	103.00	120.52	121.500	120.750	121.31	120.44

[1] Compiled from quotations published in the American Metal Market.
[2] Highest price recorded in regular market was $1.84 on Jan. 25, 1951, with a reaction to $1.83 at close of market on that day.
[3] RFC became sole procurer of tin in the United States Mar. 12, 1951.
[4] Outside market reopened Aug. 1, 1952, although a prompt price was not quoted until Aug. 11, 1952.
[5] Open-market prices since August 1952.

On the London market the average price for standard tin was £964.5 a long ton in 1952 compared with £1,079.6 in 1951. The monthly average price fluctuated from the high of £984.2 in February to the low of £948 in August. In 1952 London prices opened at £927.5, having advanced £22.5 over the New Year holidays. By January 25, the market had risen to £1,005, the top for the year, precipitated by the United States-United Kingdom agreement. A decline began in February and brought the quotation to £955 on May 14. Some recovery followed, which took the price to £977 on June 13. With restoration, on August 1, to private firms in the United States of freedom to import tin, marked easiness occurred on the market, as private interests in the United States showed no immediate desire to enter the market as buyers. Continental operators unloaded some of their tin commitments to the detriment of prices. An increase in tin stocks developed in the United Kingdom. Consequently, after the August bank holiday the market receded, and the price declined to £912 on August 7, the lowest of the year. There was appreciable recovery, which carried the price to £989 on October 10, when the uncertainties created by the Bolivian situation (where nationalization of the tin-mining industry was imminent) occasioned doubts regarding future supplies from that source. The market weakened again and later steadied, with lack of interest and very little activity on the London Metal Exchange as the year closed. The price quoted on December 31, 1952, was £946.

The Singapore market was governed largely by the New York quotations, allowing for the prevailing rate of exchange and transportation charges. The monthly average price for Straits ex-works was £944.9 for 1952 against £1,040.3 in 1951. The monthly average in 1952 was highest in February and lowest in December. The lowest price for the year, however, was £889 on January 2, and the highest for the year was £989.3 on February 5.

FOREIGN TRADE [7]

Tin has been one of the principal imports of the United States and ranked eighth in value among all commodities in 1952. The relative position of tin in value, among minerals imported (net imports) in 1952, was exceeded only by gold. The value of tin imports in 1952 was the highest ever recorded. Imports of metallic tin and of 94-percent tin alloy, including concentrates, and exports of tinplate were the main items in the foreign trade of the United States in tin in 1952. Of less importance was the foreign trade in tinplate and terneplate scrap, miscellaneous tin manufactures, and compounds. Tin contained in the babbitt, solder, type metal, and bronze imported and exported is accounted for in the Lead and Copper chapters of this volume.

On a tonnage and value basis, pig-tin imports resumed the dominant position in the foreign trade of the United States in tin in 1952. Tin imports in 1952 increased 185 percent, with resumption of shipments from Malaya—the principal source in 1952, which furnished 57 percent of the total. Other important sources of metal imported in 1952 include Netherlands (21 percent), United Kingdom (11 percent), Belgium-Belgian Congo (10 percent) and other (1 percent). Receipts were at their lowest rate in the first quarter and at their highest in the second. Under the United States-United Kingdom mutual assistance agreement of January 1952, the United States acquired 20,000 long tons of tin, most of which was Grade A quality, at $1.18 per pound f. o. b. foreign port of delivery. Receipts of concentrates in terms of metal were 11 percent less than in 1951, principally due to a 37-percent decrease in imports from Indonesia. Bolivia, the main source of tin concentrate (accounting for 48 percent of the total), furnished 12,600 tons in 1952, or 3 percent less than in 1951. Imports of concentrate and metal augmented by 7,600 long tons (gross weight—chief value, tin) of alloys were brought into the United States in 1952, mainly from Netherlands in the form of 94-percent tin alloy. Exports of metallic tin in 1952 were 380 long tons, with

[7] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

Canada as the principal destination. Tin exports were under export-license control.

The major tin-export item of the United States, as usual, was tinplate. Gains were made in the export markets of Europe and Asia, but deliveries from the United States decreased to Latin America, Australia-New Zealand, and Africa. Tonnagewise shipments to Turkey showed the largest increase and those to the Union of South Africa the largest decrease. Exports of hot-dipped tinplate totaled 248,500 long tons valued at $57,469,000 in 1952, an 8-percent decrease in quantity and 10-percent drop in value compared with 270,300 tons valued at $54,009,200 in 1951. The principal countries of destination were Netherlands, Australia-New Zealand, Argentina, Brazil, Italy, and Union of South Africa. Exports of electrolytic tinplate were 210,000 long tons (209,800 in 1951) or virtually unchanged in weight, but the value in 1952 was $44,081,200 or 4 percent less than in 1951 ($45,781,200). This material was shipped to 62 countries in 1952; the leading destinations were Brazil, Australia-New Zealand, Netherlands, Union of South Africa, and Cuba. Most of the short ternes exported went to Canada in 1952. In 1952 the Bureau of the Census removed exports of long ternes from the terneplate commodity class. These figures, which are not separately available, are now included in the item "steel sheets, black ungalvanized" in the Iron and Steel chapter of this volume.

According to the American Iron and Steel Institute, producers in 1952 shipped for export 534,200 short tons (581,700 in 1951) of tinplate, of which 298,700 tons was hot dipped (346,200 in 1951) and 235,500 tons was electrolytic in both 1951 and 1952.

Tariff.—Tin, both in the form of metal and ore, is admitted free of duty by the Tariff Act of 1930, paragraph 1785, but with the proviso that, if the mines of the United States are producing 1,500 tons annually, a tariff of 4 cents a pound on ore and 6 cents a pound on metal shall be imposed and notice given by proclamation of the President.

TABLE 12.—Foreign trade of the United States in tin concentrates and tin, 1948–52

[U. S. Department of Commerce]

Year	Imports				Exports			
	Concentrates (tin content)		Bars, blocks, pigs, grain or granulated		Ingots, pigs, bars, etc.			
					Domestic		Foreign	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
1948	37,492	$72,170,372	49,196	$103,322,952	78	$163,428	13	$27,699
1949	38,311	78,175,836	60,224	133,707,223	76	176,795	78	145,370
1950	25,960	47,163,305	82,838	152,952,294	287	594,587	512	990,000
1951	[1] 29,621	[1] 82,462,215	[1] 28,255	[1] 74,556,994	264	762,662	1,249	3,978,852
1952	26,491	65,286,937	80,543	215,669,646	301	580,855	79	209,539

[1] Revised figure.

TABLE 13.—Tin concentrates (tin content) imported for consumption in the United States, 1951–52, by countries

[U. S. Department of Commerce]

Country	1951		1952	
	Long tons	Value	Long tons	Value
Belgian Congo	1,585	$4,613,270	1,192	$3,157,360
Bolivia	[1] 13,085	[1] 35,402,610	12,639	30,779,772
Brazil	2	2,496		
Burma			8	16,685
China	1	5,307		
Egypt	11	16,794		
Indochina	14	22,988	42	105,000
Indonesia	11,684	33,136,082	7,321	18,593,128
Mexico	106	270,597	154	197,482
Portugal	19	37,815	808	2,028,192
Thailand	3,114	8,954,256	4,327	10,409,318
Total	[1] 29,621	[1] 82,462,215	26,491	65,286,937

[1] Revised figure.

TABLE 14.—Tin[1] imported for consumption in the United States, 1951–52 by countries

[U. S. Department of Commerce]

Country	1951		1952	
	Long tons	Value	Long tons	Value
Australia			30	$79,154
Belgian Congo	915	$2,625,763	1,275	3,449,279
Belgium-Luxembourg	[2] 5,501	[2] 16,374,437	7,029	19,007,989
Bolivia	20	55,391	105	268,470
China	55	150,564		
Germany	49	197,863	[3] 155	[3] 418,461
Malaya	6,986	21,610,927	45,992	123,313,016
Mexico	(4)	449		
Netherlands	[2] 12,837	[2] 27,665,390	16,861	44,817,745
Portugal			151	381,276
Syria			15	39,984
Thailand	46	185,178		
United Kingdom	[2] 1,846	[2] 5,691,032	8,930	23,894,272
Total	[2] 28,255	[2] 74,556,994	80,543	215,669,646

[1] Bars, blocks, pigs, grain, or granulated.
[2] Revised figure.
[3] West Germany.
[4] Less than 1 ton.

TABLE 15.—Foreign trade of the United States in tinplate, taggers tin, and terneplate in various forms, 1948–52, in long tons

[U. S. Department of Commerce]

Year	Tinplate, taggers tin, and terneplate		Tinplate circles, strips, cobbles, etc. (exports)	Waste-waste tinplate (exports)	Terneplate clippings and scrap (exports)	Tinplate scrap	
	Imports	Exports				Imports	Exports
1948	184	548,021	3,247	28,121	278	41,084	
1949	12,218	498,371	3,018	41,865	227	41,028	
1950	3,829	442,851	6,981	54,622	144	42,394	562
1951	398	498,808	12,995	55,955	144	51,571	810
1952	2,277	[1] 534,964	9,945	(2)		42,659	3,570

[1] Due to changes in classifications, data not strictly comparable to earlier years.
[2] Beginning Jan. 1, 1952 not separately classified; included with "tinplate."

TABLE 16.—Tinplate and terneplate exported from the United States, 1951–52,[1] by principal countries of destination

[U. S. Department of Commerce]

Destination	1951		1952	
	Long tons	Value	Long tons	Value
Algeria	87	$19,394	906	$200,052
Argentina	47,764	13,053,455	37,592	8,452,766
Australia	59,043	12,938,808	50,429	11,090,387
Austria	1,102	295,902	1,377	293,269
Belgium-Luxembourg	16,021	3,480,383	14,724	3,125,324
Brazil	66,166	15,632,756	52,742	11,766,673
British East Africa	931	201,111	1,822	363,940
Canada	7,493	1,218,577	2,194	341,229
Chile	1,578	403,294	1,424	330,267
Colombia	4,901	1,458,016	8,463	1,816,647
Cuba	19,624	4,429,628	19,750	4,428,335
Denmark	14,980	3,132,776	14,416	3,061,510
Egypt	2,219	440,518	3,213	698,522
Finland	1,035	221,514	2,194	458,394
French Morocco	9,131	2,041,115	8,724	1,915,033
Greece	3,442	678,216	8,906	1,751,633
Hong Kong	17	3,253	1,097	177,442
India	11,937	[2] 2,486,319	19,805	3,972,249
Indonesia	3,683	888,879	4,543	1,069,897
Iran	116	19,874	2,504	469,505
Ireland	2,441	676,443	1,893	433,227
Israel	2,128	461,323	2,618	596,140
Italy	18,973	4,780,455	25,882	6,131,282
Japan	1,446	370,195	4,033	595,574
Lebanon	334	57,090	2,719	527,234
Madagascar	------	------	1,322	310,046
Malaya	5,417	1,159,224	4,596	852,934
Mexico	20,248	4,176,599	16,001	3,306,793
Netherlands	47,276	10,501,692	57,710	12,807,471
New Zealand	3,586	763,438	5,363	1,114,477
Norway	13,256	2,694,729	14,109	2,965,558
Pakistan	2,007	442,621	5,246	1,064,332
Peru	3,688	826,528	4,797	1,079,450
Philippines	9,963	2,129,018	12,164	2,402,471
Portugal	12,715	3,119,373	14,519	3,309,027
Spain	278	58,803	6,449	1,610,195
Sweden	15,472	3,238,861	18,242	3,847,785
Switzerland	7,364	1,627,389	10,423	2,376,026
Taiwan	1,987	467,979	2,513	556,037
Thailand	734	152,410	3,772	721,053
Turkey	3,505	637,425	15,432	3,180,938
Union of South Africa	37,826	8,064,919	23,119	5,029,598
Uruguay	5,714	1,390,567	10,364	2,386,950
Venezuela	3,720	946,270	3,734	855,899
Yugoslavia	2,192	452,982	2,846	630,607
Other countries	5,268	1,267,546	8,273	1,851,647
Total	498,808	[2] 113,507,667	534,964	116,325,825

[1] Due to changes in classification 1952 data not strictly comparable to earlier years.
[2] Revised figure.

TABLE 17.—Foreign trade of the United States in miscellaneous tin, tin manufactures, and tin compounds, 1948–52

[U. S. Department of Commerce]

Year	Miscellaneous tin and manufactures						Tin compounds	
	Imports			Exports				
	Tinfoil, tin powder, flitters, metallics, tin and tinplate manufactures, n. s. p. f. (value)	Dross, skimmings, scrap residues, and tin alloys, n. s. p. f. — Pounds	Dross, skimmings, scrap residues, and tin alloys, n. s. p. f. — Value	Tin cans, finished or unfinished — Long tons	Tin cans, finished or unfinished — Value	Tin scrap and other tin-bearing material except tinplate scrap (value)	Imports (pounds)	Exports (pounds)
1948	$119,287	1,679,331	$659,450	36,450	$11,208,859	$1,684,402	10,917	(1)
1949	189,564	1,163,875	424,908	31,087	10,263,790	2,245,217	980	41,004
1950	215,484	6,293,459	2,146,340	28,946	10,448,917	869,404	75,825	122,716
1951	365,741	2,566,000	1,897,991	33,171	14,048,409	2,403,354	102,212	136,179
1952	447,925	18,791,939	17,660,525	41,624	16,842,755	(2) 2,086,612	1,358	73,131

[1] Not separately classified.
[2] Due to changes in classification data not strictly comparable to earlier years.

TECHNOLOGY

The fundamental properties of solder alloys and methods of applying them efficiently at modern production speeds were discussed.[8] The practical considerations involved in the development of good soldering techniques are described in this paper. Attention is given to selection of the correct solder composition for a specific application and to a discussion of the heating methods available. Surface preparation, design and assembly, and special techniques for hard-to-solder metals are also considered.

An article discusses packages where aluminum alone is used and others in which the aluminum is combined with paper, wax, plastics, or fiber materials.[9] It reports that aluminum can replace tinplate in containers by using aluminum-foil packages for applications where tin cans have been or are being used.

Investigations in the preparation of gray tin were recently reported:[10]

It is well known that most commercial forms of tin can be transformed to the gray (alpha) allotropic modification in an ordinary refrigerator by contact with particles of previously prepared gray tin. The difficulty, of course, is to get some gray tin to start with, and we know of many laboratories both in Britain and abroad in which attempts to make gray tin have been unsuccessful. We have worked on various aspects of gray tin from time to time, and, although we are not ready to give a connected account of this work, we wish to record a few of our observations in the hope that they may be helpful to other investigators.

The principle on which we make gray tin is to deform pure tin (99.99 percent) by cold work and allow it to recrystallize at a temperature below the alpha ⇆ beta transformation temperature (13.2° C.). The recrystallization temperature of tin is so low that deformation at room temperature is the equivalent to hot work. Tin may be conveniently cold worked by compression while surrounded by solid carbon dioxide. We generally compress under a pressure of 4 tons a cylinder 0.25 inch in diameter and 0.25 inch high. We then place the cold-worked tin in

[8] MacIntosh, Robert M., Technical Aspects of Soldering Practices: Welding Jour., vol. 31, No. 10, October 1952, pp. 881–897.
[9] Birdsall, G. W., How Aluminum Can Replace Tinplate in Containers: Modern Metals, vol. 8, No. 1, February 1952, pp. 47–51.
[10] Hedges, E. S. and Higgs, J. Y., Preparation of Gray Tin: Nature (London), vol. 169, No. 4302, Apr. 12, 1952, pp. 621–622.

a glass tube and store it in solid carbon dioxide. It is almost completely transformed into gray tin powder within twelve to twenty-four hours, the rate of transformation increasing with the purity of the tin.

"Tinplate: Easier Inventory Control," was the title of an article describing a new annealing line at United States Steel Corp.'s Gary sheet and tin mill, replacing traditional batch annealing of tinplate under covers, coil by coil. Advantage of the straight-ahead method is "universal temper." Sheets of tinplate annealed by this method are suitable for most types of cans, therefore smaller inventories are necessary. Annual capacity of the line is 136,000 net tons of sheets, ranging from 0.0075 to 0.015 inch in thickness in widths 36 inches and less. Eleven separate processes are performed at stages along the line as 3,000-foot sheets pass through at a speed of about 1,000 feet a minute.[11]

The Tin Research Institute, Inc., with headquarters at Greenford, Middlesex, England, maintains an office at 492 West 6th Avenue, Columbus, Ohio, and offers free service for technical inquiries and general information on tin. In its annual report for 1952 it is stated that the various groups of tin producers who provide the funds have unanimously agreed to increase their contributions by 50 percent to strengthen the institute's staff and especially to increase its free technical services to industry in the chief tin-consuming countries of the world. The report also mentions a number of applications of tin that originated from research at the institute. Decorative tin-nickel electroplate has had difficulties during its first 2 years, but a suitable filtering medium has now been found. Tin-zinc electroplate, a corrosion-resistant coating, has found many further uses in the radio, motorcar, and aircraft industries. Work is going forward on improved aluminum-tin bearing alloys; their extra hardness as compared with tin-base babbitt alloys will, it is expected, enable these alloys to recapture for tin some of the market now held by copper-lead and other high-duty bearings.

The Tin Research Institute, Inc., maintains a technical library on tin and has a number of publications available for free distribution. Those made available in 1952 included: Tin and Its Uses, Nos. 26 and 27; The Corrosion of Tin and Tin Alloys; A Survey of the Chemistry and Applications of Organotin Compounds; Tin-Zinc Alloy Plating; Tin-Nickel Alloy Plating; and Report on the Work of the Tin Research Institute, 1952.

United States patents issued during 1952 relative to tin include the following:

Muskat, I. E., and Taylor, R. H., Method of Recovering Tin in the Form of Tin Sulfide From a Low-Grade Ore: United States Patent 2,585,161, Feb. 12, 1952.

Wells, D. F., Thompson, R. B., and Roberts, E. J., Process for the Volatization of Tin Values of Tin Ores: United States Patent 2,600,351, June 10, 1952.

The recent application of conventional concentrating tables for removing sulfides from tin-wolfram concentrates in Portugal was the subject of a paper.[12]

The effect of tin in steel was discussed in an article.[13]

---

[11] Iron Age, Tinplate: Easier Inventory Control: Vol. 169, No. 3, Jan. 17, 1952, p. 51.

[12] Allan, J. C., Table Flotation for the Removal of Sulfides From Tin-Wolfram Concentrates in Portugal: Inst. Min. and Met., No. 553, December 1952, pp. 81–90.

[13] Gertsman, S. L., and Tardif, H. P., Tin and Copper in Steel: Iron Age, vol. 169, No. 7, Feb. 14, 1952, pp. 136–139.

The effects of increasing amounts of tin on surface cracking were tested at two different temperatures, 1,825° F. and 2,300° F. At 1,825° F. very faint traces of surface cracking were observed, even in the heats containing the least amounts of tin. Between 0.28 and 0.54 percent tin, the steel became brittle and the samples broke in two.

A description of an unusual tin-bronze casting was recently published.[14] The metal was composition ingot analyzing 90 percent copper, 8 percent tin, and 2 percent lead.

The electrometallurgy of tin and its alloys was described in a recently published article, under the following topics: Technology of tin and tin-alloy plating, electrodeposition of tin, tin refining by electrolysis, electrolytic detinning, electro tinplate, and electrodeposition of tin alloys.[15]

A technical paper on trends in the use of tin in the container industry was presented; among other things it stated:[16]

> There are many facts to suggest that the long-term trend toward lower tin coatings on the materials used by the container industry is far from finished and there appear to be no technical indications to the contrary. The rate at which this occurs and the extent to which it is carried will depend on a number of considerations, many of which are outside the scope of this paper. Nevertheless, in view of the nature and large number of potential developments it appears reasonable to expect that the day is not far off when the average tin coating weight for tin mill products will be nearer to one-third than the current one-half of the prewar average.

An article on a new use for tin in plastics discussed organotin compounds among other things. It stated:[17]

> We have entered a new chemical age in which plastics will play a more and more important part. This being so, it is particularly gratifying to find that one of the oldest metals known to mankind—tin—is already being used as a component in these modern synthetic materials.
>
> It may well be thought that tin metal as we know it is incompatible with plastics. That is where chemical research comes in, for tin can be transformed by a series of chemical processes into organotin compounds, some of which are compatible with plastics. These organotin compounds are generally white powders or colorless liquids which dissolve in, or mix well with, many organic materials. Their tin content may vary over a wide range, but those useful at present contain between 25 and 50 percent of tin.
>
> Organotin compounds are the best stabilizers known. They are not used universally, because for some applications of polyvinyl chlorides other stabilizers are good enough; but when a crystal clear product is required no other stabilizer can compete with them. This is not only because when mixed in the plastic the tin compounds are completely colorless and transparent, or because of the greater efficacy of organotin compounds in preventing discoloration. Among other advantages of tin compounds assure fastness to light, whereas the effect of continued exposure to light on plastics stabilized by other materials is often to produce a milky appearance.

According to the Continental Can Co., New York City:[18]

> The beer cans we make today with lighter tinplate are actually superior in quality to the cans of 10 years ago. In 1942 1 ounce of tin could coat enough steel to make 21 beer cans; however, in 1952 1 ounce of tin will coat enough steel to make 125 beer cans.

---

[14] Roast, Harold J., An Unusual Tin-Bronze Casting: Metal Prog., vol. 61, No. 3, March 1952, p. 76.
[15] Hedges, E. S., and Cuthbertson, J. W., Electrometallurgy of Tin and Its Alloys: Chem. and Ind., No. 52, Dec. 27, 1952, pp. 1250–1254.
[16] Hartwell, R. R., Trends in the Use of Tin in the Container Industry: ASTM Tech. Paper T-223, Tin Symposium, New York, N. Y., June 23, 1952.
[17] Hedges, E. S., A New Use for Tin in Plastics: Tin, October 1952, p. 9.
[18] Daily Metal Reporter, vol. 52, No. 123, June 25, 1952, p. 6.

From the viewpoint of industrial progress, there were significant developments in many of the end products requiring tin. A new and important use for an established material was the use of tin bronzes for condenser tubes to replace cupronickel. One such application was the use of 10-percent tin bronze for condenser tubes to replace the 70–30 cupronickel commonly used for this purpose.[19]

A paper describing the results of tests on the preparation of tinplate for painting was published.[20]

The general conclusions are that, when pretreatment is needed:

1. Degreasing in trichlorethylene vapor may not remove all contaminants from old tinplate and may therefore not be adequate to secure good paint adhesion.
2. A hot-water rinse after vapor degreasing is beneficial, possibly by removing metallic soaps that are not dissolved by trichlorethylene.
3. Cathodic treatment in sodium-carbonate solution is a very effective cleaning method that enables good paint adhesion to be secured without affecting the appearance of the metal.
4. Swabbing with a mixture of 5 parts hydrochloric acid to 95 parts of methylated spirit until the whole surface is darkened and etched is a good means of preparation when etching of the surface is permissible.
5. Immersion in hot alkaline chromate solution is a possible means of cleaning without changing appearance, but the time of immersion should not generally exceed 10 seconds.

WORLD REVIEW

WORLD MINE PRODUCTION

World mine production of tin, exclusive of U. S. S. R., increased 2 percent in 1952. Of the total output, Asia supplied 65 percent, South America 19 percent, Africa 14 percent, and other sources 2 percent. Most of the increase was provided by Indonesia. Output in 1952 was 3,000 long tons greater than in 1951. Production in 1952 was 6 percent above the 1925–29 average, 1 percent above the 1935–39 average, and about 71 percent of the 1941 peak.

WORLD SMELTER PRODUCTION

Smelter production of tin in the world, exclusive of U. S. S. R., was virtually unchanged in 1952 compared with 1951. The Malayan tin-smelting plants at Penang and Singapore produced 5 percent less but supplied 37 percent of the total and were (as in 1951) the world's most important sources of pig tin. Next in rank were the United Kingdom, Netherlands, United States, and Belgium. Smelters in these 5 countries supplied 90 percent of the world's tin in 1952. As a consequence of United States resumption of purchases of tin, largely from Malaya, about 61 percent of the world smelter output in 1952 was for the United States (in 1951, 36 percent).

[19] Neckervis, Robert J., Tin and Its Alloys: Ind. Eng. Chem., vol. 44, No. 10, October 1952, pp. 2360–2364.
[20] Britton, S. C., The Preparation of Tinplate for Painting: Sheet Metal Ind. (London), vol. 29, No. 302, June 1952, pp. 545–548, 558.

TABLE 18.—World mine production of tin (content of ore), by countries 1943–47 (average) and 1948–52, in long tons [1]

[Compiled by Berenice B. Mitchell and Lee S. Petersen]

Country	1943–47 (average)	1948	1949	1950	1951	1952
North America:						
Canada	333	309	276	356	155	95
Mexico	270	182	358	440	366	373
United States	3	5	68	94	88	99
Total North America	606	496	702	890	609	567
South America:						
Argentina	830	273	268	267	242	[2] 239
Bolivia (exports)	38,481	37,336	34,115	31,213	33,132	31,959
Brazil	198	570	325	180	197	[2] 180
Peru [3]	52	64	51	38	86	31
Total South America	39,561	38,243	34,759	31,698	33,657	32,409
Europe:						
France	13	76	73	117	[2] 170	[2] 354
Germany, East [2]	316		120	120	298	420
Italy	78					
Portugal [4]	705	706	785	690	902	1,028
Spain	601	261	666	[2] 575	[2] 716	589
United Kingdom [5]	1,098	1,281	1,217	[2] 1,230	[2] 1,210	954
Total Europe [6]	2,811	2,324	2,861	2,732	3,296	3,345
Africa:						
Belgian Congo [7]	16,069	13,539	13,760	13,464	13,669	13,798
French Cameroon	147	102	73	67	72	86
French Morocco	7				13	14
French West Africa	1		26	51	65	110
Mozambique	4	1	1	1	8	3
Nigeria	11,207	9,237	8,824	8,258	8,529	8,318
Northern Rhodesia	7		7	4	2	11
Southern Rhodesia	130	105	70	65	40	30
South-West Africa	156	111	120	100	76	86
Swaziland	60	20	32	37	32	36
Tanganyika (exports)	127	97	109	97	67	47
Uganda (exports)	230	190	128	192	118	82
Union of South Africa	500	457	471	643	746	935
Total Africa	28,645	23,859	23,621	22,979	23,437	23,556
Asia:						
Burma	827	1,147	1,781	1,520	1,624	1,103
China [2]	4,100	6,300	4,300	7,500	7,500	8,600
Indochina	210	30	40	62	92	156
Indonesia	9,605	30,562	28,965	32,102	30,986	35,003
Japan	340	118	190	326	426	639
Malaya	14,784	44,815	54,910	57,537	57,167	56,838
Thailand	2,674	4,240	7,815	10,364	9,502	9,473
Total Asia	32,540	87,212	98,001	109,411	107,297	111,812
Australia	2,412	1,885	1,882	1,855	1,577	1,556
Total (estimate) [6]	106,600	154,000	161,800	169,600	169,900	173,200

[1] The table incorporates a number of revisions of data published in previous tin chapters.
[2] Estimated by authors of the chapter and in a few instances from the Statistical Bulletin of the International Tin Study Group, The Hague.
[3] Minor constituent of other base-metal ores.
[4] Excluding mixed concentrates.
[5] Intake by smelters.
[6] Excluding production of U. S. S. R.
[7] Including Ruanda-Urundi.

TABLE 19.—World smelter production of tin, by countries, 1943–47 (average) and 1948–52, in long tons [1]

[Compiled by Berenice B. Mitchell and Lee S. Petersen]

Country	1943–47 (average)	1948	1949	1950	1951	1952
North America:						
Canada	333	308	276	356	155	95
Mexico	254	181	358	290	366	144
United States	33,930	36,703	35,834	33,118	31,852	22,805
Total North America	34,517	37,192	36,468	33,764	32,373	23,044
South America:						
Argentina	591	254	235	253	206	[2] 300
Bolivia (exports)	4	105	405	392	39	200
Brazil	176	185	157	118	133	[2] 240
Peru [3]	52	64	51	38	86	31
Total South America	823	608	848	801	464	771
Europe:						
Belgium	2,693	10,469	8,996	9,512	8,360	10,585
Germany, West [2]	------	------	120	375	[4] 900	[4] 1,020
Italy	42	------	------	------	------	------
Netherlands	1,985	16,402	19,247	21,027	20,977	27,913
Portugal	882	282	218	209	313	[2] 300
Spain	778	483	803	1,597	766	687
United Kingdom [5]	28,983	31,002	28,384	28,750	26,053	29,521
Total Europe	35,363	58,638	57,768	61,470	57,369	70,026
Africa:						
Belgian Congo	7,220	3,875	3,246	3,238	3,011	2,765
Southern Rhodesia	117	127	75	80	63	37
Union of South Africa	901	554	595	718	829	960
Total Africa	8,238	4,556	3,916	4,036	3,903	3,762
Asia:						
China [2]	3,900	5,900	4,000	7,000	7,000	8,000
Indochina	119	32	3			
Indonesia	4,410	136	126	------	------	------
Japan	543	53	290	389	574	637
Malaya	17,067	49,707	62,737	68,747	65,914	62,829
Thailand	1,614	------	------	2	------	------
Total Asia	27,653	55,828	67,156	76,138	73,488	71,466
Australia	2,392	1,885	1,955	2,013	1,459	1,700
Total (estimate)	109,000	158,700	168,100	178,200	169,100	170,800

[1] This table incorporates a number of revisions of data published in previous tin chapters.
[2] Estimated by authors of the chapter and in a few instances from Statistical Bulletin of the International Tin Study Group, The Hague.
[3] Tin content of dross.
[4] Unofficial reports state production of 316 long tons in East Germany in 1951 and approximately 700 long tons in 1952.
[5] Beginning January 1948, includes production from imported scrap and residues refined on toll.

WORLD CONSUMPTION

World consumption of tin in 1952 totaled 127,500 long tons—a 7-percent decrease compared with 1951. Table 20 gives the reported real consumption of tin for the United States, United Kingdom, Netherlands, Canada, Japan, and Belgium-Luxembourg. In 1952 these countries represented 67 percent of total world consumption. Figures for other countries are apparent consumption, arrived at on the basis of production of metal within the country concerned plus imports of metal and minus exports of metal and with known changes in stocks also being taken into account. The sharp increase in consumption in the Netherlands in 1952 was mainly due to the use of tin in the manufacture of highgrade tin alloys for export. Figures for U. S. S. R. are omitted from the totals.

TABLE 20.—World consumption of primary tin, by countries, 1943–47 (average) and 1948–52, in long tons [1]

Country	1943–47 (average)	1948	1949	1950	1951	1952
Argentina	871	1,912	865	1,250	1,250	1,200
Australia and New Zealand	2,569	2,579	2,504	2,552	2,910	2,966
Belgium and Luxembourg	773	1,707	986	1,363	1,770	1,224
Brazil	716	1,469	1,104	1,670	1,500	1,500
Canada	3,316	4,046	4,317	4,526	4,731	4,191
Czechoslovakia	228	1,100	1,200	1,300	1,500	1,800
Denmark	301	488	226	600	650	720
Finland	170	438	407	418	385	240
France	3,380	7,900	7,200	7,400	7,500	7,300
Germany	728	1,450	2,300	5,900	7,150	7,200
India	3,127	4,839	5,539	4,718	3,800	2,379
Italy	720	1,500	2,500	3,000	3,600	2,700
Japan	4,780	1,700	1,800	2,700	3,500	3,600
Netherlands	1,365	3,331	3,277	3,029	2,400	8,700
Poland	367	2,117	2,000	2,000	2,100	1,920
Spain	819	224	813	933	1,000	840
Sweden	490	1,250	1,000	1,000	1,000	1,020
Switzerland	328	700	700	750	800	840
Turkey	378	713	567	550	600	540
United Kingdom	21,289	25,241	20,823	23,254	23,892	22,554
United States	54,969	59,863	47,163	71,191	56,884	45,323
Others	4,316	6,433	7,209	7,896	8,078	8,743
World total	106,000	131,000	114,500	148,000	137,000	127,500

[1] Statistical Bulletin of the International Tin Study Group July, 1953.

REVIEW BY COUNTRIES

Australia.—Production of tin in concentrates in Australia totaled about 1,600 long tons, virtually unchanged from 1951. Domestic smelter production amounted to 1,700 tons, a 17-percent increase. In Queensland, the Tableland Tin Dredging N. L. dredge was being moved from the old site at Return Creek to the new leases on Smith's Creek, 9 miles away. It was expected that work would be resumed about July 1953, and the capacity of the dredge was to be increased. The estimated cost of the move was approximately £A.300,000. Total weight of the plant was 2,000 tons. The life of the new area was estimated at 12½ years, and the expected annual rate of output was 800 tons of tin concentrate.[21]

Belgian Congo.—The Belgian Congo production of tin in concentrates was 13,800 long tons compared with 13,700 in 1951. Tin contained in exports of concentrates totaled 10,900 long tons, of which United States received 2,000 and Belgium 8,900. Exports of metal from Belgian Congo were 2,800 long tons, of which United States received 1,400, Belgium 1,100, and the Union of South Africa 300. Stocks of tin metal increased from 40 tons at the beginning of 1952 to 150 at the end. Stocks of tin in concentrates decreased from 1,000 tons at the beginning of 1952 to 500 at the end.

On March 25, 1952, the Association of Belgian Congo Tin Producers concluded an agreement with the RFC for delivery of a minimum of

[21] Mining Journal (London), vol. 239, No. 6121, Dec. 12, 1952, p. 671.

7,000 and a maximum of 9,000 tons of tin a year. The price was $1.2075 a pound delivered at American ports, which was equal to $1.18 f. o. b. in Singapore. Delivery was to be made partly in the form of tin concentrates. The contract, valid for 2 years, provide that if the United States concluded a tin contract elsewhere at a higher price, Belgian Congo's price would be adjusted accordingly.

The Annual General Meeting of the Compagnie Géologique et Minière des Ingenieurs et Industriels Belges (Géomines) was held in Brussels on December 9, 1952. The following is an excerpt from the directors' report, which covers the year to June 30, 1952:[22]

In the period under review, cassiterite production was 3,576 tons, of which 532 tons were obtained from hard rock deposits. For the corresponding period last year production was 3,820 tons.

The new hard rock section is being steadily opened up and important preparatory work is being carried out. So far the natural geological features of the section have facilitated mining operations. The crushing and treatment plants continue to work steadily to improve techniques and to reduce working costs, and both are making satisfactory progress.

Any further big increase in output must await the completion of the new turbines of the central power station due in 1956 and when in full operation the enterprise should yield an output of between 7,000 and 8,000 tons of cassiterite yearly, as compared with the 4,200 tons expected in the current working year.

The tin content of the altered pegmatites is about one kilo of cassiterite per ton while that of the hard rock is between 2 and 2½ kilos. Treatment of the hard rock will, however, cost more, the estimate being 10 to 15 percent higher.

The Symetain Co. (Société Congolaise) worked tin deposits in the Maniema district, the most western part of Kivu Province, which lies astride the Lulalaka (Congo) River. Symetain has become the main producer of tin in the Belgian Congo; the company produced 5,100 metric tons of cassiterite in 1952 (5,100 tons in 1951), from which 3,900 tons (3,800 tons in 1951) of tin was extracted. The following tabulation presents data for the Symetain operations 1950–52:[23]

TABLE 21.—Production of tin concentrates by Symetain in Belgian Congo, 1950–52

Year	Ground excavated (thousand cubic meters)	Grade of ground (kilograms per cubic meter)	Tin concentrates produced (metric tons)	Tin content (metric tons)	Labor force	
					Europeans	Natives
1950	3,922	1.15	4,521	3,410	157	10,800
1951	4,568	1.10	5,109	3,849	150	10,600
1952 [1]	4,500	1.10	5,000	3,750	170	10,400

[1] Estimated.

Bolivia.—In 1952 Bolivia was the third largest tin producer in the world. Production of tin contained in concentrates was estimated at 35,500 long tons.[24]

Exports of tin in concentrates totaled 32,000 long tons, a 4-percent decrease from the previous year, due largely to cessation, after nationalization, of the private companies' practice of shipping all concentrates, even those unsold, to Chilean ports. Exports of tin metal were about 200 long tons. Of the total exports of 31,800 tons,

[22] Mining Journal (London), vol. 239, No. 6122, Dec. 19, 1952, pp. 712, 715.
[23] International Tin Study Group, Notes on Tin: No. 26, February 1953.
[24] United States Embassy, La Paz, Bolivia, State Department Despatch 68, Oct. 3, 1952, 6 pp.

the Patiño group exported 14,100 tons or 44 percent; the Hochschild group exported 6,000 tons or 19 percent; and the Aramayo group 2,600 tons or 8 percent. These three large mining groups thus exported 71 percent of the total. Medium-size mining companies exported 20 percent and the Banco Minero 9 percent. The largest single producer continued to be the Catavi Mines, the principal property of Patiño Mines & Enterprises, Inc., from which 9,500 tons was exported, or 30 percent of the total for Bolivia.

Early in April 1952 police and some civilians revolted; the revolution ended with the advent of a new government in Bolivia. On April 19, the Central Organization of Bolivia Workers (Central Obrera Boliviana), headed by the Minister of Mines and of Labor, was established to unify the workers "in a fight for nationalization of mines and railroads and agrarian reform." By a decree of May 14, a commission was created "to study the basis and conditions for the nationalization through expropriation of the mines controlled by or belonging to the enterprises forming the Patiño, Aramayo, and Hochschild Groups;" this commission was to submit its report to the Government within a maximum of 120 days.

By decree of June 2 the Bolivian State assumed the monopoly for exportation of all minerals, the mining companies to be paid for their products in Bolivian currency at world market prices converted at a rate of exchange arbitrarily fixed by the Government.

By a decree of October 2, 1952, an autonomous entity was created under the name of Corporacion Minera de Bolivia, which thereafter operated the nationalized tin properties. On October 9 the commission appointed to examine the question of nationalization filed its report with the Government, leading to the Government Executive Decree of October 31, 1952, which nationalized the "major producers" of tin, namely, Patiño Mines & Enterprises, Inc., Compagnie Aramayo de Mines en Bolivie, and Maurico Hochschild, S. A. M. I.

In view of the numerous inquiries that the United States Department of State received from the press concerning the purchase of Bolivian tin concentrates, the following release (No. 928), was issued on December 19, 1952:

First, the United States has made several spot purchases of Bolivian tin concentrates since the MNR regime assumed control of the Bolivian Government in April 1952. The last purchase, made in September 1952, from the Banco Minero, an agency of the Bolivian Government, covered all Bolivian production through September 1952, which had not already been contracted for sale. Delivery of ores in South American ports under this arrangement was not completed until the end of November.

Second, since September 1952, the Bolivian Government has not offered for spot sale to the United States any tin concentrates whatever.

Third, the United States has informed the Bolivian Government on several occasions that the RFC is prepared to consider offers from Bolivia to sell tin concentrates on substantially the same basis as in the earlier purchase agreements. At no time has the United States refused to buy Bolivian tin.

Fourth, recently the Bolivian Ambassador to the United States informed the department that the Bolivian Government wished to conclude a 1-year contract for the sale of Bolivian tin concentrates. The interested agencies of the United States Government are currently considering the feasibility of such an arrangement.

At the end of the year, a long-term contract was still to be negotiated.

Receipts of Bolivian ore at the Texas City smelter during the calendar year 1952 were:

TABLE 22.—Receipts of Bolivian ore (concentrate) at the Texas City (Tex.) smelter in 1952

Grade	Concentrates			Percent of tin content of receipts
	Long tons	Tin content		
		Long tons	Percent	
High	7,427	4,425	59.58	39.05
Medium	7,146	3,174	44.42	28.01
Low	18,183	3,733	20.53	32.94
Total	32,756	11,332	34.60	100.00

Canada.—Production of tin in concentrates during 1952 totaled 95 long tons, a 39-percent decrease from 1951. Imports of tin metal were about 4,000 tons. A memoir of the Canadian Department of Mines and Technical Surveys[25] reported:

No economic deposits of tin have been found in Canada so far. Since 1941 a small output of tin (totaling 3,340 long tons) has been recovered as a by-product in the treatment of the lead-silver-zinc ores of the Sullivan Mine of the Consolidated Mining and Smelting Co. at Kimberley, British Columbia:

The consumption by use in long tons has been as follows:

TABLE 23.—Consumption of tin in Canada, by uses, 1946–51, in long tons

Year	Tinplate and tinning	Solder	Babbitt	Brass and bronze	Foil and collapsible tubes	Other	Total
1946	2,070	910	307	332	59	29	3,707
1947	2,096	941	211	274	53	45	[1] 3,628
1948	2,181	1,241	220	281	45	78	4,046
1949	2,823	966	247	195	31	56	4,318
1950	2,440	1,427	317	159	41	142	4,526
1951	2,678	1,203	421	310	32	87	4,731

[1] As published.

Production of tinplate in Canada increased; Canada is now the third largest producer in the world. Two electrolytic tinplate plants were installed in Canada during 1948 and 1949. In 1951, 47 percent of the tinplate produced was electrolytic.

France.—The tin mines at Nosay, Abbaretz, Department of Loire-Inferiure (about 25 miles north of Nantes), have been in operation since the beginning of 1952, and the tin output increased 100 percent compared with that in 1951. The mines are being operated by the Société Nantaise des Minerais de l'Ouest, with American and foreign equipment, etc., estimated to cost between $325,000 and $350,000, plus £75,000 and 40 million Belgian francs.

The French Union (France, Algeria, and Morocco) produced 1,000 long tons of concentrates equivalent to 700 tons of metal.

[25] McClelland, W. R., Tin in Canada; Occurrences and Uses: Canadian Dept. Mines and Tech. Surveys, Mem. Ser. 125, 1952, p. 1.

Indonesia.—In 1952, Indonesia was the second largest tin producer in the world. Production of tin in concentrates totaled 35,000 long tons, a 13-percent increase from 1951. The Indonesian output of tin represented 20 percent of the world mine production. Tin production in Indonesia is confined to the islands of Banka, Billiton, and Singkep, which in 1952 supplied 63, 30, and 7 percent, respectively.

According to a recent article,[26] the Billiton Co. reported as follows:

> Of importance for the financial results for the Indonesian tin properties was the abolition as from February 4, 1952, of the former foreign exchange certificate system, which was one of differing exchange rates. The roepiah was devalued to one-third of its previous value. Unfortunately the value of the roepiah as fixed under the new exchange rate is still out of balance with its buying power. Imports are subject to differential import duties: there are five categories of imports—the first is free of duty, the second is subject to 33⅓ percent, the third to 100 percent, the fourth to 200 percent, while for the fifth group no foreign exchange is allotted.

A tin-purchase agreement between the United States and Indonesia was signed in Washington, March 18, 1952. The agreement provided for the sale of 18,000 to 20,000 long tons of tin to the United States, at a price of $1.18 per pound at ports of shipments (equal to $1.21½ delivered New York) for the first 2 years; that for the third year was to be left for future determination. The agreement provided for the tin to be supplied partly as concentrate and partly as metal smelted in Arnhem, Netherlands.

Malaya Federation.—The tin mining industry in Malaya maintained a remarkable record of production during 1952, despite the difficulties that beset the industry. Mine production of tin in ore was 56,800 long tons in 1952, compared with 57,200 in 1951, with 84,100 in the peak year 1940, and with an annual average of 55,300 per year during the prewar period, 1935–39. At the end of 1952, 80 dredges were in operation compared with 83 at the beginning of the year, whereas the corresponding figures for gravel pumping were 550 and 580, respectively. Whereas the total dredge output showed some decline, the production from gravel pump mines increased appreciably; this probably was due to the reduced price of tin in 1952 compared with 1951, resulting in the necessity for gravel pump operators to concentrate on higher grade material. Table 24 presents the tin production (long tons) and the number of tin mines operating in Malaya, 1952:

TABLE 24.—Production of tin, by method and number of tin mines in Malaya in 1952

Method	Number of tin mines operating (end of period)	Concentrates (long tons)		Percent of total tin production
		Gross weight	Tin content	
Dredging	80	39,447	29,585	52
Gravel pumping	552	28,783	21,587	38
Hydraulicking	13	2,138	1,604	3
Open cast	5	957	718	1
Underground	10	3,061	2,296	4
Miscellaneous	46	1,397	1,048	2
Total	706	75,783	56,838	100

[26] Metal Bulletin (London), No. 3805, June 30, 1953, p. 11.

The principal sources of pig tin in the world in 1952 were the large smelting plants of the Eastern Smelting Co., Ltd., Penang, and Straits Trading Co., Ltd., Singapore. These plants decreased their output 5 percent and supplied 37 percent of the world smelter production in 1952. Concentrates treated were derived mostly from Malaya, with smaller tonnages from Thailand, Burma, Indonesia, and French Indochina. The tin content of concentrates available from Malaya was 56,800 long tons compared with 57,200 tons in 1951. Imports originating elsewhere contained 7,900 tons of tin against 7,700 in 1951. The exports of tin metal totaled 64,100 long tons, of which the United States received 19,400. Stocks of tin metal decreased from 2,900 long tons at the beginning of 1952 to 1,500 at the end, while stocks of tin in concentrates increased from 4,500 at the beginning to 5,200 at the end.

On November 10, 1952, the report of the United States Tin Mission to Malaya 1951,[27] was released by the Department of State, the Department of the Interior, the Defense Materials Procurement Agency, and the Reconstruction Finance Corp.

The conclusions of the report were published in the Tin chapter, Bureau of Mines Minerals Yearbook, 1951.

The 700 tin-mining concerns in Malaya are owned predominantly by the British and Chinese. In 1952, 46,400 long tons of tin was produced by European mines and 29,300 tons by Chinese mines. The tin-mining industry employed 44,700 workers at the end of 1952, including 21,100 employed by European-owned mines and 23,600 by Chinese-owned mines. The Federation Government collected about $70,000,000 from the export duty on tin in 1952 at rates that have prevailed for many years.[28] The nominal capital of tin companies incorporated in the United Kingdom and registered in Singapore and Malaya at the beginning of 1950 was:[29]

	Singapore	*Malaya*
Tin mining	--------	£10, 833, 530

Table 25 presents exports of tin metal from Singapore and Malaya in 1952:

TABLE 25.—Exports of tin metal from Singapore and Malaya, 1952, in long tons [1]

Country	Long tons	Country	Long tons
Canada	1, 530	United Kingdom	16, 298
United States	19, 381	Yugoslavia	228
		Other Europe	131
Argentina	155		
Brazil	497	Hong Kong	102
Chile	420	India	2, 015
Other South America	25	Japan	1, 731
		Syria	202
Belgium	275	Pakistan	195
Denmark	340	Turkey	267
France	2, 617	Other Asia	340
Germany	1, 335		
Greece	110	Egypt	209
Italy	3, 993	Union of South Africa	409
Netherlands	9, 140	Other Africa	153
Poland	850		
Rumania	200	Australia	10
Spain	140	New Zealand	185
Sweden	150		
Switzerland	486	Total	64, 119

[1] Bureau of Mines, Mineral Trade Notes: Vol. 36, No. 3, March 1953.

[27] Bureau of Mines, Mineral Trade Notes: Special Suppl. 39 (to vol. 35, No. 3), September 1952, p. 26.
[28] Mining Journal (London), Ann. review No., May 1953, p. 151.
[29] International Tin Study Group, Notes on Tin: No. 24, December 1952, p. 396.

Nigeria.—The Colony and Protectorate of Nigeria, including the Cameroons under British trusteeship, is the largest British possession in west Africa. The tin deposits are situated chiefly in the Northern Provinces-Plateau, Kabba, Niger, and Benue. Deposits currently worked are alluvial or eluvial and are mined by placer methods. Lode deposits are known to occur. Production of tin in concentrate in Nigeria totaled 8,318 long tons in 1952, a 2-percent decrease from 1951. Most of the world supply of columbium (niobium) is recovered from the large tin deposit of the plateau though considerable quantities are also obtained from the Kano and Bauchi Provinces.

South-West Africa.—The 1952 annual report of Ventures, Ltd., contained the following statement:

> The Uis mine, in the Brandberg area of South-West Africa, has a pilot plant operating on it at present and a mill with a daily capacity of 1,000 tons under construction. The ore is in the form of cassiterite distributed through pegmatites that appear to be very extensive and to have an unusual uniformity in tin content. Ore reserves, from geological mapping and bulk sampling, appear to run into several million tons with a grade that is reported to yield 5 to 6 pounds of tin per ton.

Thailand.—Thailand in 1952 ranked as the fifth largest tin-producing country; production of tin in concentrates totaled 9,500 long tons, virtually unchanged from 1951. The tin deposits are situated in two regions—in the Northwest, in a narrow band along the Burmese frontier, where mining is relatively recent, and in the South, where the more important productive areas are situated.

The Thailand Under Secretary of the Ministry of Industry announced [30] at the beginning of 1952 that in the future aliens would be granted no mining concessions north of Chumporn, a province some 200 miles south of Bangkok. Further restrictions on aliens were imposed by a new law requiring many businesses to employ 50 percent Thai personnel and 100 percent Thai accountants.

On September 16, 1952, the foreign exchange surrender requirements on tin exports were reduced from 40 to 20 percent. The cabinet announced that in the future concessions for exploiting natural resources would be limited to Thai nationals. Exceptions would be made in instances where Thai nationals could not finance or operate concessions.[31]

In 1952, tin-ore exports had an approximate value of $25 million and composed roughly 8 percent of Thailand's total exports. Government revenue from tin mining royalties in 1952 were estimated at 50 million baht.[32] There is no export duty on tin concentrate.[33]

In 1948–52, as shown in table 26, a large share of Thailand's exports of tin in concentrates went to the United States.

[30] Foreign Commerce Weekly, vol. 46, No 11, Mar. 17, 1952, p. 17.
[31] U. S. Department of State, Semiannual Report: State Dept. Despatch, Bangkok, Thailand, No. 854, Apr. 30, 1953, pp. 12.
[32] Nominal 1952 exchange rate, b18.75=$1.00.
[33] Work cited in footnote 31, p. 5.

TABLE 26.—Exports of tin in concentrates from Thailand, 1948–52, in long tons

Destination	1948	1949	1950	1951	1952
United States	3,911	4,671	2,908	2,727	4,677
Malaya	1,740	3,312	8,040	6,003	4,560
Netherlands			7	79	504
Total	5,651	7,983	10,955	8,809	9,741

United Kingdom.—Mine production in the United Kingdom (Cornwall and Devon) totaled about 1,000 long tons in 1952 compared with about 1,200 in 1951. United Kingdom smelter production of tin was the second largest in the world in 1952. Output increased 13 percent compared with 1951. Year-end stocks of tin in concentrates were 2,400 tons (1,900 at the beginning of the year) and of metal 4,200 tons (8,000 at the beginning). Total stocks, including tin metal and concentrates afloat and visible consumer stocks, were reported to be 7,000 tons at the end of 1952—a 47-percent decrease from 13,100 tons at the beginning of the year. Total virgin tin consumed totaled 22,600 tons, a 6-percent decrease from 1951.

During 1952 both the South Crofty, Ltd., and Geevor Tin Mines, Ltd., had successful years. Although the New Consols mine continued to work throughout most of the year, the directors decided to abandon operations late in the autumn, and the pumps were withdrawn from the lower levels after development results were disappointing. Mineral Recovery, Ltd., was producing tin at the Kieve mill. Another small producer of tin was the Malayan Tin Syndicate, which is working old dumps at Carnkie near Redruth.[34]

On January 18, 1952, the Governments of the United States and the United Kingdom concluded an agreement on steel, aluminum, and tin. Under that agreement, the United Kingdom provided for the supply of 20,000 long tons of tin during 1952 in roughly equal installments at $1.18 per pound for tin of Straits quality or equivalent, f. o. b. Penang, Singapore, London, or Liverpool (at the option of the United Kingdom). By August 1, 1952, the United Kingdom Government had virtually completed the purchase of tin for delivery to the United States pursuant to section C, paragraph 1, of the agreement, dated January 18, 1952.[35]

[34] Mining Journal (London), Ann. review No., May 1953, p. 171.
[35] Department of State, Press Release 605, July 31, 1952.

Titanium

By Alfred F. Tumin[1] and Frank J. Cservenyak[2]

GOVERNMENT programs established in 1952 called for expansion of titanium dioxide pigment and titanium-metal production facilities. Titanium-metal production in 1952 doubled the 1951 output; however, the production of titanium pigments decreased slightly from 1951.

Rutile, required mainly for welding-rod coatings, was in short supply during the first part of 1952. The removal of price controls on rutile resulted in record imports from Australia adequate to meet record requirements and to double year-end inventories.

An appreciable quantity of titanium slag imported from Canada in 1952 compensated for lower ilmenite imports from India. Domestic production and shipments of ilmenite changed slightly.

The Bureau of Mines published reports covering investigations on the production and properties of titanium metal and utilization of brookite and titaniferous iron ores. Extensive research on utilization of titanium metal also was reported by other Government agencies and by industry.

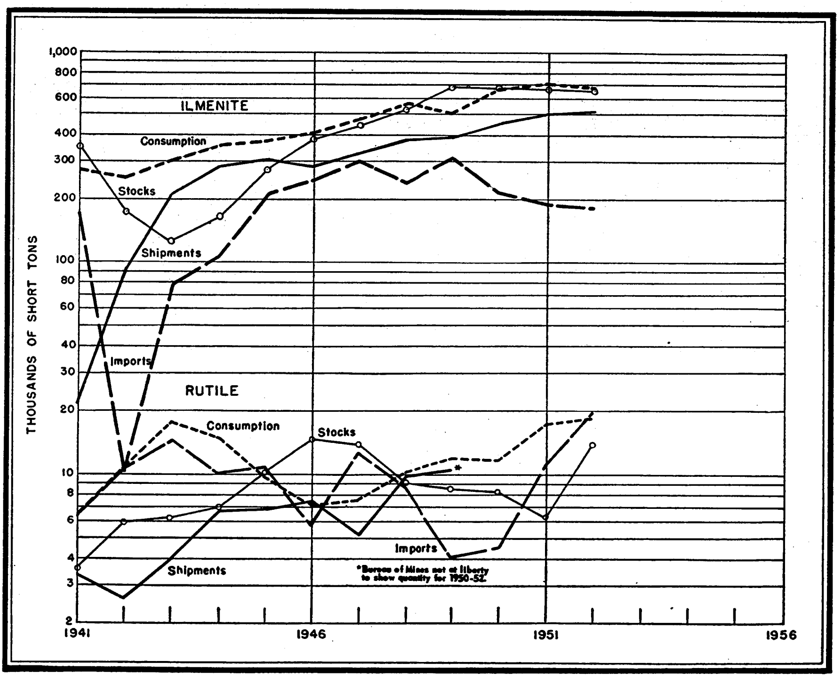

FIGURE 1—Domestic shipments, imports, consumption, and stocks of ilmenite and rutile, 1941–52.

[1] Commodity-industry analyst.
[2] Chief, Light Metals Branch.

DOMESTIC PRODUCTION

Concentrates.—Output of ilmenite in 1952 decreased 7,200 short tons from the record established in 1951. On the other hand, mine shipments increased 11,700 tons over 1951 and established a new record for the sixth successive year.

Lower production was reported by the American Cyanamid Co., Piney River, Va.; E. I. du Pont de Nemours & Co., Starke, Fla.; National Lead Co., Tahawus, N. Y.; Rutile Mining Co. of Florida, Jacksonville, Fla.; and the Yadkin Mica & Ilmenite Co., which ceased operations at Findley, N. C., in October 1952. The Florida Ore Processing Co., Melbourne, Fla., tripled its 1951 production, and Baumhoff-Marshall, Inc., doubled its 1951 recovery of ilmenite from monazite operations at Boise, Idaho. Production of Baumhoff-Marshall, Inc., included output of the Idaho-Canadian Dredging Co. and Warren Dredging Corp. Ilmenite statistics in 1952 include a mixed product containing ilmenite, rutile, and leucoxene. Of the total ilmenite production, New York continued to supply over half and Florida about one-third; the remainder came from North Carolina, Virginia, and Idaho. A small quantity of low-grade ilmenite produced in California for nontitanium use is not included in the production and shipments of titanium concentrates.

Factors that contributed to the new peak in ilmenite shipments in 1952 were larger shipments from the National Lead Co., Tahawus, N. Y., and the Yadkin Mica & Ilmenite Co., Finley, N. C. The latter company in 1952 shipped all of its production and material in stock. Shipments by other ilmenite producers were about the same as production, except for Baumhoff-Marshall, Inc., which reported no ilmenite shipments in 1952. Shipments of ilmenite ranged from 45 to 66 percent TiO_2.

Rutile production in the United States in 1952 decreased slightly from 1951 output. Rutile was produced in 1952 by the Rutile Mining Co. of Florida, Jacksonville, Fla., and the Florida Ore Processing Co., Melbourne, Fla. Domestic production of rutile is not published as it would disclose operations of the major producer. Shipments of rutile ranged from 93 to 97 percent TiO_2.

Under the Defense Production Act of 1950, the Defense Minerals Exploration Administration issued Order 1 on March 7, 1952, placing rutile and brookite in the classification of strategic and critical minerals and set forth provisions whereby the Government would contribute up to 75 percent of the total exploration cost of these minerals.

Titanium Pigments.—Production and shipments of titanium pigments in 1952 decreased 4 and 11 percent, respectively, from 1951, as production dropped to the 1950 level, and shipments fell to near the 1948 figure. Titanium pigments were produced by the American Cyanamid Co., Calco Chemical Division, Bound Brook, N. J.; Chemical & Pigment Co. Division of the Glidden Co., Baltimore, Md.; E. I. du Pont de Nemours & Co., Wilmington, Del.; and the National Lead Co., New York, N. Y. Statistics in this industry are supplied in confidence and consequently are not given here. The percentage distribution of titanium-pigment shipments, by consuming industries, is shown in table 3.

TABLE 1.—Production and mine shipments of titanium concentrates from domestic ores in the United States, 1943–47 (average) and 1948–52, in short tons

Year	Ilmenite				Rutile			
	Production (gross weight)	Shipments			Production (gross weight)	Shipments		
		Gross weight	TiO_2 content	Value		Gross weight	TiO_2 content	Value
1943–47 (average)	281,931	283,959	130,436	$5,675,565	6,821	6,044	5,645	$819,890
1948	383,745	381,508	177,447	5,793,973	7,380	9,907	9,226	647,334
1949	402,334	389,234	186,535	6,212,348	[1] 11,988	[1] 10,559	[1] 9,414	[1] 489,798
1950	[1] 468,320	[1] 452,370	[1] 230,826	[1] 5,606,584	(2)	(2)	(2)	(2)
1951	[1] 535,835	[1] 510,840	[1] 261,982	[1] 7,689,272	(2)	(2)	(2)	(2)
1952	[1] 528,588	[1] 522,515	[1] 265,596	[1] 8,022,752	(2)	(2)	(2)	(2)

[1] Includes a mixed product containing altered ilmenite, leucoxene, and rutile.
[2] Bureau of Mines not at liberty to publish.

Defense Production Administration announced on April 3, 1952, an expansion goal for titanium dioxide pigments calling for an annual production capacity of 370,000 short tons by January 1, 1954—an expansion of 88,000 tons over the capacity of January 1, 1951. Tax-amortization certificates approved as of February 20, 1953, provided for 69,000 tons of the expanded capacity. The remaining 19,000 tons was open for issuance of certificates of necessity.

Metal.—Commercial titanium-sponge production in 1952 totaled 1,075 short tons, approximately double the 1951 output, coming from plants operated by E. I. du Pont de Nemours & Co., at Newport, Del.; Titanium Metals Corp. of America, Henderson, Nev.; Crane Co., Chicago, Ill.; and the Bureau of Mines during research operations at its Boulder City, Nev., pilot plant.

The Defense Production Authority, in November 1952, set its goal for production of commercial titanium sponge at 22,000 short tons per year by the end of 1955. The Titanium Metals Corp. of America signed a letter of intent in August 1951 for construction and operation of a plant at Henderson, Nev., to produce 3,600 tons of titanium per year for 5 years. An advance of $15,000,000 was made to Titanium Metals Corp. of America by the Government to carry on this work. One year later (July 28, 1952), the Defense Materials Procurement Agency contracted with E. I. du Pont de Nemours & Co., Wilmington, Del., for additional production of 13,500 short tons of titanium sponge during the next 5 years. The Government will advance the company $14,700,000 to increase the capacity of its Newport, Del., plant to 10 tons per day. The agreement with Du Pont is similar to one the Government made with Titanium Metals Corp. of America in August 1951, whereby the loan, plus interest of 4 percent a year on the unpaid balance, is repayable either in dollars or in titanium metal.

The revolving-fund purchase and resale program, established by General Services Administration in August 1951 to maintain capacity operation of sponge-manufacturing facilities during the period of development of military applications, continued throughout 1952 to assure an increased supply of titanium and the utilization of such supply in the manner most advantageous to national defense. The revolving fund contained $5,000,000 for the purchase and resale of not more than 1 million pounds of titanium sponge at not over $5 per pound. The following specifications were set up for purchase of titanium sponge under this program: Titanium, 99.3 percent minimum; iron, 0.25 percent maximum; nitrogen, 0.03 percent maximum; magnesium, 0.10 percent maximum; chlorine, 0.15 percent maximum; and Vickers hardness No. 250 (Brinell hardness No. 225) maximum. The first contract to sell titanium sponge to the Government under this program was negotiated in 1951 between E. I. du Pont de Nemours & Co., Wilmington, Del., and GSA with the expiration date being March 15, 1952; however, this contract was extended to December 31, 1952, at the company's request, and in the latter part of 1952 negotiations were made to continue this program, with revised specifications, until December 1953. E. I. du Pont de Nemours & Co. sold to the Government, as of December 31, 1952, 303 short tons of titanium sponge. Five tons of metal, that was placed in the revolving-fund stockpile October 21, 1951, was resold to Rem-Cru Titanium, Inc., Midland, Pa., in September 1952, and was reported satisfactory for production of milled products. As of October 15, 1952, 280 short tons of titanium sponge sold by Du Pont contained the following average quality, based on analysis by the manufacturer and confirmed by the Bureau of Mines for GSA; in percent: Titanium, 99.64; iron, 0.16; nitrogen, 0.025; magnesium, 0.04; chlorine, 0.11; and Brinell hardness No. 172. The revolving-fund stockpile is intended as a temporary reserve of titanium sponge available for resale and is in no way connected with the National Stockpile. Negotiations were under way at the end of 1952 between Defense Materials Procurement Agency and Titanium Metals Corp. of America for inclusion of that company under a similar purchase and resale contract

High-purity titanium (99.9 percent Ti) was produced, by thermal decomposition of volatile titanium iodides, by the Foote Mineral Co., Philadelphia, Pa., throughout 1952 and by the New Jersey Zinc Co., Palmerton, Pa., in the first quarter of 1952. Titanium alloyed and unalloyed mill products were manufactured by the Titanium Metals Corp. of America, New York, N. Y.; Rem-Cru Titanium, Inc., Midland, Pa.; Mallory-Sharon Titanium Corp., Niles, Ohio; and Republic Steel Corp., Cleveland, Ohio. Titanium tubing was supplied by the Superior Tube Co., Norristown, Pa., and the Trent Tube Co., East Troy, Wis., in unalloyed grades.

Titanium Powder.—Metal Hydrides, Inc., Beverly, Mass., produced 201,000 pounds of titanium powder (96 to 98 percent Ti) in 1952, by reducing titanium oxide with calcium hydride, an increase of 57,000 pounds over 1951 output. Titanium metal produced in the form of powder can be compressed into suitable forms and sintered either in vacuum or in a nonoxidizing atmosphere, into solid blocks or finished products at as low a temperature as 1,000° C.

Inventory controls that called for a practicable minimum working inventory were placed on titanium products, such as sponge, semifabricated shapes, sheets, tubes, extrusions, titanium-bearing alloys and titanium-base alloy scrap as of October 22, 1951, under NPA Regulation 1, as amended, and remained in effect throughout 1952.

New titanium organizations were formed in 1952. The Titanium Co. of America, East Chicago, Ind., chartered in Delaware, was organized by the Christiansen Corp., Chicago, Ill., to manufacture wrought products from titanium. The Glidden Co., Cleveland, Ohio, and Bohn Aluminum & Brass Corp., Detroit, Mich., combined their research facilities to develop methods for producing pure titanium and titanium alloys. It was also reported that research studies will be conducted in Glidden's laboratory at Baltimore, Md., and in Bohn's laboratory at Detroit, Mich. The Kennecott Copper Corp. constructed a 200-pound pilot plant at the Battelle Memorial Institute, Columbus, Ohio, in 1952 to develop and evaluate several methods of producing titanium metal. Kennecott Copper Corp. also announced that a new Research and Development Department for Chase Brass & Copper Co. was established at Waterbury, Conn., to conduct research on the production, treatment, and uses of copper and titanium alloys, and other metals.

Welding-Rod Coatings.—Production of titanium-coated welding rods was 266,400 short tons in 1952, a decrease of 7 percent under the 287,100 short tons in 1951; 188,000 short tons was coated in 1950 and 154,000 in 1949. Record production of 481,000 tons was reported in 1943. Of the 1952 tonnage, 48 percent was coated with natural rutile, 18 percent with manufactured titanium dioxide, 17 percent with a mixture of rutile and manufactured titanium dioxide, and 17 percent with ilmenite.

CONSUMPTION AND USES

Ilmenite consumption in 1952 decreased 30,500 short tons (21,500 tons titanium dioxide) from 1951. Ilmenite consumption was lower in the titanium-pigment industry; however, this decrease was offset by using 24,200 short tons of titanium slag containing 16,800 tons of titanium dioxide. Titanium slag imported from Canada in 1952 was consumed for the first time in appreciable quantities for titanium pigments, welding-rod coatings, and chlorinating experiments. Titanium slag is discussed further under World Review. Rutile consumption totaled 18,300 short tons in 1952—an increase of 1,100 tons over 1951—and established a new record. The previous record set in 1943 totaled 17,600 tons. The increase in rutile consumption was caused by expansion of the titanium-metal industry.

An analysis of titanium aircraft-engine parts as compared to alloy steels showed the following weight savings, per part: Propeller shaft, 21 pounds; crankshaft front, center, and rear, 18, 24, and 13 pounds, respectively; articulated and master rods, 1 and 7 pounds; rocker arm, 0.4 pound; turbine support, 1 pound; and compressor-rotor disk, stator blade, and rotor blade, 11, 0.02, and 0.04 pound, respectively. Other comparisons between these metals were described also.[3]

[3] Hanink, H. H., Titanium Aircraft Engine Parts, an Analysis: Iron Age, vol. 1, No. 20, May 15, 1952, pp. 121-125.

TABLE 2.—Consumption of ilmenite and rutile in the United States, 1943–49 total, and 1950–52, by products, in short tons

Product	Ilmenite		Rutile	
	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content
1943	302,822	142,868	17,634	16,451
1944	360,941	175,475	14,813	13,837
1945	381,178	187,580	9,791	9,144
1946	404,283	202,663	7,134	6,670
1947	479,524	250,859	7,692	7,083
1948	565,000	300,408	10,230	9,488
1949	510,608	268,000	[1] 11,888	[1] 10,863
1950				
Pigments (manufactured titanium dioxide) [1] [2]	671,335	347,747	(3)	(3)
Welding-rod coatings [2]	210	106	9,218	8,516
Alloys and carbide	7,666	3,803	1,454	1,366
Ceramics			195	185
Miscellaneous	33	19	854	802
Total	679,244	351,675	11,721	10,869
1951				
Pigments (manufactured titanium dioxide) [1] [2]	703,068	367,937	(3)	(3)
Welding-rod coatings [2]	258	130	11,708	10,834
Alloys and carbide	10,024	4,962	2,939	2,752
Ceramics			265	248
Miscellaneous	13	8	[4] 2,315	[4] 2,184
Total	713,363	373,037	17,227	16,018
1952 [5]				
Pigments (manufactured titanium dioxide) [1] [2]	670,829	345,368	(3)	(3)
Welding-rod coatings [2]	719	416	11,418	10,798
Alloys and carbide	11,293	5,763	2,997	2,858
Ceramics	5	3	281	265
Miscellaneous	4	3	[4] 3,621	[4] 3,432
Total	682,850	351,553	18,317	17,353

[1] Includes a mixed product containing altered ilmenite, leucoxene, and rutile used to make pigments and metal.
[2] "Pigments" includes all manufactured titanium dioxide, consumption of which in welding-rod coatings was 1,439 tons in 1950, 1,770 tons in 1951, and 2,209 tons in 1952.
[3] Included with "Miscellaneous," to avoid disclosure of individual company operations.
[4] Includes metal and fiberglass.
[5] A total of 24,236 short tons (16,746 tons TiO_2) of titanium slag was consumed in 1952 for titanium pigments, welding-rod coatings, and experimental purposes.

Commercially pure and alloy-grade titanium metal was reported used as a substitute for aluminum alloy and stainless steel in aircraft engine nacelles in 1952. According to aircraft manufacturers, the weight reduction by using titanium in aircraft structural parts, such as fuselage webs, channels, frames, and angles where operating temperatures do not exceed 800° F., would increase the operating range of an airplane by 150 miles. Additional reduction of 300 pounds in the weight of an airplane can be obtained, according to the manufacturers, by replacing 88 percent of the skin of the engine nacelles with titanium sheet.[4] The United States Air Force announced that

[4] Light Metals Bulletin, vol. 14, No. 24, Dec. 4, 1952, p. 17.
Engineering and Mining Journal, Metal and Mineral Markets, Titanium in Planes: Vol. 23, No. 25, June 19, 1952, p. 7.
Eshman, A. N., Titanium Sheet Metal Parts Successfully Made: Iron Age, vol. 170, No. 3, July 17, 1952, pp. 132–135.

530 pounds of sheet titanium instead of sheet steel was to be used in the production of certain airframe parts for the B–36 bomber.[5]

Evaluation service tests were performed by the Bureau of Ships, USN, on use of titanium in wet exhaust mufflers for submarine diesel engines; meter disks for oil, gasoline, and salt-water meters; condenser and heat-exchanger tubes with high water velocities; seats for salt-water valves; and blades for steam turbines. The exhaust muffler, tested 900 hours under normal wet operation and 100 hours under thermal shock operation, showed no perceptible damage; meter disks were found superior to all other materials including aluminum; condenser and heat-exchanger tubes tested over a year were found in perfect condition; the titanium seats for the salt-water globe valve tested for 18 months were found in perfect condition. Some difficulty was encountered in cold-peening the tenons onto the shrouds when using titanium blading for steam turbines installed in a low-pressure, low-temperature (400° F.) 300-kw. turbogenerator, owing to cracking of the tenons; however, this was overcome by peening at temperatures between 600° to 900° F. Applications of titanium in an 8-foot section of submarine snorkel tubing, submarine superstruction and fairwater construction, aircraft landing gear components and propeller blades, armor plate, and a 30-gallon ships-service hot-water tank were also under investigation during 1952.[6]

TABLE 3.—Distribution of titanium-pigment shipments, by industries, 1938–47 (average) and 1948–52, in percent of total

Industry	1938–47 (average)	1948	1949	1950	1951	1952
Distribution by gross weight:						
Paints, varnishes, and lacquers	78.4	76.4	74.5	74.5	73.3	70.9
Paper	6.6	5.4	6.6	6.2	5.9	7.0
Floor coverings (linoleum and felt base)	2.8	4.5	4.6	4.2	4.4	5.0
Rubber	2.1	2.5	3.1	3.0	2.5	2.8
Coated fabrics and textiles (oilcloth, shade cloth, artificial leather, etc.)	2.4	2.1	1.6	1.5	1.5	2.1
Printing ink	1.0	.9	.9	.9	1.3	1.0
Other	6.7	8.2	8.7	9.7	11.1	11.2
Total	100.0	100.0	100.0	100.0	100.0	100.0
Distribution by titanium dioxide content:						
Paints, varnishes, and lacquers	70.2	69.9	67.5	66.9	64.9	62.9
Paper	9.5	7.4	9.6	9.1	8.9	10.4
Floor coverings (linoleum and felt base)	3.9	5.9	5.8	5.2	5.7	5.6
Rubber	2.7	3.2	3.9	3.9	3.4	3.6
Coated fabrics and textiles (oilcloth, shade cloth, artificial leather, etc.)	3.1	2.7	2.1	2.0	2.1	2.9
Printing ink	1.6	1.4	1.4	1.4	1.8	1.6
Other	9.0	9.5	9.7	11.5	13.2	13.0
Total	100.0	100.0	100.0	100.0	100.0	100.0

[5] Iron Age, Airborne Titanium: vol. 170, No. 14, Oct. 9, 1952, p. 215.
[6] Michalos, Lt. G. P., USNR, Titanium—The New Metal: Bureau of Ships Jour., vol. 1, No. 5, September 1952, pp. 7–14.
Beardman, E. L., Navy Has Large Titanium Program: Jour. Metals, vol. 5, No. 2, February 1953, pp. 138–139.

The Army Ordnance Corps, USA, authorized production of 81 mm. mortar-base plates from titanium in 1952. The lightness of titanium as compared to steel allowed the mortar-base plate to be redesigned to a 1-piece welded construction, weighing only 24 instead of 48 pounds, and releasing 1 man for other duties. Other items from titanium, such as armor plate for tanks and vehicles, flash suppressors, structural components such as outriggers, and helical springs, were under test.[7]

At the National Metal Exposition in October 1952, at Philadelphia, Pa., a titanium ingot weighing 4,000 pounds and a continuous sheet of titanium coil, 0.015 inch thick, 460 feet long, and worth $12,000, were displayed for the first time. A model of the J–47 Air Force engine highlighted the uses of titanium in blades, casings, compressor wheels, and other components. Titanium was displayed also in the following forms: 0.38 caliber paratrooper's pistol, filters, cutting tools, valves, and other machine parts. An organic bonding agent ideal for low-heat bonding of titanium was revealed, and parts drawn from commercially pure titanium were demonstrated.

Staurolite ($2FeO.5Al_2O_3.4SiO_2.H_2O$), previously wasted, was recovered in 1952 from ilmenite operations in Florida by using induced-roll magnetic separators. This mineral, containing approximately 50 percent Al_2O_3, was reported as a source of aluminum and iron in making cement. Staurolite production schedules called for 25,000 tons per year; however, plant capacity in 1952 was reported at about 35,000 tons per year.[8]

Tanarc produced from titanium slag was manufactured in 1952 by the Foote Mineral Co., Philadelphia, Pa., and consumed in the welding-electrode industry as a partial substitute for rutile. Tanarc, which contains about 70 percent TiO_2, was not used as a complete substitute for natural rutile but was mixed with rutile to yield a product containing approximately 25 percent Tanarc. Additional research by the electrode manufacturers may increase the proportion of Tanarc up to 50 percent in the mixture. Production of Tanarc, considered still in the development stage, was estimated at 500 tons in 1952.

Titanium dioxide rectifiers, consisting of a layer of semiconducting titanium dioxide, a sheet of titanium metal, and a counterelectrode of some other conducting material, were described in an article released by the National Bureau of Standards. The rectifiers were reported to withstand reverse voltages of 20 volts per plate and operate satisfactorily at elevated temperatures.[9]

Studies on the use of titanium pigments, anatase and rutile, for exterior house paints showed that after exposure for 5 years rutile-pigment paint protected the surface and was in good condition for repainting, whereas the anatase paint had completely chalked away and offered no protection to the surface. Repeat tests on the same

[7] Mesick, Col. B. S., Titanium Evaluated for Ordnance: Jour. Metals, vol. 5, No. 2, February 1953, pp. 136–137.
[8] Engineering and Mining Journal, Induced-Roll Magnetic Separators Now Recovering Staurolite Formerly Wasted: vol. 153, No. 12, December 1952, pp. 108–109.
[9] Breckenridge, R. G., and Hosler, W. R., Research Paper 2344: Nat. Bureau of Standards, Jour. Research, vol. 49, No. 2, August 1952, pp. 65–72.

paints but with short exposures showed clean, white, mildew-free panels for anatase paints and dirty mildewed surfaces for the rutile versions. Other comparisons between these two pigments were discussed.[10] An informal summary on the development, production, properties, and uses of titanium pigments was also published.[11]

STOCKS

Year-end stocks of ilmenite decreased slightly in 1952 and were equivalent (TiO_2 content basis) to 11½ months' requirements at the rate of consumption in 1952. The pigment producers reported lower ending inventories in 1952; however, this was offset by an increase in stocks of titanium slag. Stocks of titanium slag increased from 3,000 short tons at the end of 1951 to 17,000 in 1952. Rutile stocks in 1952 more than doubled 1951 ending inventories and would sustain industry (TiO_2 content basis) at the 1952 rate of use for 9 months. Even though rutile consumption in 1952 established a new peak, supply was greater than demand owing to record imports from Australia, the sole supplier of rutile to the United States in 1952.

The National Production Authority announced inventory controls on rutile January 28, 1952, in NPA Regulation 1, as amended; however, rutile was removed from the inventory control list September 9, 1952, in NPA Regulation 1, as amended.

TABLE 4.—Stocks of titanium concentrates in the United States at end of year 1951–52, in short tons

Stocks	1951 [1]				1952 [2]			
	Ilmenite		Rutile		Ilmenite		Rutile	
	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content	Gross weight	Estimated TiO_2 content
Mine	57,139	26,925	55	51	63,212	30,621	306	285
Distributors [3]	692	415	539	511	958	574	5,353	5,113
Consumers	619,714	307,211	5,801	5,491	610,499	307,993	8,156	7,765
Total stocks	677,545	334,551	6,395	6,053	674,669	339,188	13,815	13,163

[1] Revised figures reflecting inventory corrections reported by industry.
[2] Consumers stocks of titanium slag imported from Canada totaled 17,000 short tons containing 12,000 tons of estimated TiO_2.
[3] Includes ilmenite and rutile content of mixed zirconium-titanium concentrates.

PRICES

Ore.—Quotations in E&MJ Metal and Mineral Markets for 1952, per gross ton for ilmenite containing 56 to 59 percent TiO_2, f. o. b. Atlantic seaboard, were \$16–\$18 at the beginning of 1952 and increased to \$16–\$20 in March and to \$18–\$20 in April, at which level the price of ilmenite remained for the rest of the year. All quotations were nominal.

[10] Paint, Oil and Chemical Review, Francis G. Smith Tells N. Y. Production Men About Titanium: vol. 115, No. 6, Mar. 13, 1952, p. 61.
[11] E. I. du Pont de Nemours & Co., Wilmington, Del., Titanium—The Common Rarity: February 1952.

Nominal quotations for rutile guaranteed minimum 94 percent concentrates were 5¼ to 6¼ cents per pound at the beginning of the year and decreased on January 3, 1952, to 3½ to 4½ cents per pound and then increased during the year as follows: 4 to 5 cents at the end of January; 5 to 7 cents in March; 6 to 8 cents in April; 7 to 8 cents in September; and 7 to 8½ cents a pound in November 1952, where they remained for the rest of 1952.

Amendment 13 to General Overriding Regulation 13, issued January 18, 1952, by the Office of Price Stabilization, Economic Stabilization Agency, exempted from price control all sales of imported and domestic rutile ores and concentrates and the allied services of mining and processing such materials. Rutile, under coverage of General Ceiling Price Regulation, January 27, 1951, was removed from price control to permit domestic consumers and dealers to compete with other countries in obtaining this material and to allow domestic producers to continue production by meeting higher operating costs.

Tanarc, containing 70 percent TiO_2, was quoted by the Foote Mineral Co., Philadelphia, Pa., in 1952, at $130 per ton, after processing, grinding, etc., in carlots, f. o. b. Exton, Pa.

Ferrotitanium.—Price quotations on all grades of ferrotitanium remained the same in 1952 as that quoted in the latter part of 1951. Steel Magazine quoted ferrotitanium in 1952 as follows:

Ferrotitanium, low-carbon:	
(Ti, 20–25 percent: Al, 3.5 percent maximum; Si, 4 percent maximum; C, 0.10 percent maximum). Contract, ton lots 2'' x D, per pound of contained Ti	$1. 50
Less-than-ton lots per pound	1. 55
(Ti, 38–43 percent, Al, 8 percent maximum, Si, 4 percent maximum; C, 0.10 percent maximum). Ton lots per pound	1. 35
Less-than-ton lots per pound	1. 37

The above prices are f. o. b. Niagara Falls, N. Y., freight allowed to St. Louis, spot add 5 cents.

Ferrotitanium, high-carbon:	
(Ti, 15–18 percent; C, 6–8 percent) contract per net ton, f. o. b. Niagara Falls, N. Y., freight allowed to destination east of Mississippi River and north of Baltimore and St. Louis	$177
Ferrotitanium, medium-carbon:	
(Ti, 17–21 percent; C, 2–4.5 percent) contract per ton, f. o. b. Niagara Falls, N. Y., freight not exceeding St. Louis rate allowed	195

Metal.—The price of titanium-sponge metal in 1952 remained the same as in 1951 at $7.50 per pound in quantities of less than 100 pounds and $5 per pound in quantities of 100 pounds or more, all prices f. o. b. shipping point. Titanium-metal prices, commercially pure and alloy grades, as quoted in Steel Magazine and by the Titanium Metals Corp. of America, New York, N. Y., also remained the same during 1952; base prices per pound in lots of 10,000 pounds and over in commercially pure and alloy grades, f. o. b. mill were as follows; Hot- and cold-rolled sheets, $15, Brackenridge, Pa.; hot-rolled sheared mill plate, $12, Brackenridge; cold-rolled strip, $15, West Leechburg, Pa.; rolled or cold-drawn round bar in small diameters and round wire, $10, Dunkirk, N. Y.; forgings (rounds, disks, and round-cornered squares and rectangles), $6, Watervliet, N. Y., hot-rolled bars (rounds, flats, and squares), $6, Watervliet. Extremely pure titanium made by the iodide process was quoted by the Foote Mineral Co., Philadelphia, Pa., at $95 per pound in lots of 100 pounds and up, in lots less than 100 pounds, $125 per pound, f. o. b. Exton, Pa., with a minimum order of $10. This metal was available as crystalline bars approximately ½ inch in diameter by 19 inches in maximum length.

Powder.—Titanium powder (97 percent Ti) was quoted by Metal Hydrides, Inc., Beverly, Mass., in 1952, at $9 a pound in single pound quantities and $7.95 a pound in 5,000 pound quantities, f. o. b. Beverly, Mass.

Manufactured Titanium Dioxide.—Manufactured titanium dioxide (anatase), ceramic, chalk-resistant, and regular grade in bags, carlots, delivered, were all quoted throughout 1952 at 21–21½ cents per pound. Rutile, nonchalking, was quoted at 23–23½ cents during 1952.

FOREIGN TRADE [12]

Imports.—Increased imports from Canada counterbalanced lower ilmenite imports from India. Titanium slag accounted for 99 percent of the titanium concentrates imported from Canada in 1952. Rutile imported from Australia in 1952 increased 74 percent over 1951 and established a new record over that previously set in 1943. Rutile imports were slightly higher in 1952 than domestic rutile consumption. Shortage of rutile at the end of 1951 caused United States buyers to contract in advance to meet military requirements in 1952.

Imports of titanium potassium oxalate and compounds and mixtures containing titanium including titanium pigments totaled 72,500 pounds in 1952 coming from Austria (400), Canada (1,300), France (4,400), Italy (62,300), and the United Kingdom (4,100). This material was valued at $17,900. Ferrotitanium valued at $116,700 was imported from France (28,300 pounds) and the United Kingdom (195,700 pounds). Value of titanium metal imported from Canada (500 pounds) and France (44 pounds) totaled $2,500 in 1952.

Exports.—Shipments of titanium dioxide and pigments in 1952 declined 9 percent under the record established in 1951. Canada was the major recipient of titanium pigments from the United States in 1952 receiving 21,300 short tons, a decrease of 4,700 tons from that shipped in 1951. Other countries receiving 500 tons or more were as follows: Belgium and Luxembourg, 1,300; Brazil, 1,800; Cuba, 980; France, 1,100; Italy, 800; Japan, 800; Mexico, 2,000; Netherlands, 1,100; and Union of South Africa, 1,100. The remaining 3,400 tons were distributed among 45 other countries. Exports of titanium concentrates increased slightly in 1952 over 1951, as 867 and 3 short tons were shipped to Canada and Hong Kong, China, respectively. Two new export classifications; namely, titanium metals and alloys in crude form and scrap and titanium metal in primary form, were initiated by the Department of Commerce in 1952 owing to the increased production of titanium metal. Metals and alloys in crude form and scrap were shipped in 1952, in pounds, to Canada, 1,520,000; France, 1,400; Italy, 2,200; and the United Kingdom, 1,300, whereas recipients of titanium metal in primary forms were, in pounds, Belgium and Luxembourg, 4,500; Canada, 2,100; and the United Kingdom, 300. Exports of titanium ferroalloys in 1952 about doubled

[12] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

1951 shipments as exports to Canada totaled 290 short tons, an increase of 126 tons over 1951. The remaining quantity of 70,300 pounds was shipped to Chile, 7,000; France, 14,600; Italy, 25,200; the United Kingdom, 22,500; and Western Germany, 1,000.

TABLE 5.—Titanium concentrates [1] imported for consumption in the United States, 1943–47 (average) and 1948–52, by countries, in short tons

[U. S. Department of Commerce]

Country of origin	1943–47 (average)	1948	1949	1950	1951	1952
ILMENITE						
Australia	776	(2)		112	100	
Brazil	3,205	8,708			1	
Canada	22,675	4,519	540	1,357	[3] 3,776	[4] 38,451
Ceylon	930		2			
Egypt			721			
France				1		
India	146,369	184,309	289,739	187,834	185,145	145,562
Malaya		3,335			56	
Norway	12,200	41,248	33,155	27,155		
Total as reported	186,155	242,119	324,157	216,459	189,078	184,013
Australia: In "zirconium ore" [5]	1,999					
Grand total	188,154	242,119	324,157	216,459	189,078	184,013
Value of "as reported"	$1,084,933	$1,758,848	$2,479,071	$1,198,545	$1,323,438	$2,478,077
RUTILE						
Australia	3,921	8,771	3,085	3,427	11,023	19,394
Brazil	1,371					
French Cameroon	220					
India	213					
Norway		(2)				
Total as reported	5,725	8,771	3,085	3,427	11,023	19,394
Australia:						
In "zirconium ore" [6]	3,955		1,096	1,133	210	156
In "ilmenite" [7]	1,012					
Grand total	10,692	8,771	[8] 4,181	[8] 4,560	[8] 11,233	19,550
Value of "as reported"	$375,336	$588,713	$179,746	$149,733	$491,383	$1,728,803

[1] Classified as "ore" by the U. S. Department of Commerce.
[2] Less than 1 ton.
[3] Includes titanium slag.
[4] Chiefly all titanium slag averaging about 70 percent TiO_2.
[5] Ilmenite content of zirconium ore as reported to the Bureau of Mines by importers.
[6] Rutile content of zirconium ore as reported to the Bureau of Mines by importers.
[7] Rutile content of ilmenite as reported to the Bureau of Mines by importers.
[8] Revised figures.

TABLE 6.—Exports of titanium products from the United States, 1943–47 (average) and 1948–52, by classes

[U. S. Department of Commerce]

Year	Ore and concentrates		Metal and alloys in crude form and scrap		Primary forms, n. e. c.		Ferroalloys		Dioxide and pigments	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1943–47 (average)	825	$134,259	(1)	(1)	(1)	(1)	671	$102,349	14,200	$2,854,779
1948	1,454	187,225	(1)	(1)	(1)	(1)	480	82,874	26,824	7,126,956
1949	1,505	143,412	(1)	(1)	(1)	(1)	179	40,918	29,621	8,140,991
1950	600	57,753	(1)	(1)	(1)	(1)	171	42,741	32,660	8,799,758
1951	646	63,050	(1)	(1)	(1)	(1)	175	107,718	39,242	13,274,143
1952	870	110,737	762	$31,134	3	$38,979	325	88,664	35,636	10,691,698

[1] Before Jan. 1, 1952, not separately classified.

TECHNOLOGY

Investigations on a vacuum-distillation process for removing magnesium and magnesium chloride from titanium sponge produced by modifications of the Kroll process were conducted on a pilot-plant scale by the Bureau of Mines laboratory at Boulder City, Nev., with results far superior to those achieved by the method of grinding and leaching. In the purification method, magnesium metal and chloride were volatilized away from titanium in a vacuum at about 930° C., leaving the titanium virtually magnesium-free in sponge-metal form. A description of the pilot-plant equipment, techniques of operation, method of sponge recovery, operation data, and power and labor requirements are discussed in a Bureau of Mines report.[13]

Pilot-plant investigations on 105 production runs in which titanium metal was made in 200-pound batches were made by the Bureau of Mines at Boulder City, Nev. Techniques developed in these studies brought about a decrease in the moisture absorbed by the magnesium chloride in the reaction mass, lowered iron contaminations, eliminated the labor- and time-consuming job of cleaning the vessel after each reduction, and lowered the temperature during reduction from 850° to 750° C. to give better and more consistent results. The equipment and techniques used in preparing raw material, the reduction process, removal of the mass from the reaction vessel and data on man-hour requirements were published in a Bureau of Mines report.[14]

Mineral-dressing investigations on titanium ore samples from the Christy deposit in the Magnet Cove area, Hot Spring County, Ark., conducted by the Bureau of Mines laboratory at Rolla, Mo., produced flotation concentrates containing 91 to over 92 percent titanium dioxide. Two samples of the titanium-bearing ore averaging about 6.0 percent titanium dioxide yielded a 60.6-percent recovery at a grade of 92.8 percent titanium dioxide and a 55.2-percent recovery at a grade of 91.2 percent titanium dioxide.[15]

Studies were made by the Bureau of Mines laboratory at College Park, Md., on the recovery of titania, iron, and byproducts from titaniferous iron ore from deposits at Tahawus, N. Y., and Woonsocket, R. I. Ore from Tahawus, N. Y., was roasted with coke and soda ash, wet-ground, and magnetically separated to produce powered iron and slag. Titania and byproducts were recovered from the slag by acid decomposition. Combined data from tests indicated that 85 to 90 percent of the titania content of the ore is recoverable and about 90 percent of the iron can be recovered as a metallic-iron powder.

With certain modifications, the process used on the Tahawus magnetite was reported applicable to a titaniferous iron ore from Iron Mine Hill near Woonsocket, R. I.[16]

Development of a method for treating titaniferous magnetite ore from the Iron Mountain, Wyo., deposit to recover vanadium, iron, and titanium as high-grade, salable products was reported by the

[13] Cook, M. A., and Wartman, F. S., Removal of Magnesium and Magnesium Chloride From Titanium Sponge by Vacuum Distillation: Bureau of Mines Rept. of Investigations 4837, 1952, pp. 1–17.

[14] Fuller, H. C., Baker, D. H., Jr., and Wartman, F. S., Recent Practice at the Bureau of Mines Boulder City, Nev., Titanium Plant: Bureau of Mines Rept. of Investigations 4879, 1952, pp. 1–20.

[15] Fine, M. M., and Frommer, D. W., Mineral-Dressing Investigation of Titanium Ore From the Christy Property, Hot Spring County, Ark.: Bureau of Mines Rept. of Investigations 4851, 1952, pp. 1–7.

[16] MacMillian, R. T., Heindl, R. A., and Conley, J. E., Soda-Sinter Process for Treating Low-Grade Titaniferous Ores: Bureau of Mines Rept. of Investigations 4912, 1952, pp. 1–15.

Bureau of Mines laboratory at Salt Lake City, Utah. A mixture of sodium carbonate and titaniferous ore was roasted and then leached to obtain vanadium. The leach residue smelted in an arc furnace returned an iron product assaying less than 0.1 percent vanadium and titanium. Titanium was recovered in a soda slag, assaying 60 percent titanium dioxide and 2 percent iron, which was upgraded to 75 to 80 percent titanium dioxide by leaching with dilute sulfuric acid.[17]

Studies were made in 1952 at the Bureau of Mines laboratory, College Park, Md., on corrosion rates for titanium-, zirconium-, and chromium-nickel (20–29)-type stainless steel in mineral acids and metal chlorides. Titanium was fully resistant to corrosion in concentrations of nitric acid and in an atmosphere of water-saturated chlorine and solutions of alkali and alkaline earth chlorides; satisfactorily resistant to all concentrations of phosphoric acid only at lower temperatures; and highly resistant to attack by hypochlorite solutions. Heavy-metal chloride solutions, such as ferric, cupric, mercuric, etc., had a negligible effect on titanium.[18] Electrode potential measurements and corrosion data showed that titanium was passive in hydrochloric acid solutions in the presence of air or copper ion.[19]

Investigations on the machining of titanium were conducted by a number of companies in 1952. It was reported that machining of titanium compared with mild steel involved less plastic deformation and less friction between chip and tool, allowed better chip formation, had lower power consumption, and yielded a better finish.[20] Four new machining and grinding processes were evaluated by the National Research Council. Electrolytic, electroarcing, electrosparking, and ultrasonic processes showed promise for such applications as carbide-tool grinding, titanium jet-engine disk machining, and rifling gun barrels.[21]

Research data and practices of machining titanium covering tool design, speeds, feeds, coolants, single-point turning, drilling, tapping, reaming, planning, shaping, milling, broaching, sawing, grinding, and tensile testing, were published in 1952.[22]

Brochures published by the titanium industry in 1952 discussed various characteristics of titanium and titanium alloys, such as chemical composition, physical and mechanical properties, chemical and corrosion properties, testing procedures, fabrication and process

---

[17] Back, A. E., Chindgren, C. J., and Peterson, R. G., Treatment of Titaniferous Magnetite Ore From Iron Mountain, Wyo.: Bureau of Mines Rept. of Investigations 4902, 1952, pp. 1–15.

[18] Golden, L. B., Lane, I. R., Jr., and Acherman, W. L., Corrosion Resistance of Titanium, Zirconium, and Stainless Steel: Ind. Eng. Chem., vol. 44, August 1952, pp. 1930–1939.

[19] Schlain, D., and Smatko, J. S., Passivity of Titanium in Hydrochloric Acid Solutions: Jour. Electrochem. Soc., vol. 99, No. 10, October 1952, pp. 417–422.

[20] Merchant, M. E., Fundamental Factors in Machining Titanium: Modern Metals, vol. 9, No. 3, April 1953, pp. 60–62.

[21] Elwers, G., New Machining Techniques Evaluated: Iron Age, vol. 169, No. 12, Mar. 20, 1952, pp. 103–105.

[22] Rem-Cru Titanium, Inc., Midland, Pa., The Machining of Titanium: Rem-Cru Titanium Review, vol. 1, No. 1, June 1952, pp. 1–8.

Tarasov, L. P., Grinding Recommendations for Titanium: Tech. Bull. 524, October 1952, pp 1–24, Norton Co., Worcester, Mass.

Goldbey, D. C., and Hazelton, W. S., How to Machine Titanium: Iron Age, vol. 169, No. 16, Apr. 17, 1952, pp. 107–110.

Eshman, A. N., Titanium Sheet-Metal Parts Successfully Made: Iron Age, vol. 170, No. 3, July 17, 1952, pp. 132–135.

practices, and price, size, and weight information on titanium products.[23]

Research to determine certain aspects on the behavior of a commercially available Ti-Fe-Cr alloy exhibited a martensitic transformation on cooling and two nucleation and growth reactions on isothermal holding below the single-phase beta temperature range. The reactions were followed by metallagraphic, X-ray diffraction, and microhardness analyses.[24]

Commercially pure titanium metal was found suitable for deep drawing at room temperatures. Experiments with tools of conventional design produced initial reduction at room temperature up to 40 to 45 percent from blank to cup diameter, followed by redraws with further reduction of 15 to 25 percent. Chemical surface treatments and high-pressure lubricants were proved helpful for preventing severe score marks and scratches. Titanium drawing required greater pressure than mild steel. To reduce work hardening and restore enough ductility for subsequent forming it was necessary to anneal titanium at about 1,325° F., after each drawing, for periods of time varying from 2 minutes for 0.010-inch material to 7 minutes for 0.078-inch material. Titanium deep-drawn parts successfully produced with carbide tooling were run at one-half to two-thirds the usual speed for mild steel.[25]

Helical springs formed from commercially rolled or drawn titanium exhibited low fatigue life as the result of surface oxidation produced in manufacturing. Research investigations indicated that coatings of titanium silicide offered protection up to 2,000° F.; such coated products may show satisfactory performance upon exposure to hot gases. Anodic coatings produced on titanium by chemical or electrochemical methods proved to be effective in reducing wear and galling. Research published by industry in 1952 revealed that no known method of direct plating nickel or chromium was devised in 1952, however, methods were developed whereby titanium was copper-plated and joined to other metals by soldering.[26]

Welding studies in helium atmosphere were reported for three grades of titanium. Commercially pure grades of titanium retained considerable measure of the strength and ductility of the parent metal. The ductility of the medium-strength alloys was affected adversely by carbon content, but low-carbon, oxygen-nitrogen alloys compared favorably with the pure grades. High-strength alloys showed low ductility after welding and were not recommended for welded fabrication.[27]

---

23 Mallory-Sharon Titanium Corp., Niles, Ohio, Titanium: 1952, pp. 1–8.
Rem-Cru Titanium, Inc., Midland, Pa., Rem-Cru Titanium and Titanium Alloys: July 1952, pp. 1–24.
Republic Steel Corp., Alloy Steel Div., Massillon, Ohio, Republic Titanium and Titanium Alloys: 1952, pp. 1–30.
Titanium Metals Corp. of America, 60 E. 42d St., New York 17, N. Y., Handbook on Titanium Metal: 6th ed., October 15, 1952, pp. 1–109.

24 Phillips, C. W., and Frey, D. N., Isothermal Transformation Characteristics of an Iron-Chromium Alloy of Titanium: Jour. Metals, vol. 4, No. 4, April 1952, pp. 381–385.

25 Gulliksen, W. J., Pioneering the Deep Drawing of Titanium: Worcester Pressed Steel Co. Circ., summary of a paper presented Oct. 8, 1952, at the Titanium Symposium, Watertown Arsenal, Watertown, Mass.

26 Mesick, Col. B. S., Titanium Evaluated for Ordnance: Jour. Metals, vol. 5, No. 2, February 1953, pp. 136–137.

27 Rosenberg, A. J., and Hutchinson, E. F., How to Weld Titanium: Am. Mach., vol. 96, No. 11, May 26, 1952, pp. 93–96.

A low-temperature brazing flux was developed in 1952 for use in joining both metals and nonmetallic materials with active metals such as titanium. Tensile strength of 45,000 to 50,000 p. s. i. was obtained with butt joints in commercially pure titanium.[28]

An arc-casting process was reported to produce titanium rods ranging from ⅛ to ¼ inch in diameter by 4 to 7 inches long without any indication of shrinkage or blowholes. Contamination was minimized by casting into molds of high-thermal conductivity, and the rapidity of cooling of the melt did not give the reactive metal an opportunity to pick up impurities from the mold.[29]

Investigations on refractories for titanium casting indicated that shell-molded mixtures of stabilized zirconia and fused zirconia containing 4 percent resin, used without mold washes, were the most promising mold materials. The best mold wash for silica molds appeared to be a colloidal graphite dispersion. Good surface and soundness of cast titanium containing only small quantities of surface contamination were obtained.[30]

Two grades of titanium carbide containing various quantities of graphitic carbon were produced by the pressure-sintering method. Physical properties of these binder-free and very dense titanium carbide specimens were determined and found to compare favorably with those of certain cemented titanium carbide grades. The hot strength of titanium carbide bodies appeared to be unaffected by the amount or type of binder material employed.[31]

WORLD REVIEW

World production of ilmenite in 1952 was estimated at the same level as the 1951 output, whereas rutile production continued to increase and established a new record.

The United States, the world's largest producer of ilmenite, supplied over half of the ilmenite concentrates in 1952. Australia remained the leader in the production of rutile. Increased output of titanium slag reported from Canada was included under ilmenite concentrates for 1951 and 1952.

Available data on world production of ilmenite and rutile, with revised figures, are shown in table 7.

Africa.—Prospected deposits of massive ilmenite and titaniferous magnetite on the west coast of Africa near the cities Grafton and Hastings, Sierra Leone, showed that much of the ore was coarsely crystalline and granular and that the ilmenite and magnetite existed as separate crystalline identities, which could be parted magnetically to yield ilmenite containing at least 48 percent TiO_2 and magnetite low in titanium. Alluvial concentrations of ilmenite in the beach sands between Tokeh and York in the Whale River estuary also contained material reported to be satisfactory for the manufacture of titanium pigment.[32] The Titanium Corp. of South Africa, Ltd.,

---

[28] Materials and Methods, Low-Temperature Brazing Flux for Titanium: vol. 35, No. 4, April 1952, p. 162.
[29] Kuhn, W. E., Titanium and Zirconium Castings Now Practicable: Mat. and Meth., vol. 36, No. 6, December 1952, pp. 94–95.
[30] Kura, J. G., Titanium Casting Research Tests Shell-Molded Refractories: Iron Age, vol. 170, No. 18, Oct. 30, 1952, pp. 88–92.
[31] Glaser, F. W., and Ivanick, W., Sintered Titanium Carbide: Jour. Metals, vol. 4, No. 4, April 1952, pp. 387–390.
[32] Mining Journal (London), Sierra Leone: vol. 239, No. 6105, Aug. 22, 1952, p. 197.

Umgababa, Natal, estimated capacity of its proposed ilmenite plant at 60,000 to 100,000 tons of ilmenite per year. Production of zircon, rutile, and monazite from this operation was anticipated to be 10, 5, and 0.5 percent, respectively, of the ilmenite production. This company was considering a plan to erect a pilot plant to produce titanium pigments. South Africa's pigment requirements are about 3,000 tons a year.[33]

Deposits of ilmenite were found near Port Edward, Natal, about 125 miles south of Durban. Samples analysed at the University of Natal indicated that the ores contained a high percentage of titanium.

Pure rutile was reported to be found in veins and in the alluvials in the region southwest of Lake Albert and in Central Katānga.[34]

Australia.—Proved reserves in high-grade mineral deposits from North Stradbroke Island to Lennox Head totaled 2,500,000 long tons of heavy minerals containing 754,000 long tons of rutile, and larger quantities were reported to exist in lower-grade deposits.

The Australian production of rutile in 1952 was estimated at 40,000 tons, and exceeded the total of other producing countries. Rutile was produced from the east coast beach sand deposits in the form of a concentrate containing more than 96 percent rutile.

TABLE 7.—World production of titanium concentrates (ilmenite and rutile), by countries, 1948–52, in metric tons [1]

[Compiled by Lee S. Petersen]

Country	1948	1949	1950	1951	1952
Ilmenite:					
Australia [2]	11,756	9,884	12,417	12,091	(3)
Brazil	[4] 7,900	650	----------	----------	(3)
Canada	4,029	490	[5] 3,177	[5] 19,235	[5] 38,276
Egypt	1,601	635	260	317	(3)
India	233,098	313,126	216,076	223,092	(3)
Malaya	12,909	20,034	25,315	[4] 44,191	[4] 22,046
Norway	90,017	99,013	105,150	105,150	118,270
Portugal	155	919	66	169	75
Senegal	3,690	8,338	540	2,500	4,622
Spain	181	376	637	437	1,110
United States	348,126	364,989	424,851	486,099	479,524
Total ilmenite	713,500	818,500	788,500	893,300	[6] 893,000
Rutile:					
Australia [7]	15,348	13,958	17,985	35,534	38,752
Brazil	----------	----------	(8)	----------	(3)
French Cameroon	576	403	25	106	294
French Equatorial Africa	----------	----------	6	----------	----------
India	129	----------	(8)	(8)	(3)
Norway	----------	16	(8)	(8)	43
Senegal	----------	----------	----------	(8)	(8)
United States	6,695	10,875	(9)	(9)	(9)
Total rutile	22,700	25,300	25,300	42,000	[6] 47,000

[1] This table incorporates a number of revisions of data published in previous titanium chapters.
[2] Estimated ilmenite content of all ilmenite-bearing concentrates.
[3] Data not available; estimate by author of chapter included in total.
[4] Exports.
[5] Includes titanium slag containing approximately 70 percent TiO_2. See Canada under World Review.
[6] Estimate.
[7] Estimated rutile content of all rutile-bearing concentrates.
[8] Figure withheld to avoid disclosure of U. S. production by difference. See footnote 9.
[9] Figure withheld in order to avoid disclosure of individual company operation.

[33] Bureau of Mines, Mineral Trade Notes: vol. 34, No. 3, March 1952, p. 24.
[34] Bureau of Mines, Mineral Trade Notes: vol. 35, No. 5, November 1952, p. 46.

Australian rutile production for 1934–51 totaled 143,000 tons plus 9 tons produced in 1906. No rutile production was reported from 1906 to 1934. Of the total production from 1934 to 1951, 95 percent (135,495 tons) was exported in all types of products. The export of clean separated concentrates was subject to license and control by the Department of Trade and Customs (Proclamation 611 of 1944); exports were readily permitted provided they did not contain more than 0.5 percent monazite. Export of unseparated sands was prohibited, except small quantities for experimental purposes.

TABLE 8.—Exports of rutile concentrates from Australia, 1946–52, long tons [1]

Country	1946	1947	1948	1949	1950	1951	1952
Belgium	171	85	111	155	839	(2)	(2)
France		100	50	368	611	(2)	(2)
Germany				337	1,020	(2)	(2)
Italy		60	199	572	740	(2)	(2)
Netherlands		90	18	336	539	(2)	(2)
Poland				200		(2)	(2)
Sweden	60	539	1,289	477	1,825	(2)	(2)
United Kingdom	787	1,954	3,710	6,713	5,882	9,938	7,128
United States	3,765	5,798	7,863	2,214	3,246	9,864	13,499
Other [3]	73	255	30	252	606	15,238	6
Total	4,856	8,881	13,270	11,624	15,308	[4] 35,040	[4] 27,103
Value in £	(5)	(5)	(5)	(5)	(5)	853,140	1,094,542

[1] Includes data for 9 months in 1952.
[2] Data not available, estimate included in total.
[3] Individual country breakdowns were not available in 1951 and 1952; includes rutile exports to all countries except the United States and United Kingdom, which are given separately.
[4] Estimate.
[5] Data not available.

Ilmenite production from 1933 to 1950 totaled 85000 long tons. Ilmenite, which was separated as a reject at the rate of 12,000 tons per annum from rutile operations on the east coast, has for the most part been unsalable because the concentrate contains a small percentage of chromite (up to 7 percent Cr_2O_3), which makes it unsuitable for manufacture of titanium pigments. Ilmenite from Western Australia contains less than 0.1 percent chromium and will probably prove suitable for pigments. Reserves of 500,000 tons of ilmenite, low in chromium are known to exist on the south and southwest coasts of Western Australia and considerable tonnages of ilmenite, low enough in chromium may be separated from the eastern coast deposits. The Australian Titan Products Pty., Ltd., a subsidiary of British Titan Products Co., Ltd., at Burnie, Tasmania, imported in 1950, 3,800 tons of ilmenite from India and produced more than 1,700 tons of titanium pigment. There were no imports of ilmenite into Australia before 1948; imports totaled 1,500 and 2,300 tons in 1948 and 1949, respectively.

Companies in Australia engaged in commercial mining of rutile and zircon as of May 1, 1951, are listed as follows, with deposit location and heavy mineral monthly production capacity in long tons enclosed in parentheses: Mineral Deposits Syndicate at Southport, Queensland (Broadbeach-Burleigh and the Spit, Southport—1,500); Zircon Rutile, Ltd., at Byron Bay, New South Wales (Seven Mile Beach and Tallow Beach, south of Byron Bay—1,400); Cudgen R. Z., at Cudgen Headland, New South Wales (Cudgen Headland, beach and foredune—

1,000); Titanium Alloy Manufacturing Div., National Lead Co., at Cudgen Beach, New South Wales (Cudgen Beach and adjacent area—900); Associated Minerals Pty., Ltd., at Southport, Queensland (Southport-Broadbeach—750); Titanium and Zirconium Industries Pty., Ltd., at Dunwich township, North Stradbroke Island, Queensland (North Stradbroke Island, 2 miles south of Point Lookout—720); Rutile Sands Pty. at Currumbin, Queensland (Tugun Beach and Palm Beach—650); Tweed Rutile Syndicate at Cudgen Beach, New South Wales (adjacent to Cudgen Beach—500); Metal Recoveries Pty., Ltd., at Crabbe's Creek and Mooball Siding, New South Wales (Beach and adjacent area, Cudgera to New Brighton—375); and the National Minerals, Ltd., with the tabling plant at Swansea, New South Wales, and the separation plant at Wickham, Newcastle (Catherine Hill Bay Beach, 3 miles south of Swansea—250). Mining was carried on by conventional methods, such as stripping the overburden with power scoops or bulldozers and either hand or power loading into motor trucks. One company reported that raw sand including overburden was fed by dredging to Humphrey spirals. Some high-grade deposits were loaded directly from the beach. Treatment of heavy minerals varied slightly with each operation; however, in general, the minerals were separated on Wilfley or curvilinear tables, dewatered, dried in a rotary drier, followed by low-intensity magnetic separation of ilmenite, and electrostatic separation of rutile and zircon, and the products were then cleaned by high-intensity electromagnetic separators. The rutile and zircon products marketed by the Australian producers ranged from 94 to 99 percent TiO_2 and 94 to 99 percent ZrO_2, respectively.[35]

Properties of the Tweed Rutile Syndicate were obtained by the New South Wales Rutile Mining Co., Ltd., in 1952. It was estimated that the company's leases will cover 15 to 20 years of mining. The New South Wales Rutile Mining Co., Ltd., at Cudgen, New South Wales, reported that it is the world's biggest producer of rutile sand. Daily production is estimated at 100 tons of rutile, 100 tons of zircon, and 50 tons of ilmenite.[36]

Trem. Watson Metallurgists, of Lane Cove, New South Wales, reported opening a new mine and separation plant in the southern part of the State. Annual output will be an estimated 4,000 tons of rutile, 2,600 tons of zircon, and 750 tons of ilmenite. The treatment plant was to be located at Wollongong, New South Wales.[37] Zircon Rutile, Ltd., erected a small plant in 1952 for the manufacture of chemicals from its products, and a new concentrator was installed and another improved to permit up to 50-percent increase in treatment of heavy sands.[38] Extensions to the Titanium and Zirconium Industries Pty., Ltd., pilot plant at Stradbroke Island, New South Wales, were completed in 1952. This expansion was intended to double production capacity of rutile and zircon; however, severe drought conditions in 1952 prevented higher outputs.[39]

---

35 Gardnes, O. E., Titanium (Rutile and Ilmenite): Min. Resources of Australia, Summary Rept. 2, July 1951, pp. 1–35.
Quarterly Review, The Australian Mineral Industry: vol. 5, Nos. 1 and 2, 1952.
36 Engineering and Mining Journal, vol. 153, No. 10, October 1952.
37 Metal Bulletin (London), No. 3707, July 8, 1952, p. 23.
38 Mining World, vol. 14, No. 3, Mar. 1952, p. 73.
39 Metal Bulletin (London), No. 3705, July 1, 1952, p. 26.

Canada.—The Quebec Iron & Titanium Corp., subsidiary of the Kennecott Copper Corp. and the New Jersey Zinc Co., completed construction of the last of the five electric furnaces used in the production of titanium slag at the Sorel, Quebec, treatment plant. Titanium-slag production and data on other operations are shown in long tons as follows:

	1951	*1952*
Ore mined and crushed	339, 224	237, 249
Ore treated	44, 299	93, 005
Iron and steel produced	12, 877	28, 948
Titanium slag produced	17, 259	37, 626
Titanium slag shipped	7, 179	34, 739

The quantity of ore mined and crushed in 1952 decreased about 30 percent from 1951, owing to a strike at the treatment plant at Sorel, which lasted 2 of the 8 months of the mining season. All titanium-slag shipments went to the United States and were chiefly consumed in the titanium-pigment industry. Titanium slag shipped to pigment producers in 1951 was in trial lots so that processing characteristics could be studied; however, orders from customers were received in 1952.[40]

Preliminary statistics for 1952 published by the Dominion Bureau of Statistics, Department of Trade and Commerce, stated that output of ilmenite concentrates in Canada was 47 long tons valued at $C456 in 1952, compared with 1,519 tons valued at $C69,790 in 1951.

The ilmenite-hematite ore in the Allard Lake region is dense black, mostly coarse-grained, and made up of thick tabular crystals. The typical high-grade ore contains about 75 percent ilmenite and 20 percent hematite. An analysis of this ore showed the following percentage: TiO_2, 34.8; Fe, 38.8; S, 0.36; P_2O_5, 0.004; Cu, 0.037; V, 0.22; Mn, 0.08; Ni, 0.03; and Co, 0.014. Although all deposits are of the same origin, they may be divided into three broad groups on the basis of shape and attitude. These include flat-lying, tabular bodies of large areal extent (Lac Tio deposit and satellites), steeply dipping dikelike bodies (Puyjalon deposit), and lenticular masses very irregular in shape (Mills deposit). Estimates of grade and tonnage in the Lac Tio ore body in 1952 placed the ore reserves above 112,000,000 tons of ilmenite, averaging 32 percent TiO_2 and 36 percent Fe. Vertical drill holes in a 100-foot grid in the cliff ore body (Lac Tio satellite) showed 12,000,000 tons of proved ore. The Puyjalon deposit contains a dikelike deposit of ilmenite 2 miles southeast of Lac Tio near the shore of Puyjalon Lake. Ilmenite has been traced for a length of 2,400 feet and in width from 20 to 250 feet. Ilmenite occurs in the Mills deposit, 8 miles southwest of Lac Tio, as a series of 4 massive lenses of irregular shape, which extend 3,000 feet.[41]

Titaniferous magnetite deposits found near the Bay of Seven Islands, 320 miles east of Quebec City, are reported to contain over a half million tons of ore assaying 50 percent iron and over 13 percent titanium.[42]

The Titanium Development Corp. estimated a total of 2,859,000 tons of titanium ore, averaging 30.84 percent TiO_2, on its property at

[40] Kennecott Copper Corp. Annual Report to Stockholders, 1952: Pp. 17–18.
[41] Hammond, P., Allard Lake Ilmenite Deposits: Econ. Geol., vol. 47, No. 5, September 1952, pp. 634–649.
[42] Mining Magazine (London), Ungava Peninsula: vol. 87, No. 2, August 1952, pp. 82–83.

Ivry, some 60 miles north of Montreal. Readings taken every 100 feet over a distance of 5.8 miles, and a diamond-drilling program covering a total of 4,029 feet indicated that the ore extended to a depth of 300 feet.[43]

The Terrebonne Titanium Co., Montreal, Quebec, reported that test samples taken at depths of 250 and 450 feet at its titanium-iron ore deposits 55 miles from Montreal contained an average of 17.1 percent TiO_2 and 22.4 percent iron. Plans by this company in 1952 called for building a $3,000,000 concentrating plant at Ste. Marguerite de Terrebonne, Quebec.[44]

Ceylon.—The Ceylon Ministry of Industries called for new bids to establish the proposed ilmenite plant at Palmodai in the Trincomalee district, Ceylon, which is estimated to cost over 7 million rupees ($1,470,000). Previous bids called for in September 1951 received no satisfactory response. The plant is expected to treat between 100,000 and 120,000 long tons of raw material per year from which 65,000 to 75,000 tons of ilmenite and about 4,000 tons of rutile could be obtained.[45]

Egypt.—The Anglo-Egyptian Mining Co., 5 Cherif Pasha St., Alexandria, Egypt, owner of the Rosetta mine, Borallus mine, and the Damietta mine, reported that the Rosetta mine produced 1,900 metric tons of crude black sand in 1951. The sand consists largely of ilmenite, magnetite, and zirconium, with smaller quantities of garnet, greensand, and monazite. Ore reserves were estimated at 15,000,000 long tons at the Rosetta mine. The separation plant at Alexandria has a monthly productive capacity of 600 tons of ilmenite, 180 tons of magnetite and 100 tons of zirconium. Ilmenite production in Egypt from 1932 to 1951 consecutively totaled 5,300 long tons.[47]

Germany.—Titangesellschaft m. b. H., of Leverkusen, Germany, owned jointly by Titan Co. a/s, National Lead subsidiary, and I. G. Farbenindustrie, which was formed in 1927 and constructed a plant in 1928, was bought outright in July 1952 by the National Lead Co., New York, N. Y. The German firm makes titanium dioxide pigments in a plant claimed to be the largest of its type in Europe. Ilmenite for the plant, which is expected to have an output of pigment to supply all the requirements of Western Europe, will come from National Lead's property in Norway.[46]

India.—The Travancore Titanium Products, Ltd., at Trivandrum, Travancore-Cochin State, India, began to produce titanium pigments January 25, 1952; however, owing to the high cost of production and shortage of sulfur and sulfuric acid, the plant ceased production October 10, 1952. The plant, with an annual production capacity of 1,800 long tons of titanium pigments, employed between 300 and 400 persons.[48] The Indian Titan Products Co., Ltd., a subsidiary of the British Titan Products Co., Ltd., United Kingdom, was named as the managing agent for the company. The latter company provided

---

43 Paint, Oil and Chemical Review, Rich Titanium Deposit Located Near Montreal: Vol. 115, No. 13, June 19, 1952, p. 52.
44 Metal Bulletin (London), Another Canadian Deposit: No. 3674, No. 19, Mar. 11, 1952, p. 19.
45 Mining Journal (London), Ceylon Plans Ilmenite Reduction Plant: vol. 238, No. 6086, Apr. 11, 1952, p. 364.
46 Chemical and Engineering News, National Lead Buys German Pigment Firm: vol. 30, No. 28, July 14, 1952, p. 2895.
47 Bureau of Mines, Mineral Trade Notes: vol. 35, No. 2, August 1952, pp. 22–23.
48 Bureau of Mines Mineral Trade Notes: vol. 35, No. 5 ,November 1952, pp. 22–23.

technical assistance through its Indian subsidiary. The Travancore-Cochin State Government, which holds 51 percent of the capital of the company, about 4 million rupees ($840,000), considered reviving the plant in December 1952 with a loan from the Industrial Finance Corp. It was reported that the Indian Government agreed to supply technical advice to the company.[49]

Heavy mineral deposits in Travancore, South India, beach sands occur north from Quilon and at Manavalukurichi 100 miles to the south toward Cape Comorin, with smaller deposits between these localities and 3 miles east of Cape Comorin. The deposits at Manavalukurichi were not worked in 1951, and production was confined to north Quilon. The black sands at Quilon occur down to 10 feet below low tide and were worked to a total depth of 20 feet in places but averaged about 9 feet. Reserves were estimated at 11,000,000 long tons in this deposit, which ranges along the coast from the river bar at Quilon north for 14 miles. The average width is about 250 yards, but dunes rise to about 20 feet above sea level. The Manavalukurichi deposit extends over a length of 5 miles with the dunes rising to over 30 feet. This deposit is somewhat smaller than the Quilon deposit.

Mining leases are issued by the Travancore Government. Government regulations do not permit the deposits in this area to be worked within 150 feet of the sea to the west or 150 feet of the canal to the east, because of the possibility of erosion. The mining width along the spit is restricted to an average of less than 150 yards. Excavation is not permitted within 150 feet of holy places. Excavation is entirely manual. Sands are loaded directly into boats (10 to 12 tons capacity), which transport 400 to 1,000 tons daily during the working (dry) season to the following treatment plants located along the canal: F. X. Pereira & Sons, Travancore, Ltd., Quilon, Travancore; Hopkin & Williams, Ltd., Chavara, Travancore; Travancore Minerals Concerns, Chavara, Travancore; and the Associated Minerals Co., Ltd., Quilon, Travancore. The total production capacity of these 4 plants was estimated in 1951 at 450,000 tons of ilmenite annually.[50]

Japan.—The Ishihara Chemical Co. of Tokyo and Osaka, Japan, negotiated with the Glidden Co., Cleveland, Ohio, in 1952, for technical cooperation for the manufacture of titanium pigment and titanium metal. Plans were under way by the Japanese firm to build a titanium plant at Yokkaichi and to develop ilmenite mines in Sumatra.[51]

Over 20 Japanese manufacturing firms were engaged in the titanium metal industry in 1952. Information on the 6 most prominent companies as reported, is briefed as follows:

Osaka Titanium Co. (formerly Osaka Special Iron Works).—A subsidy of ¥5,600,000 ($15,556) granted to the firm by the International Trade and Industry Ministry provided capital for constructing a titanium-sponge pilot plant (monthly production capacity, 1 ton) in 1950. Titanium production at the end of 1952 was reported at 4½ tons per month. The company considered a plan to increase output capacity of titanium to 50 tons a month in the latter part of 1952. The expansion cost of ¥440,000,000 ($1,222,222) was to be

[49] Chemical Age (London), Titanium Plant to Reopen: vol. 67, No. 1745, Dec. 20, 1952, p. 850.
[50] Economic Notes and Statistics, Australian Mineral Industry: vol. 3, No. 4, 1951, p. 100.
[51] Metal Bulletin (London), Japanese Developments: No. 3715, Aug. 8, 1952, p. 27.

financed by the Development Bank. The Japanese firm stated its interest in 1952 in negotiating a long-term contract under which it would sell a total of 100 tons of titanium sponge to companies in the United States at $4.80 a pound.

Japan Electrometallurgy Co.—This firm began manufacturing titanium in 1950. A 7½-ton-a-month titanium-sponge pilot plant with Government subsidies, ¥1,150,000 ($3,194) in 1951 and ¥9,000,000 ($25,000) in 1952, was under construction in 1952.

Sumitomo Metal Co.—This firm manufactured 20-kilogram (45-pound) titanium ingots in 1952 from titanium sponge produced by the Osaka Titanium Co.

Kobe Steel Co.—One-ton titanium ingots were reported to be produced by this company from titanium sponge obtained from Osaka Titanium Co.

Mitsui Metal Mining Co.—A pilot plant to manufacture 1 ton of titanium metal a month was being constructed by this firm in 1952.

Sakai Chemical Industry.—With the assistance of experts from the Osaka University, this firm was engaged in research work in 1952 to improve the chloric method in titanium production, with emphasis on continuous and efficient reclamation of magnesium and chlorine and dispensing with argon.[52]

Malaya.—No production figures are kept on ilmenite, but exports declined from 42,700 long tons in 1951 to 22,500 tons in 1952.[53]

TABLE 9.—Exports of ilmenite from Malaya in 1952

Destination	Long tons	Value f. o. b. $M [1]
France	7,210	158,465
United Kingdom	5,194	114,268
Germany	3,995	87,890
Czechoslovakia	3,000	66,000
Japan	2,800	61,600
Belgium	299	6,153
Total	22,498	494,376

[1] $M1 equals $US0.33.

United Kingdom.—Ilmenite imports into the United Kingdom totaled 91,900 long tons in 1952, as compared to 69,700 tons in 1951.[54]

[52] Sangyo Keizai, Overseas Edition, Titanium Manufacturing Firms Want Capital and Tieups to Keep Operating: vol. 2, No. 5, Mar. 1, 1953.
[53] Bureau of Mines, Mineral Trade Notes: vol. 36, No. 4 ,April 1953, p. 22.
[54] Metal Age, No. 14, February 1953, p. 18.

Tungsten

By Robert W. Geehan [1]

DOMESTIC production of tungsten concentrates was equivalent to 84 percent of consumption in 1952. This contrasts with 52 percent in 1951 and with an average of 50 percent for 1940–51. General imports increased from 7,533,000 pounds, metal content, in 1951 to 16,985,000 pounds in 1952. The increased availability from domestic and foreign sources led to a relaxation of Government regulations regarding the use of tungsten. The quoted price for domestic concentrates remained at $65 per short ton unit but foreign prices declined to $50.[2]

TABLE 1.—Salient statistics of tungsten concentrates in the United States,[1] 1943–47 (average) and 1948–52, in pounds of contained tungsten

Year	Production	Shipments from mines	Imports for consumption	Consumption	Industry stocks at end of year		
					Producers	Consumers and dealers	Total
1943–47 (average)	6,864,757	6,861,711	11,100,520	13,378,800	421,089	2,958,348	3,379,437
1948	4,033,389	3,838,287	7,548,101	8,853,000	563,418	5,284,901	5,848,319
1949	2,896,084	2,631,506	6,274,102	4,958,000	827,045	4,229,444	5,056,489
1950	3,965,040	4,587,687	16,147,313	6,597,000	216,468	5,121,206	5,337,674
1951	5,913,750	5,972,551	6,376,513	11,410,000	234,282	4,037,502	4,271,784
1952	7,233,199	7,243,589	17,405,869	8,634,000	208,300	2,816,405	3,024,705

[1] Includes Alaska.

DOMESTIC PRODUCTION

Domestic production of tungsten concentrates in 1952 was greater than in any year since 1944. California was again the leading tungsten-producing State, followed by Nevada and North Carolina. The Pine Creek mine of United States Vanadium Co. retained first place among United States tungsten producers.

Production in 1952 was obtained from many widely scattered operations in 11 States and Alaska, but 4 States—California, Nevada, North Carolina, and Colorado—supplied 94 percent of the total; and 8 operators—Bradley Mining Co., Climax Molybdenum Co., Getchell Mine, Inc., Nevada-Massachusetts Co., Nevada Scheelite, Surcease Mining Co., Tungsten Mining Corp., and United States Vanadium Co.—produced 84 percent of the United States total. However, 1952 was marked by a very large increase in the number of mines producing tungsten ores, by a considerable increase in the quantity of tungsten produced by small mines, and by an increase in the number of mines producing material for shipment to custom mills.

[1] Assistant chief, Ferrous Metals and Alloys Branch.
[2] A short-ton unit equals 20 pounds of tungsten trioxide (WO_3) and contains 15.862 pounds of tungsten (W). A short ton of 60-percent WO_3 contains 951.72 pounds of tungsten.

Most tungsten ore mined and milled in the United States contains 0.3 to 2.5 percent WO_3 and is beneficiated to a concentrate containing 60 percent or more WO_3. Ores containing scheelite (calcium tungstate) were important sources of tungsten in California and Nevada; ores containing hübnerite (manganese tungstate), wolframite (iron-manganese tungstate), and ferberite (iron tungstate) were important sources in Colorado, Idaho, and North Carolina.

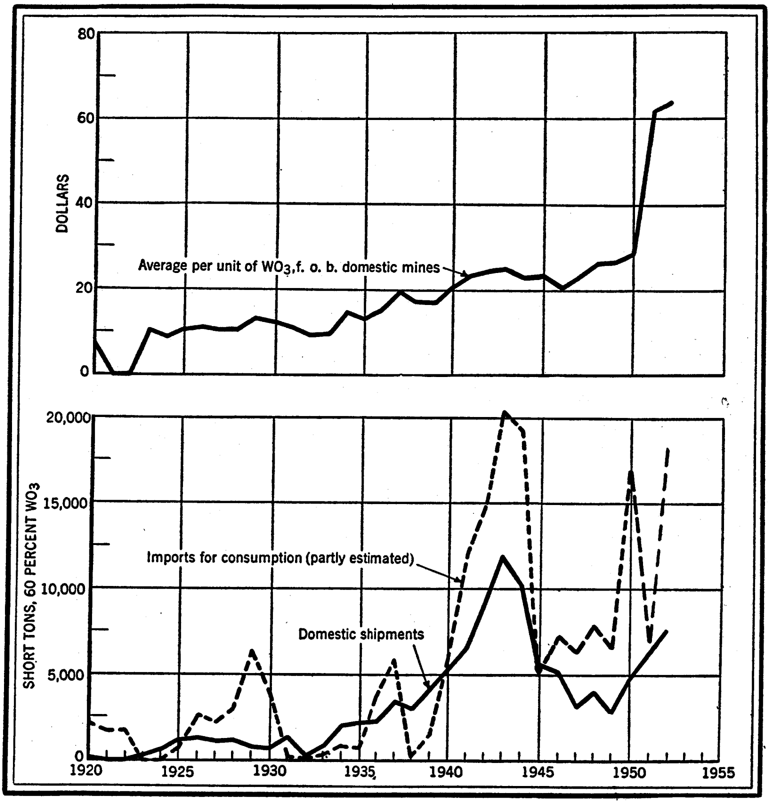

FIGURE 1.—Domestic shipments, imports, and average price of tungsten ores and concentrates, 1920–52.

Most of the large producers expanded their mills and mine plants, and conducted extensive development during 1952; brief descriptions follow:

Bradley Mining Co.—Ima mine, Lemhi County, Idaho.—Two Defense Minerals Exploration Administration contracts were negotiated and work was in progress. Production of ore increased from 41,000 to 46,000 tons. Production of tungsten concentrates increased 33 percent. The Yellow Pine mine, Valley County, was shut down in June.[3]

[3] Mining World, vol. 14, No. 2, February 1952, pp. 34–37.

TABLE 2.—Tungsten concentrates produced and shipped in the United States, 1951–52, by States [1]

State	Produced				Shipped from mines			
	1951		1952		1951		1952	
	Short tons (60 percent WO_3 basis)	Units	Short tons (60 percent WO_3 basis)	Units	Short tons (60 percent WO_3 basis)	Units	Short tons (60 percent WO_3 basis)	Units
Alaska	1	60	8	451	10	606	8	451
Arizona	15	919	77	4,628	11	655	71	4,269
California	2,495	149,694	2,790	167,411	3,007	180,402	2,980	178,779
Colorado	326	19,565	682	40,908	336	20,188	625	37,521
Idaho	401	24,044	352	21,144	377	22,636	333	19,986
Montana					1	44		
Nevada	1,922	115,307	2,431	145,882	1,482	88,916	2,329	139,760
New Mexico			(2)	1				
North Carolina	1,035	62,078	1,248	74,904	1,041	62,463	1,254	75,226
Oregon	1	43	5	274	1	43	4	266
South Dakota			(2)	6			(2)	6
Utah	(2)	21	3	163	(2)	9	3	163
Washington	18	1,094	4	236	9	570	4	236
Total	6,214	372,825	7,600	456,008	6,275	376,532	7,611	456,663

1 Production is credited to the State where ore was mined. Shipments are credited to the State where final concentrates were produced.
2 Less than 1 ton.

TABLE 3.—Tungsten concentrates shipped from mines in the United States,[1] 1943–47 (average) and 1948–52

Year	Quantity		Reported value f. o. b. mines [2]		
	Short tons (60 percent WO_3 basis)	Tungsten content (pounds)	Total	Average per unit of WO_3	Average per pound of tungsten
1943-47 (average)	7,210	6,861,711	$10,141,357	$23.44	$1.48
1948	4,033	3,838,287	6,355,386	26.27	1.66
1949	2,765	2,631,506	4,377,066	26.38	1.66
1950	4,820	4,587,687	8,170,924	28.25	1.78
1951	6,275	5,972,551	22,976,028	61.02	3.85
1952	7,611	7,243,589	28,970,264	63.44	4.00

1 Includes Alaska.
2 Values apply to finished concentrates and in some cases are f. o. b. custom mills.

Climax Molybdenum Co.—Climax mine, Lake County, Colo.—Molybdenum ore treated for recovery of tungsten increased from 2,910,000 to 3,809,000 tons. Production of tungsten concentrates was double that of 1951.

Getchell Mine, Inc.—Getchell mine, Humboldt County, Nev.—During 1952 the mill treated 131,000 tons of ore. Concentrates recovered from ore mined by Getchell increased 12 percent. The mill also treated custom ore.

Nevada-Massachusetts Co.—Mill City group, Pershing County, Nev.—The Stank, Humboldt, and Sutton No. 2 underground mines were operated steadily throughout the year. The Humboldt was at a depth of 1,850 feet, the Stank at 1,300 feet, and the Sutton No. 2 at 800 feet. Several open-pit mines also were productive. Changes

TABLE 4.—Tungsten ore and concentrates shipped from mines in the United States, by States, 1943–47 (average) and 1948–52, shipments for maximum year, and total shipments, 1900–52, in short tons of 60 percent WO_3 [1]

State	Maximum shipments		Shipments by years							Total shipments, 1900–52	
	Year	Quantity	1943–47 (average)	1948	1949	1950	1951	1952		Quantity	Percent of total
								Quantity	Percent of total		
Alaska	1916	47	12	-------	-------	13	10	8	0.11	208	0.14
Arizona	1936	489	44	23	(2)	1	11	71	.93	3,996	2.76
California	1943	3,871	1,926	1,767	952	2,025	3,007	2,980	39.15	45,416	31.42
Colorado	1917	2,707	238	208	222	196	336	625	8.21	26,213	18.13
Connecticut	1916	3	-------	-------	-------	-------	-------	-------	-------	11.	.01
Idaho	1943	4,648	2,297	86	66	222	377	333	4.38	16,292	11.27
Missouri	1940	13	(2)	4	2	(2)	-------	-------	-------	37	.02
Montana	1946	84	23	28	9	-------	1	-------	-------	546	.38
Nevada	1942	3,052	2,410	949	740	1,123	1,482	2,329	30.60	42,377	29.31
New Mexico	1915	45	2	-------	-------	-------	-------	-------	-------	103	.07
North Carolina	1952	1,254	241	965	770	1,240	1,041	1,254	16.48	6,473	4.48
Oregon	1952	4	-------	-------	3	-------	1	4	.05	8	.01
South Dakota	1917	270	2	-------	-------	-------	-------	(2)	(3)	1,296	.90
Texas	1946	1	(2)	-------	-------	-------	-------	-------	-------	1	(3)
Utah	1917	33	13	3	1	-------	(2)	3	.04	242	.17
Washington	1938	303	2	-------	-------	-------	9	4	.05	1,339	.93
Total	1943	11,945	7,210	4,033	2,765	4,820	6,275	7,611	100.00	144,558	100.00

[1] Shipments are credited to the State where final concentrates were produced.
[2] Less than 1 ton.
[3] Less than 0.01 percent.

in the milling-plant flowsheet to increase capacity and improve recovery were completed in 1952. During the year 147,000 tons of ore was mined and treated.

Nevada Scheelite Division of Kennametal, Inc.—Nevada Scheelite mine, Mineral County, Nev.—The tonnage of ore mined increased from 15,000 to 27,000, and concentrates produced increased 89 percent. The mill also treated custom ore.

Surcease Mining Co.—Atolia mine, San Bernardino County, Calif.—During 1952, 165 tons of tungsten concentrates was recovered.

Tungsten Mining Corp.—Hamme mine, Vance County, N. C.—This firm deepened the Central shaft to 944 feet and the Sneed shaft to 885 feet and completed enlargement of the milling plant to a capacity of 600 tons per day. Production of ore increased from 104,000 tons to 134,000.

United States Vanadium Co.—Pine Creek mine, Inyo County, Calif.—The mill and digestion plant were damaged by a snowslide during March 1952; but rehabilitation was completed in a short time, and there was no great loss of production. Over 2,000 feet of drifts was driven in 1952; the long raise, designed to connect the upper workings with the main haulage level, was advanced 388 feet in 1952 and scheduled for completion in 1953. This firm was the leading producer of tungsten ores and concentrates, and its Pine Creek mill treated more custom ore than any other plant.

The largest shipments to custom mills were from the Black Rock mine, Inyo County, Calif., and the Riley mine, Humboldt County, Nev. Activities in 1952 at the Black Rock mine of Black Rock Mining Corp. included production of 24,000 tons of ore, construction of a 250-ton mill, and an exploration program. The United States Vanadium Co. Riley mine was operated by a contractor; ore was shipped to the Getchell mill.

The Black Rock Mining Corp. also operated the Lincoln mine in Lincoln County, Nev.; during 1952 a 750-ton mill was constructed, several thousand tons of tailings from prior operations was treated, and the mine was in production. Boulder Tungsten Mines, Inc., Boulder County, Colo., remodeled the Marion mill and treated custom ore in addition to that produced by the company.[4] Consolidated Tungsten Mine Division of Kennametal, Inc., Tulare County, Calif., produced 6,200 tons of ore at the Harrel Hill mine; but the operation was terminated, and no production was scheduled for 1953.

Chauncy Florey purchased the Silver Dyke deposit, Mineral County, Nev., from Nevada Tungsten Co. The Gabbs Exploration Co., Nye County, Nev., was active in 1952. The Garnet Dike mine, Fresno County, Calif., mined and treated tungsten ore. Lindsay Mining Co. operated the Gunmetal mine, Mineral County, Nev.; during 1952, 17,000 tons of ore was mined, 21,000 tons was milled, including custom ore treated for others, and an exploration program was conducted. Mineral Materials Co. produced tungsten ore at its Star Bright mine in San Bernardino County, Calif. The Strawberry mine, Madera County, Calif., was active.

Vanadium Corporation of America produced tungsten ore in Boulder County, Colo.; this firm also treated custom ore, produced by over 50 individual shippers, at the Wolf Tongue mill. The Wolfram Co. mined 18,000 tons of tungsten ore at the Star-Nightingale mine, Pershing County, Nev.

The Domestic Tungsten Program of General Services Administration and Defense Materials Procurement Agency is quoted below.:

SECTION 1. *Basis and purpose.* This regulation interprets and implements the authority of the Administrator of General Services to purchase tungsten concentrates of domestic origin for the fiscal years 1951–1956 as authorized by the Defense Production Administration on March 30, 1951, and outlines the attendant responsibilities and functions of the Administrator of General Services in purchasing such tungsten concentrates for Government use and resale, pursuant to delegation of authority from the Defense Materials Procurement Administrator, dated September 14, 1951. In accordance with the Program set forth herein, the Administrator will buy domestically produced tungsten concentrates, at a base price of $63 per short ton unit of contained tungsten trioxide (WO_3), less penalties.

SEC. 2. *Definitions.* As used in this regulation:

(a) "Administrator" means the Administrator of General Services.

(b) "Program" means the program as set forth in this regulation.

(c) "Milling point" means plant where ores are processed into specification grade tungsten concentrates.

(d) "Tungsten concentrates" means tungsten concentrates produced in the United States, its Territories and possessions from ores mined in the United States, its Territories and possessions.

(e) "Short ton unit" means one percent of 2,000 pounds avoirdupois dry weight.

(f) "Ferberite" means concentrates containing tungsten primarily as $FeWO_4$ with not more than 20 percent of the tungsten as $MnWO_4$.

(g) "Hübnerite" means concentrates containing tungsten primarily as $MnWO_4$ with not more than 20 percent of the tungsten as $FeWO_4$.

(h) "Wolframite" means concentrates containing tungsten as both $FeWO_4$ and $MnWO_4$ in any proportions from 80 percent $FeWO_4$ and 20 percent $MnWO_4$ to 20 percent $FeWO_4$ and 80 percent $MnWO_4$.

(i) "Scheelite" means concentrates containing, in nature, tungsten as $CaWO_4$.

[4] Engineering and Mining Journal, vol. 153, No. 5, May 1952, p. 140.

(j) "Synthetic Scheelite" means chemically precipitated scheelite produced from any natural type of ore, and shall be chemically precipitated scheelite produced from any original type of ore, further processed so that not over ten percent of any lot shall pass a 35-mesh Tyler Standard Screen.

SEC. 3. *Participation in the Program.* (a) Any person may participate in the Program by notice given to the nearest General Services Administration regional office, in the form of a letter, postcard or telegram postmarked or dated by the telegraph office not later than June 30, 1953. Such notice shall state that the writer desires to participate in the Program and will either prospect for or produce tungsten, but the giving of such notice will not permit the participant to deliver material in any form other than that of concentrates meeting minimum specifications. Such notification must be signed and a return address given. Any person participating in the Program will promptly be sent a certificate authorizing him to deliver concentrates meeting minimum specifications f. o. b. carriers conveyance, milling point. Miners holding certificates but who do not operate concentrating facilities may participate in this Program, to the extent of the ore produced by them, as follows:

(1) By selling such ore to operators of concentrating plants, in which event the resulting concentrates meeting specifications may be sold by such operators to the Administrator under this Program; or

(2) By having such ore treated on a toll basis and selling the resulting concentrates meeting specifications to the Administrator under this Program.

(b) Any operator of a concentrating plant by agreeing to participate in this Program also agrees to purchase or process suitable tungsten contained ores offered to him by independent miners to the limit of the capacity of his plant in excess of that required for his own production and on fair and equitable terms and conditions (including prices). Each operator of a concentrating plant participating in this Program shall promptly establish a schedule setting forth his terms and conditions (including prices) for the purchase and processing of crude tungsten ores. Each such operator shall promptly submit a copy of such schedule to the Administrator, and shall also submit promptly any changes made in such schedule thereafter.

SEC. 4. *Deliveries.* Tungsten concentrates purchased under the Program are to be delivered f. o. b. carriers conveyance any milling point designated by the Administrator. Delivery of less than one short ton of concentrates will not be accepted. Each delivery will be analyzed by the Government after beneficiation at the milling point, and payment will be made in accordance with such analysis. Deliveries not conforming to minimum specifications will be rejected and any expenses in connection therewith will be borne by the seller.

SEC. 5. *Duration of the Program.* The Program shall terminate and be of no further force or effect when 3,000,000 short ton units of tungsten have been delivered to and accepted by the Government under this Program, or on July 1, 1956, whichever occurs first.

SEC. 6. *Specifications and penalties.* (a) The specifications for tungsten concentrates and penalties applicable to deliveries of such concentrates appear below:

(1) Percentage of tungsten trioxide (WO_3) required with respect to each of the following:

	Ferberite	Hübnerite	Wolframite	Scheelite and/or synthetic scheelite
	Percent	*Percent*	*Percent*	*Percent*
Standard	60	60	65	60
Minimum	55	55	60	55

(2) Maximum percentage allowances of the following elements without penalty:

	Ferberite	Hübnerite	Wolframite	Scheelite and/or synthetic scheelite
	Percent	*Percent*	*Percent*	*Percent*
Tin (Sn) max	0.20	0.25	1.50	0.10
Copper (Cu) max	.10	.10	.05	.05
Arsenic (As) max	.15	.10	.25	.10
Antimony (Sb) max	.10	.10	.10	.10
Bismuth (Bi) max	1.00	1.00	1.00	.25
Molybdenum (Mo) max	.50	.50	.40	2.75
Phosphorus (P) max	.07	.05	.05	.05
Sulphur (S) max	.50	.50	.50	.50
Manganese (Mn) max	1.00	(1)	(1)	1.00
Lead (Pb) max	.20	.20	.20	.10
Zinc (Zn) max	.10	.10	.10	.10

[1] Not specified.

(b) The minimum base price shall be subject to the following adjustments:

(1) For each short ton unit of delivered tungsten trioxide (WO_3) the sum of twenty cents ($0.20) shall be deducted from the base price for each one percent of tungsten trioxide (WO_3) below the standard requirements set forth in paragraph (a) of this section. No tungsten concentrates not meeting the minimum requirements set forth in said paragraph (a) of this section will be accepted.

(2) For each short ton unit of delivered tungsten trioxide (WO_3) a deduction of twenty-five cents ($0.25) shall be made for each of the following increments in excess of the maximum allowances (paragraph (a) of this section), as to each of the following elements:

	Percent		Percent
Copper (Cu)	0.01	Sulphur (S)	0.10
Phosphorus (P)	.01	Antimony (Sb)	.10
Arsenic (As)	.10	Manganese (Mn)	1.00
Bismuth (Bi)	.50	Lead (Pb)	.10
Molybdenum (Mo)	.10	Zinc (Zn)	.10
Tin (Sn)	.10		

Dated: July 28, 1952.

JESS LARSON, *Administrator.*

[F. R. Doc. 52-8475; Filed, July 31, 1952; 8:56 a. m.]

(Published in the Federal Register, August 1, 1952, 17 F. R. 7051)

CONSUMPTION AND USES

Consumption of concentrates (60 percent WO_3 basis) was 9,072 short tons in 1952, compared with 11,989 short tons in 1951. The distribution of the tungsten concentrates used in 1952 is listed in table 5.

The use of Class A, high-speed steel, which contains a maximum of 6.75 percent tungsten, was encouraged by the high price of tungsten concentrates, by restrictions of the Government on the quantity of Class B high-speed steel (22 percent W maximum) manufactured, and by technologic improvements at the plants of producers and consumers. The increase in use of Class A steel led to the use of less tungsten in steel during 1952. The following tabulation indicates the relationship between the shipments of Class A steel [5] and the use of tungsten by the steel industry.

[5] From statistics of the American Iron and Steel Institute.

Year:	Percent of total high-speed steel shipments represented by Class A	Percent of total consumption of tungsten concentrates used by manufacturers of steel and ferrotungsten
1948	47	64
1949	40	63
1950	53	45
1951	80	30
1952	87	24

TABLE 5.—Distribution of tungsten concentrates consumed

	Net tons (60 percent WO_3)	Percent of total
Manufacturers of steel ingots and ferrotungsten	2, 207	24
Manufacturers of hydrogen-reduced metal powder	[1] 3, 827	42
Manufacturers of carbon reduced metal powder, tungsten chemicals, and consumption of firms producing several products	[1] 3, 038	34

[1] Includes the entire consumption of firms that use tungsten concentrates primarily for the purpose listed, except the quantities used to produce ferrotungsten.

Manufacturers of hydrogen-reduced metal powder were the chief consumers of wolframite-hübnerite type concentrates. High-grade scheelite and synthetic scheelite type concentrates were used for direct charging to steel, and by manufacturers of all groups of tungsten products; however, the specifications for the various uses were not similar. Manufacturers of metal powder specified material low in molybdenum content; freedom from elements such as copper and phosphorus was important to manufacturers of steel.

Consumption of tungsten concentrates reported to the Bureau of Mines was confined to 2 general areas: 30 percent was used in Ohio, Illinois, and Michigan and 70 percent in New York, Pennsylvania, and New Jersey.

The following actions regarding allocations and prices were of interest to consumers during 1952:

National Production Authority—
- March 4. Order M–81, Section 7, paragraph d. Provided for sale of laboratory chemicals.
- September 4. Order M–20, Section 5. Provided for allocation of high alloy scrap, defined as scrap containing less than 50 percent iron.
- September 12. Order M–81, amended. Terminated allocations of pure tungsten.
- December 10. Order M–80, Schedule 3, revoked. Terminated allocations of ferrotungsten.

Office of Price Stabilization—
- September 29. CPR–71, Supplementary Regulation 1. Permitted adjustments in ceiling prices of tungsten carbide.

International Materials Conference—
- December 31. Terminated international distribution plans for tungsten concentrates and primary products.

STOCKS

Industry stocks dropped for the second consecutive year and at the end of 1952 were less than any year since 1944.

PRICES

The quoted prices for domestic tungsten concentrates of known good analysis were at the ceiling price of $65 per short-ton unit, f. o. b. mine, during all of 1952. However, there was a steady decline in foreign prices during the year. E&MJ Metal and Mineral Markets quotations of London prices, shillings per long-ton unit, were as follows: January 1–10, 520–525; January 10–April 10, 485; April 10–June 12, 480; June 12–26, 465; June 26–July 10, 445; July 10–October 23, 425; October 23–November 27, 410; November 27–December 31, 410–400. These quotations are equivalent to a range of $65.50 to $50 per short-ton unit.

During the period when foreign prices plus freight and the duty of $7.93 per unit were higher than the $65 domestic ceiling price, foreign tungsten concentrates were purchased by the Government, and the quantities needed by domestic firms were sold at the ceiling price.

As reported to the Bureau of Mines, the average price for domestic concentrates shipped was $63.44 per short-ton unit in 1952.

FOREIGN TRADE [6]

Domestic production is inadequate for requirements, and the United States imports both tungsten concentrates and products, chiefly the former. Imports during 1952 more than doubled those of 1951. Korea was the greatest single source in 1952; Bolivia, Portugal, and Spain were in the group contributing over 2 million pounds each (tungsten content).

Table 8 lists general imports and imports for consumption of concentrates for 1951 and 1952. General imports represent ores and concentrates received in the United States, irrespective of final disposition. Imports for consumption cover ores and concentrates on which duty has been paid and which have thereby entered the domestic commerce of the United States and concentrates that enter duty-free for the United States Government. This classification includes concentrates that are withdrawn from bonded warehouses; actual physical imports of such concentrates may have been included under "general imports" in prior years.

In 1952 there were reexports of 3 tons of concentrates and exports of 11 tons, compared with 16 tons and none in 1951. One ton was received for smelting, refining, and reexport during 1952.

Imports (for consumption) of ferrotungsten were as follows for 1952:

Source:	*Gross weight, pounds*	*Tungsten content, pounds*
Japan	277, 214	211, 468
Korea	181, 230	140, 564
Portugal	121, 253	87, 934
Sweden	43, 593	33, 812
Taiwan (Formosa)	6, 537	4, 917

[6] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 6.—Tungsten ores and concentrates imported into the United States, 1951–52, by countries

[U. S. Department of Commerce]

Country	General imports[1]		Imports for consumption[2]		
	Gross weight (pounds)	Tungsten content (pounds)	Gross weight (pounds)	Tungsten content (pounds)	Value
1951					
Argentina	22	17	507,086	295,423	$598,538
Australia	1,688,160	884,295	1,563,897	846,631	2,443,617
Belgian Congo	188,448	105,047	55,382	30,746	72,462
Bolivia	2,354,595	948,169	[3] 1,471,555	692,588	[3] 2,182,465
Brazil	1,882,617	[3] 1,070,213	1,079,661	618,899	1,156,380
British East Africa	35,663	19,096	35,663	19,096	46,339
Burma	488,950	248,538	576,921	289,296	275,255
Chile	982	533	982	533	2,151
China	58,006	33,522	35,967	18,175	43,435
Japan	113,380	65,108	283,467	155,692	295,512
Korea	1,721,923	904,810	1,323,974	705,131	2,450,549
Mexico	520,663	231,897	345,943	152,017	526,148
New Zealand	2,548	1,313			
Peru	788,725	431,198	634,537	345,894	647,539
Portugal	2,424,060	1,279,872	1,897,109	997,570	3,552,367
Spain	1,004,690	536,117	877,813	468,653	1,948,732
Thailand	1,427,230	772,470	1,367,873	739,519	1,360,567
Union of South Africa	1,000	650	1,000	650	1,900
Total	[3] 14,701,662	[3] 7,532,865	[3] 12,058,830	6,376,513	[3] 17,603,956
1952					
Argentina	277,075	141,640	277,075	141,640	509,197
Australia	1,762,874	823,884	1,942,816	905,429	3,336,327
Belgian Congo	66,146	37,330	66,146	37,330	127,402
Bolivia	6,325,189	2,867,947	6,515,656	2,940,931	10,599,924
Brazil	1,829,137	1,045,722	2,495,864	1,424,182	4,453,472
British East Africa	22,198	12,098	22,198	12,098	38,483
British Malaya	16,845	8,685	706	367	353
Burma	1,968,741	911,148	579,646	305,168	350,341
Canada	2,958,442	642,655	2,638,001	631,380	2,304,397
China	84,084	42,318	84,084	42,318	169,992
Finland	10,362	4,766	10,362	4,766	13,726
Hong Kong	310,216	159,249	290,631	151,121	468,230
Japan	258	133	9,381	4,088	10,813
Korea	7,723,668	3,723,474	8,098,841	3,923,314	14,036,199
Mexico	3,011,723	468,457	3,220,543	585,826	1,660,574
Netherlands	19,918	11,230	19,918	11,230	38,211
Peru	399,827	216,391	703,679	378,052	771,373
Portugal	4,792,206	2,590,840	4,842,011	2,674,062	7,950,761
Spain	3,886,920	2,044,510	3,944,991	2,074,384	7,207,272
Thailand	2,239,164	1,220,867	2,120,964	1,158,183	2,999,734
Union of South Africa	22,400	11,548			
Total	37,727,393	16,984,892	37,883,513	17,405,869	57,046,781

[1] Comprises ores and concentrates received in the United States; part went into consumption during year and remainder entered bonded warehouses.
[2] Comprises ores and concentrates withdrawn from bonded warehouses during year and receipts during year for consumption.
[3] Revised figure.

Exports of ferrotungsten (gross weight) included 288,401 pounds to Canada and 6,615 pounds to Italy; reexports (gross weight) comprised 33,195 pounds to Canada, 15,047 pounds to United Kingdom, 4,592 pounds to Austria, and 44,333 pounds to Italy.

Imports (for consumption) of tungsten metal were 147 pounds from Germany, 1,787 pounds from Japan, and 330 pounds from Netherlands. Exports of tungsten-metal powder totaled 53,416 pounds; countries receiving over 100 pounds included Australia (891), Canada (51,462), India (158), and Italy (720).

Additional tungsten-bearing items imported for consumption during 1952 comprised tungsten carbide (137 pounds content), tungstic acid

(5,382 pounds content), ferrochromium tungsten (64 pounds content), and tungsten nickel (134 pounds content); additional exported items comprised metals, alloys, and scrap (70,053 pounds gross) and primary forms not elsewhere classified (36,391 pounds gross).

The International Materials Conference recommendations regarding distribution of tungsten concentrates during 1952 were accepted by member governments and serve as a guide to indicate important importing areas. The four distribution plans announced during the year have been combined in table 7. The quantities listed for France, Germany, Japan, Sweden, the United Kingdom, and the United States include material for conversion to primary products for reexport.[7]

The International Materials Conference distribution plans were discontinued at the end of 1952.

TABLE 7.—Summary of International Materials Conference distribution plans for tungsten concentrates, 1952

Country	Metric tons, tungsten content of concentrates	Country	Metric tons, tungsten content of concentrates
Australia	78	Spain	75
Austria	31	Sweden	756
Belgium	17	Switzerland	30
Canada	194	United Kingdom	3,800
France	1,540	United States	8,865
Germany	1,789	Other	41
Italy	158		
Japan	434	Total production estimate	17,846
Netherlands	38		

In May the United Kingdom formed British Tungsten, Ltd., to act as agent of the Government for the import and distribution of tungsten ores. This formalized the joint action of three firms—Derby & Co., Ltd., Metal Traders, Ltd., and H. A. Watson, Ltd.—which previously acted jointly as the Government's agents.

TECHNOLOGY

During 1952 the following technological developments were significant:

Mining.—The price of $63 per short-ton unit provided by the domestic tungsten program of the Government encouraged production of material previously considered too low grade to work; several firms mined ores containing about 0.3 percent WO_3. In general, less selective mining methods were used than when ores containing 0.6 to 0.75 percent WO_3 were mined, and there was a considerable increase in the tonnage produced by open-cut mining. There was also a trend toward greater production of shipping ore from deposits not equipped with milling plants. The exploration loans available under the DMEA program were widely applied for by individuals and firms wanting to explore tungsten deposits; table 7 lists the DMEA contracts negotiated for this purpose in 1952.

[7] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 1, January 1952, p. 22, vol. 34, No. 4, April 1952, p. 26, vol. 35, No. 2, August 1952, p. 24; vol. 35, No. 5, November 1952, p. 24.

Getchell Mine, Inc., installed slusher equipment for loading skips from a nearly horizontal underground bin and utilized similar equipment for loading dump trucks; in both instances, chute gates were eliminated and bin construction simplified.

United States Vanadium Co. continued to develop large blocks of ore for production by long-hole blasting. During 1952 this firm substituted percussion drilling for diamond drilling at many of the long-hole stopes.

TABLE 8.—Defense Mineral Exploration Administration contracts executed in 1952 for exploration of tungsten deposits

State or Territory	County	Firm	Total cost	Government participation
Alaska	2d Judicial	Alaska Copper Corp	$41,000	$30,750
Arizona	Pinal	Nikas Mining Co	59,200	44,400
California	Inyo	Northfield Mines, Inc	44,720	33,540
	Riverside	Sweeney Tungsten Co	29,800	22,350
	San Bernardino	Hidden Hills Co	16,800	12,600
		Tungsten Prospecting Assoc	6,700	5,025
	Tuolumne	T. A. Hazelton	5,960	4,470
Colorado	Boulder	A. W. Brown	10,500	7,875
		G. Coughlin and E. Henderson	4,800	3,600
		G. Jump	18,900	14,175
		S. Larson and R. Plummer	25,000	18,750
		J. McBroom and L. R. Allen	12,600	9,450
		J. M. Smith and C. R. Rugg	24,400	18,300
		Vasco Tungsten Corp	17,500	13,125
	Ouray	A. Robitsch and Wm. Brewster	9,650	7,237
Idaho	Boundary	Chief Joseph Mines, Inc	7,440	5,580
	Idaho	Mullen Mines Co	12,400	9,300
	Lemhi	Bradley Mining Co	112,000	84,000
	Shoshone	J. Etherton and W. Schmittroth	24,000	18,000
	Valley	McRae Tungsten Corp	53,800	40,350
Montana	Beaverhead	American Alloy Metals, Inc	66,914	50,185
		Minerals Engineering Co	121,280	90,960
	Powell	Western Mines Co	21,600	16,200
	Silver Bow	Standard Ore & Alloy Co	10,080	7,560
Nevada	Esmeralda	I. Sykes	10,600	7,950
	White Pine	Baltimore Camas Mines, Inc	20,280	15,210
		Graham Development Corp	17,120	12,840
		Mt. Wheeler Mines, Inc	75,476	56,607
New Mexico	Santa Fe	Potter and Sims	77,520	58,140
Utah	Millard	L. Garrick	26,700	20,025
Total			984,740	738,554

The results of sampling by the Bureau of Mines at the Combination mine, Granite County, Mont., were described.[8] The work, which was conducted in 1947 and 1948, comprised 10,732 linear feet of trenches, 16 diamond-drill holes, and 236 channel samples. One hundred and fifty-eight drill hole samples were analyzed.

Milling.—1952 was marked by construction of several new mills and by modification and expansion at several others.

Nevada-Massachusetts Co. modified the flowsheet at the Tungsten, Nev., mill. The design calls for a greater percentage of the concentrates to be produced at the gravity section and a corresponding decrease in the quantity recovered by the flotation units.

The sampling unit at the Getchell mill, Red House, Nev., was improved to provide for automatic sampling of custom ores. Ore from outside sources is sent to a separate primary crusher. An

[8] Volin, M. E., Roby, R. N., and Cole, J. W., Investigation of the Combination Silver-Tungsten Mine, Granite County, Mont.: Bureau of Mines Rept. of Investigations 4914, 1952, 26 pp.

infrared lamp unit to aid the drying of concentrates at this mill was described.[9] Lamps are also used to dry concentrates produced by Tungsten Mining Co. at Henderson, N. C., without using auxiliary heating pans. The capacity of the Henderson unit was increased to 600 tons per day during 1952.

Tests of concentration methods for scheelite ores were reported.[10] A limited procedure was used, designed to answer specific questions regarding six ores from California and Nevada. The methods of treatment included flotation, gravity concentration, and magnetic separation.

The flowsheet at the Yellow Pine antimony unit, Stibnite, Idaho, was described; tungsten concentrates were produced as a byproduct by flotation followed by tabling. Production of tungsten from a placer also is included in the article. Material mined by power shovel and trucked to a central plant was sized by a grizzly and trommel. The minus-4-inch, plus-⅜-inch ore was hand sorted under ultra-violet light; minus-⅜-inch ore was treated in jigs and tables and cleaned by a magnetic separator.[11]

Three former gold mills near Virginia City, Nev., were converted to enable treatment of tungsten ores.[12]

Tungsten Carbide.—A program for salvaging scrap tungsten carbide at a plant in England was described;[13] broken and worn tungsten carbide was used on small tools; at wear points of fixtures, dies, and gages; on scriber tips; and, after being pulverized, as a component of grinding and lapping compounds. In the United States the tendency is to salvage tungsten carbide by converting it to synthetic scheelite or by charging it to steel furnaces along with scrap tool steel.

Technical information on the binding agent in sintered tungsten carbide was published.[14] The authors discuss the conflicting literature and provide a bibliography regarding the structure of this material.

Tests indicate a structure of isolated carbide grains in a matrix of binder metal, rather than a continuous skeleton of tungsten carbide. Conclusions are quoted below.

1—Densification of cemented tungsten carbide-cobalt alloys takes place by a rearrangement of the carbide particles, which achieve a denser packing under the influence of the surface tension forces of the binder. The disappearance of small grains and the growth of large grains of tungsten carbide also contribute to densification.

2—The resulting structure is one of carbide particles embedded in a cobalt-rich matrix. A continuous tungsten carbide skeleton is not formed during the sintering treatment.

3—This structure accounts for some of the characteristic properties of the cemented compacts. Their high strength and lack of ductility can be attributed to the mechanical restraint exerted by the carbide particles upon the thin films of the binder, the yield strength of which is correspondingly raised, and to the complex state of stress resulting from the presence of residual stresses of thermal origin.

---

[9] Engineering and Mining Journal, vol. 152, No. 11, November 1952, p. 116.

[10] Engel, A. L., Treatment Tests of Scheelite Ores and Tailings: Bureau of Mines Rept. of Investigations 4867, 1952, 11 pp.

[11] Huttl, J. B., Yellow Pine is Expanding Its Output of Strategic Metals: Eng. and Min. Jour., vol. 153, No. 5, May 1952, pp. 72–77.

[12] Mining Record, vol. 63, No. 33, Aug. 14, 1952, p. 3.

[13] Halliday, W. M., Iron Age, vol. 169, No. 10, Mar. 6, 1952, pp. 208–210.

[14] Gurland, J., and Norton, J. T., Role of the Binder Phase in Cemented Tungsten Carbide-Cobalt Alloys: Jour. Metals, vol. 4, No. 10, October 1952, pp. 1051–1056.

4—The following are the essential characteristics required of an effective binder for cemented tungsten carbide compacts: it must supply a liquid phase at relatively low temperatures; tungsten carbide must be soluble in the binder; and the liquid binder must wet the solid carbide particles.

The phases and equilibria in the tungsten-cobalt-carbon system were studied.[15]

The use of tungsten carbide-tipped hammers at pulverizing mills resulted in a substantial increase in the tonnage treated before the hammers were replaced. The efficiency was also increased because the overall length of the tipped hammers remained more constant after long use than steel hammers.[16]

Tool Steel.—The production of exceptionally large bars of tool steel without carbide concentrations in the center was described.[17]

WORLD REVIEW

Argentina.—The Argentine Trade Promotion Institute was authorized to conclude an agreement regarding the sale of tungsten ores and concentrates exported, with Minerales y Metales, S. R. L. The agreement covers the sale for export of all exportable surplus of tungsten concentrates produced by Sominar, Sociedad Minera Argentena S. A. (an affiliate of Minerales y Metales) and any other quantity that the Trade Promotion Institute makes available for export. This agreement was expected to expedite the $5,000,000 Export-Import Bank loan to Sominar for expansion of tungsten and sulfur production.[18] The Arrequintin mine was reported to be an active producer.[19]

Australia.—King Island Scheelite, Ltd., mined 174,000 tons of ore and produced 1,000 tons of tungsten concentrates during the year ending October 31, 1952; in addition, 210,000 tons of overburden was removed. The deposit being worked is on King Island in Bass Strait between the Victorian mainland and Tasmania. The Frogmore mine in New South Wales was in operation.[20]

Bolivia.—Early in 1952 production of tungsten in Bolivia was stimulated by long-term contracts, Export-Import Bank loans, and a schedule of exchange deliveries more favorable than the restrictive provisions in effect from August 1950 to July 1951. However, in October of 1952 the mines of Patino Mines and Enterprises Consolidated, Inc., Mauricio Hochschild (SAMI), and Cia Aramayo de Mines in Bolivia were nationalized. This effectively halted the plant expansion planned by Bolivian Tin & Tungsten, a Patino subsidiary, at the Kami and Araca mines under terms of a $1,000,000 loan negotiated in December 1951; Hochschild's expansion at the Bolsa Negra mine, using a $1,000,000 loan negotiated in November 1951; and Aramayo's development at Pacuni, for which a $580,000 loan was granted in January 1952. The nationalization did not include tungsten deposits of other firms and did not affect the long-term contract between the Mining Bank and the United States Government, providing for the delivery of 3,000 to 5,000 tons of tungsten concentrates

15 Rautala, P., and Norton, J. T., Tungsten-Cobalt-Carbon System: Jour. Metals, vol. 4, No. 10, October 1952, pp. 1045–1050.
16 Fawcett, W. E., Carbide-Tipped Hammers Cut Pulverizing Costs: Iron Age, vol. 170, No. 22, Nov. 27, 1952, pp. 114–116.
17 Hughes, David P., Bigger Tool-Steel Bars: Steel, vol. 4, No. 10, Nov. 3, 1952, pp. 96–97.
18 Boletin Oficial, Argentina, Decree 5,200, Mar. 14, 1952: Mar. 24, 1952.
19 Mining World, vol. 14, No. 13, December 1952, p. 63.
20 Mining World, vol. 14, No. 6, May 1952, p. 65.

TABLE 9.—World production of tungsten ores, by countries, 1948–52, in metric tons [1] of concentrates containing 60 percent WO_3,

[Compiled by Pauline Roberts and Berenice B. Mitchell]

Country	1948	1949	1950	1951	1952
North America:					
Canada	791	191	215	15	923
Mexico	133	65	67	325	443
United States (shipments)	3,659	2,508	4,373	5,693	6,905
Total North America	4,583	2,764	4,655	6,033	8,271
South America:					
Argentina	33	[2] 30	[2] 20	100	600
Bolivia (exports)	2,485	2,543	2,461	2,718	3,707
Brazil (exports)	1,144	575	759	1,422	[2] 1,800
Peru	353	455	516	655	630
Total South America	4,015	[2] 3,600	[2] 3,760	4,895	[2] 6,700
Europe:					
Finland	4	49	20	8	47
France	567	792	442	765	[2] 1,000
Italy	4	3	2	6	5
Portugal	2,944	2,700	2,500	4,680	4,900
Spain	876	888	850	2,553	2,400
Sweden	317	468	362	[2] 450	[2] 380
U. S. S. R.[2]	5,000	6,000	7,500	7,500	(3)
United Kingdom	46	81	76	61	55
Total Europe (estimate)	9,800	11,000	11,800	16,000	[4] 8,800
Asia:					
Burma	1,824	740	930	1,647	1,260
China	12,200	[2] 9,000	[2] 12,000	[2] 15,800	[2] 20,000
Hong Kong	----	----	----	23	104
India	----	----	2	15	----
Japan	9	20	64	86	239
Korea:					
Korea, Republic of	1,245	1,448	2,000	1,269	3,500
North Korea	1,000	1,000	[2] 1,000	[2] 1,200	[2] 1,200
Malaya, Federation of	87	69	27	54	79
Thailand [2]	800	1,100	1,200	1,350	1,600
Total Asia (estimate)	17,200	13,400	17,000	21,400	28,000
Africa:					
Algeria	----	----	----	17	75
Belgian Congo	236	276	164	330	[2] 500
Egypt	15	----	----	7	21
French Morocco	1	----	7	38	13
Nigeria	4	5	5	23	23
Southern Rhodesia	80	26	64	231	420
South-West Africa	13	6	4	33	118
Tanganyika (exports)	1	42	15	15	14
Uganda (exports)	115	180	218	167	109
Union of South Africa	151	416	96	188	263
Total Africa	616	951	573	1,049	[2] 1,600
Oceania:					
Australia	1,234	1,371	1,235	1,892	[2] 2,000
New Zealand	28	28	24	35	[2] 35
Total Oceania	1,262	1,399	1,259	1,927	[2] 2,035
Grand total (estimate)	37,500	33,100	39,000	51,300	[4] 55,400

[1] This table incorporates a number of revisions of data published in previous tungsten chapters.
[2] Estimate.
[3] Data not available: No estimate included in totals.
[4] Excluding U. S. S. R.

over a 5-year period. Exports of tungsten in 1951, by individual firms and groups, were published.[21]

Canada.—The Emerald mine near Salmo, British Columbia, was a major producer of tungsten during 1952. The Canadian Government operated the mine during World War II; after the wartime demand for tungsten declined, the deposit was sold to Canadian Exploration, Ltd., a wholly owned subsidiary of Placer Development, Ltd. Shortly after the outbreak of hostilities in Korea the Government repurchased the mine and negotiated an agreement with the company for its operation. Canadian Exploration, Ltd., developed ore outside the Government-owned area and expanded the mill from the 250-ton plant needed to treat ore for the Government to a 700-ton daily capacity; in October 1952 the Canadian Government announced resale of the mine to Canadian Exploration, Ltd.[22]

The Red Rose and Rocher De Boule mines in British Columbia, operated by Western Tungsten Copper Mines, Ltd., were reported to have produced 168 tons of tungsten concentrates during the first 8 months of 1952. The mill has a daily capacity of 150 tons of ore per day; an expansion program was under consideration. Production was sold to a London firm under a 2-year contract at the prevailing market quotation, subject to a minimum of $45 and a maximum of $110 a unit.[23]

Finland.—During 1952, 41 metric tons of tungsten concentrates, containing 69.2 percent WO_3, was produced as a byproduct at the Ylojarvi copper mine.

Korea.—Korea was the greatest single source of United States imports of tungsten concentrates during 1952. In March the Department of the Army announced that the Republic of Korea was supplying the United States with its output of tungsten,[24] and it was reported that a battalion of United States infantrymen was deployed in the area to defend the mine from guerilla troops.[25] In December a contract was negotiated between the Republic of Korea and the Utah Construction Co. of San Francisco. The agreement is a management contract that calls for rehabilitation and improvement at the Government-owned Sangdong and Dalsung mines, a training program for a Korean staff, and plans for construction of a tungsten refinery.[26]

Mexico.—A 50-ton tungsten mill was operated near Leon, Guanajuato, by Cia Bisentungsteno S. A.[27] A list of tungsten producers and exporters was published.[28]

Peru.—The Pasto Bueno mine in the Department of Ancash was being developed during 1952; an Export-Import Bank loan of $650,000, approved in July 1951, provided part of the funds used for mine and mill equipment, a power plant, and construction of an 80-kilometer road.

Portugal.—Portugal is the largest producer of tungsten concentrates in Europe. The Panasqueira, Ribeira, and Borralha mines

[21] Bureau of Mines, Mineral Trade Notes: Vol. 34, No. 5, May 1952, pp. 25–27.
[22] Mining Record, vol. 63, No. 9, Feb. 28, 1952, p. 6. American Metal Market, vol. 59, No. 76, April 19, 1952, p. 11; vol. 59, No. 177, Sept. 12, 1952, p. 1.
[23] Northern Miner, vol. 38, No. 40, Dec. 25, 1952, p. 3. American Metal Market, vol. 59, No. 192, Oct. 3, 1952, p. 4. Metal Bulletin (London), No. 3752, Dec. 16, 1952, p. 23.
[24] Mining Record, vol. 63, No. 10, Mar. 6, 1952, p. 1.
[25] Engineering and Mining Journal, vol. 153, No. 12, November 1952, p. 128.
[26] Mining Record, vol. 63, No. 51, Dec. 18, 1952, p. 3. American Metal Market, vol. 59, No. 240, Dec. 16, 1952, p. 1.
[27] Mining World, vol. 14, No. 4, April 1952, p. 60.
[28] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 1, July 1952, p. 23.

342070—55——69

have been the source of much of the production. During 1952 Beralt Tin & Wolfram, Ltd., concluded 2 contracts with the United States Government; 1 calls for 1,000 short tons of tungsten concentrates within 2 years and another for 2,500 long tons over a 5-year period.[29] This firm owns tin and tungsten properties at Panasqueira. In October 1952, the United States canceled a contract with the Atlantica Co. that had called for a minimum of 2,970 and a maximum of 4,290 short tons of concentrates, because the firm sought to deliver material purchased on the open market rather than that produced by the mines specified in the agreement.[30] Minas de Borralha, a French-owned company, was reported to have produced ferrotungsten by an electrometallurgical process in addition to exporting substantial quantities of tungsten concentrate.[31]

Southern Rhodesia.—The tungsten deposits of Southern Rhodesia were described in considerable detail. Wolframite is said to occur in quartz veins associated with much tourmaline and in greisenized aplite veins and dikes, associated with chlorite, muscovite, tourmaline, fluorspar, topaz, and sulfides. The four main types of scheelite ore occurrence are in quartz veins, schist lodes, skarn lodes (tactite), and veins in basalt.[32]

Spain.—Tungsten concentrates were produced in the Provinces of La Coruna, Salamanca, Orense, Pontevedra, Badajoz, and Leon. At the beginning of 1952, 223 mines were operating; 158 of these were brought into production in 1951. Most of these mines were small operations worked almost entirely by hand labor. An exception was Compania Minera Montanas del Sur; this firm negotiated a $230,000 Export-Import Bank loan for mining machinery and equipment.[33]

Union of South Africa.—The O'okiep Copper Co., Ltd., signed a contract with the United States Government covering the sale of all its production of tungsten concentrates. The company expects to spend $500,000 to provide mining and milling equipment; the mill will have a capacity of 200 tons per day.[34]

Yugoslavia.—A tungsten deposit near Neresnica in eastern Serbia produced tungsten concentrates; the separation plant and some mine equipment were procured with the aid of a loan from the Export-Import Bank. Plans for production of ferrotungsten at Sibenik were reported.[35]

[29] Mining World, vol. 14, No. 12, November 1952, p. 64.
[30] American Metal Market, vol. 59, No. 211, Oct. 31, 1952, p. 1, 7.
[31] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 4, October 1952, p. 22.
[32] Southern Rhodesia Geological Survey, Tungsten: Mineral Resources Ser. 5, May 1952, p. 9.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 4, October 1952, pp. 22–23.
[34] Mining World, vol. 14, No. 12, November 1952, p. 59.
[35] American Metal Market, vol. 59, No. 137, July 17, 1952, p. 1.

Uranium, Radium, and Thorium

By H. D. Keiser [1]

UNPRECEDENTED expansion of the Nation's atomic energy program, foreshadowed in 1951, became a reality in 1952. Besides authorization of funds to support the expansion, implementation of the increased scale of operations, involving adequate supplies of raw materials, seemed assured. Program goals were defined more clearly than before. Marked progress was made on such objectives as the development of more effective nuclear weapons and the application of atomic power for industrial purposes. In short, the tenth anniversary of the first chain reaction—produced on December 2, 1942, at Chicago—saw the United States proceeding in a substantial manner toward security and new economic horizons.

Funds at a new high level were appropriated to the Atomic Energy Commission in 1952 under the major expansion of facilities for the production of fissionable materials and weapons. During the fiscal year 1952 the AEC received three appropriations totaling $1,605,897,750; the initial appropriation for fiscal year 1953 amounted to $1,137,727,500; and on July 15, 1952, a supplemental appropriation of $2,986,894,000 was authorized—the largest ever made for the atomic energy program. Capital investment of the United States in atomic energy will be about $7,500,000,000 when the construction involved under the appropriations is completed.

Production of atomic weapons continued at the rate authorized by the President for the calendar year 1952. Two series of weapons tests were held—one during April, May, and June at the Nevada proving ground near Las Vegas and the other during November at Eniwetok Atoll in the Pacific. In October the Army demonstrated a 280-mm. cannon for which an atomic projectile had been developed.

Under the expansion program supported by the supplementary appropriation of July 15, 1952, a major new facility—a gaseous diffusion plant to cost about $1,200,000,000—was planned for erection along the Scioto River, in Pike County, Ohio, about 22 miles north of Portsmouth. Additional plant capacity was scheduled at the several gaseous diffusion and plutonium plants.

The materials-testing reactor constructed at the National Reactor Testing Station in Idaho went into operation in 1952. One prototype reactor for submarine propulsion was substantially completed, and work was begun on the reactor to power the submarine U. S. S.

[1] Commodity-industry analyst.

Nautilus. Construction of a second reactor-powered submarine, the U. S. S. *Sea Wolf*, was authorized.

The impending industrial application of atomic energy was the subject of much discussion in 1952. The first four industrial groups to survey the technical and economic problems of power-reactor development released some information relating to their studies. Approval was granted a fifth group to make a similar survey.

Production of fissionable uranium-235 and plutonium in 1952 was reported by the AEC to have continued as scheduled. Foreign production and procurement programs, according to the AEC, progressed at a satisfactory rate, and plans for expansion and development of new sources were underway. Domestic uranium production continued to increase.

MINE AND MILL PRODUCTION

Production and processing of uranium ores continued on an accelerated basis in 1952, with an expansion in all phases of exploration, development, metallurgy, and research involved under the AEC raw materials program.[2] Two new and important sources of uranium were brought into production in 1952—the gold ores of South Africa (see Union of South Africa, this chapter) and the phosphate rock of Florida. At the close of the year the first processing plants treating the gold ores and phosphate rock had reached scheduled performance.[3]

Domestic uranium-mining activity in 1952 was centered on the Colorado Plateau as in 1951. Significant discoveries in Arizona and New Mexico in 1952 indicated further expansion southward and westward of the area of known uranium mineralization.[4] More than 200 mines, ranging from small 1-man operations to mines employing 100 men or more, were active on the plateau in 1952, and over 5,000 persons were engaged in exploration, drilling, mining, milling, construction, and trucking.[5] Discoveries of new ore bodies on the plateau in 1952 were mostly within or adjacent to known uranium districts—Uravan, Colo.; Moab, Green River, San Rafael Swell, and Henry Mountains, Utah; Lukachukai Mountains, Ariz.; and Shiprock, N. Mex. Importance of the Grants area in New Mexico, where a large deposit of uranium ore in Todilto limestone had previously been found,[6] was enhanced by the discovery in 1952 of good-size deposits in sandstone near Laguna, southeast of Grants.[7] Airborne and ground exploration in 1952 disclosed several new deposits east and west of the original Craven Canyon discovery in South Dakota.[8] Northwest of Edgemont, S. Dak., in the Powder River Basin of Wyoming, the Geological Survey found a number of small, high-grade deposits.[9] Except for the deposit near Marysvale, Utah, a steady producer of

[2] Atomic Energy Commission, Twelfth Semiannual Report: July 1952, p. 2.

[3] Atomic Energy Commission, Thirteenth Semiannual Report (Assuring Public Safety in Continental Weapons Tests): January 1953, p. 5.

[4] Waylett, William J., Uranium: Mining World, vol. 15, No. 5, Apr. 15, 1953, pp. 78–79.

[5] Meyers, Burt, Uranium: Eng. and Min. Jour., vol. 154, No. 2, February 1953, pp. 90–91.

[6] Towle, Charles C., and Rapaport, Irving, Uranium Deposits of the Grants District, New Mexico: Min. Eng., vol. 4, No. 11, November 1952, pp. 1037–1040.

[7] Rapaport, Irving, Interim Report on the Ore Deposits of the Grants District, New Mexico: Atomic Energy Commission Rept. RMO–1031, November 1952, 19 pp.

[8] Baker, K. E., Smith, L. E., and Rapaport, I., Carnotite Deposits Near Edgemont, S. Dak.: Atomic Energy Commission Rept. RMO–881, February 1952, 13 pp.

Page, L. R., and Redden, J. A., The Carnotite Prospects of the Craven Canyon Area, Fall River County, S. Dak; Geol. Survey Circ. 175, 1952, 18 pp.

[9] Love, J. D., Preliminary Report on Uranium Deposits in the Pumpkin Buttes Area, Powder River Basin, Wyo.: Geol. Survey Circ. 176, 1952, 37 pp.

good ore, efforts in 1952 to develop significant tonnages in vein-type deposits were disappointing.[10] Probably the most significant discovery of 1952 was made on the Steen property, in San Juan County, Utah, about 39 miles southeast of Moab, where a massive ore body of better-than-average grade for the Colorado Plateau was opened up in the Chinle formation. Geologic guides to ore on the Colorado Plateau were discussed in publications issued by the AEC and the Geological Survey.[11]

Exploration drilling for uraniferous ores by the AEC, Geological Survey, and Bureau of Mines totaled more than 1,100,000 feet in 1952 as compared with 765,000 feet in 1951. Additional drilling by private interests was estimated at 725,000 feet. Most of the drilling was done on the Colorado Plateau, with minor footages in the Colorado Front Range, the Black Hills region and certain uranium-bearing lignite areas of South Dakota, isolated areas in Wyoming, and in an investigation of the continuity of thickness and grade of the Chattanooga shale in Tennessee begun near the close of the year by the Bureau of Mines.[12] Drilling and mining techniques employed on the Colorado Plateau were described in several articles published in the technical press during 1952.[13]

Intensive exploration programs were conducted in 1952 by private interests. Anaconda Copper Mining Co. was active in the Grants, N. Mex., area and the nearby Laguna Indian Reservation; the Homestake Mining Co. in the South Dakota Black Hills and adjacent area in Wyoming; and the Kerr-McGee Oil Industries, Inc., in the Lukachukai Mountains of northern Arizona. United States Vanadium Co., Vanadium Corp. of America, and Climax Uranium Co., producers of substantial quantities of uranium ore on the Colorado Plateau, carried forward their respective exploration programs.

Airborne exploration by the AEC and Geological Survey was increased in 1952 and totaled 625 hours of flying in the Black Hills area of South Dakota, in the Big Horn and Powder River Basins of Wyoming, and on the Colorado Plateau. Considerable airborne exploration was also conducted by private interests, including Anaconda Copper Mining Co., Homestake Mining Co., Kerr-McGee Oil Industries, Inc., and Hunt Oil Co.[14] Application of radioactivity methods of prospecting for uranium expanded in 1952; several thousand portable radiation detectors, mostly the well-known Geiger counters, were said to have been in use. Gamma-ray logging of exploratory boreholes, largely by Government agencies, was estimated to have totaled about 1,000,000 feet for the year.[15]

[10] Gillingham, T. E., Uranium Program Continues to Expand: Min. Cong. Jour., vol. 39, No. 2, February 1953, pp. 82–84, 89.

[11] Reinhardt, Elmer V., Practical Guides to Uranium Ores on the Colorado Plateau: Atomic Energy Commission Rept. RMO–1027, Sept. 30, 1952, 13 pp.

Weir, Doris Blackman, Geologic Guides to Prospecting for Carnotite Deposits on the Colorado Plateau: Geol. Survey Bull. 988–B, 1952, pp. 15–27.

[12] Works cited in footnote 3, pp. 9–10, and footnote 4.

[13] Burwell, Blair, New Developments in Uranium Mining: Min. Cong. Jour., vol. 38, No. 10, October 1952, p. 113.

Kellogg, John P., Exploration Drilling Techniques on the Colorado Plateau: Atomic Energy Commission Rept. RME–2, Nov. 12, 1952, 25 pp.

Knoerr, Alvin W., How to Make Uranium Mining Pay More: Eng. and Min. Jour., vol. 153, No. 1, January 1952, pp. 72–81.

Mining Congress Journal, New Mining Technique for Uranium: Vol. 38, No. 12, December 1952, p. 92.

Sullivan, R. G., New Developments in Exploratory Drilling for Uranium Ore: Min. Cong. Jour., vol. 38, No. 6, June 1952, pp. 42–44, 84.

[14] Works cited in footnote 3, p. 9, and footnote 4.

[15] Joesting, H. R., Geophysics: Min. Eng., vol. 5, No. 2, February 1953, pp. 151–155.

Additional assistance in various forms was afforded the domestic uranium industry by Government agencies in 1952. The AEC paid $902,551 during the year to uranium miners as a bonus for initial production of uranium. Uranium contracts for exploration project assistance executed by Defense Minerals Exploration Administration in 1952 totaled $613,969.54 in contract value, with $552,572.59, or 90 percent thereof, representing Government participation. A total of $4,119,284.16 was certified for accelerated amortization by the Defense Production Administration in 1952 in connection with the mining of uranium ore and the expansion of uranium ore-processing facilities. The Bureau of Public Roads in 1952 completed 160 miles of access roads serving uranium mines and was engaged in constructing 543 additional miles of such roads. The exploration contracts executed by DMEA and the certificates of necessity certified by DPA through December 31, 1952, are listed in tables 1 and 2, respectively.

TABLE 1.—Defense Minerals Exploration Administration contracts involving uranium, by States, through Dec. 31, 1952

Name of contractor	County	Date of contract	Government participation
COLORADO			
Anaconda Lead & Silver Co	Eagle	Sept. 15, 1952	$9,000.00
Cherokee Mines	Larimer	July 16, 1951	21,600.00
Gateway Mining & Development Co	Mesa	Sept. 26, 1952	46,772.10
Moreno-Cripple Creek Corp	Jefferson	May 21, 1952	56,475.00
The Realty Co	Gilpin	Oct. 9, 1951	72,000.00
Uranium Co. of America	do	Feb. 25, 1952	22,500.00
Uranium Development Corp	Montrose	Nov. 24, 1952	19,570.00
MONTANA			
David Nieminen, et al	Jefferson	Apr. 17, 1952	13,599.00
Elkhorn Mining Co	do	Aug. 16, 1951	23,125.50
Do	do	Aug. 22, 1951	11,520.00
D. A. McNabb	do	Jan. 16, 1952	20,616.30
NEVADA			
Nevada Uranium Co	Pershing	Dec. 18, 1952	8,230.50
NEW MEXICO			
Black Hawk Consolidated Mines Co	Grant	Apr. 11, 1952	18,000.00
UTAH			
Boomerang Mining Co	Grand	Nov. 4, 1952	21,705.84
Bullion Monarch Mining Co	Piute	June 23, 1952	24,957.00
Canary Mining Co	Daggett	Dec. 5, 1951	24,052.50
Abe Day	San Juan	Mar. 17, 1952	9,810.00
J. Walter Duncan, Jr	do	Mar. 4, 1952	38,871.00
Ellihill Mining Co	do	Sept. 4, 1952	17,145.00
Excalibur Uranium Corp	Emory	Jan. 24, 1952	53,363.70
Glenn Mining Co	Piute	Oct. 15, 1952	29,139.30
R. A. Glenny, et al	do	Aug. 19, 1952	22,050.00
Moreno-Cripple Creek Corp	San Juan	Oct. 29, 1952	19,260.00
Plateau Mining Co	do	Oct. 23, 1951	17,049.60
Salina Mining & Smelting Co	Kane	Sept. 10, 1952	15,255.45
J. R. Simplot	Wayne and Garfield	Dec. 13, 1951	64,340.48
Sunnyside Uranium Co	Piute	Sept. 8, 1952	39,114.00
White Canyon Mining Co	San Juan	Feb. 19, 1952	47,138.40
Total			786,260.67

TABLE 2.—Certificates of necessity, involving uranium, certified by Defense Production Administration for assistance through tax amortization, by States, through Dec. 31, 1952

Company	Type of project	Date certified	Percentage of depreciable assets certified	Amount allowed for accelerated amortization
COLORADO				
Climax Uranium Co	Ore-processing facilities	Apr. 16, 1951	90	$817,374.74
Do	Mine buildings and equipment.	May 1, 1951	90	156,329.12
Do	Ore-processing facilities	Nov. 7, 1952	80	226,602.34
Do	Mine buildings and equipment. Ore-processing facilities	Nov. 26, 1952	80	17,698.50
NEW MEXICO				
Anaconda Copper Mining Co	Ore-processing facilities	Jan. 8, 1952	90	3,197,610.00
UTAH				
Vitro Chemical Co	do	June 5, 1952	80	677,373.32
Total				5,092,988.02

The capacity of several of the 8 uranium ore-processing plants operating in 1952 was increased during the year, and plans were announced for the early construction of 3 new plants. Largest of the mill-expansion programs was that at the Uravan, Colo., plant of U. S. Vanadium Corp., where a new process was placed in operation and capacity of the plant doubled.[16] Vanadium Corp. of America completed a major expansion of its facilities at Durango, Colo.; Climax Uranium Co. increased substantially the capacity of its Grand Junction, Colo., plant; and Vitro Chemical Co. more than doubled the capacity of its Salt Lake City, Utah, plant. In January 1952 the AEC announced that the Anaconda Copper Mining Co. would build an ore-processing plant near Grants, N. Mex., that was scheduled to be placed in operation about September 1953. Toward the close of 1952 announcement was made that Kerr-McGee Oil Industries, Inc., would build and operate an ore-processing plant at Shiprock, N. Mex., and that a similar plant would be erected and operated at Hite, Utah, by Vanadium Corp. of America.

The first production of byproduct uranium from phosphoric acid was begun in September 1952 at the Joliet, Ill., plant of Blockson Chemical Co. Additional plants for similar recovery of uranium were under construction near Mulberry, Fla., by International Minerals & Chemical Corp. and Virginia-Carolina Chemical Corp., and at Texas City, Tex., by Texas City Chemicals, Inc.[17]

The Bureau of Mines continued in 1952 the survey of domestic thorium resources, on behalf of the AEC, which involved evaluation of the monazite content of (1) placer deposits in Idaho, Montana, Wyoming, North Carolina, and South Carolina and (2) beach deposits found along the East Coast from North Carolina to Georgia. The Geological Survey collaborated with the Bureau of Mines in examining

[16] Mining Engineering, U. S. Vanadium's Uravan, Colo., Mill Doubles Output: Vol. 4, No. 11, November 1952, pp. 1025–1026.
[17] Work cited in footnote 3, p. 5.

several southeastern placer deposits. Detailed descriptions of the evaluation methods and analytical procedure employed by the Bureau were published.[18]

REFINER AND REACTOR PRODUCTION

Uranium.—Output of fissionable uranium–235 in 1952 was reported to have continued as scheduled. On July 15, 1952, the President signed an act appropriating funds for expanding the atomic energy program. To achieve the increased production goal for uranium–235 under the expanded program, additional plant capacity was scheduled at the Oak Ridge, Tenn., gaseous diffusion plant and at the gaseous diffusion plant under construction near Paducah, Ky., and a major new facility, also a gaseous diffusion plant to cost about $1,200,000,000, was planned for erection along the Scioto River, in Pike County, Ohio, about 22 miles north of Portsmouth.[19]

Plutonium.—Production of plutonium was reported to have continued as scheduled in 1952. Following presidential approval in July of the supplementary appropriation for the expansion of atomic energy capacity, work was begun at Hanford, Wash., on construction of additional reactors to increase the production of plutonium, and the number of such reactors planned for the Savannah River plant, under construction in Aiken and Barnwell Counties, S. C., was increased for the same purpose.[20] Reclamation of uranium, depleted partly in U–235 content, was indicated to be an important factor in the production of plutonium.[21]

Isotopes.—The AEC made 9,102 shipments of radioisotopes in 1952, an increase of 16 percent compared with the 7,825 shipments in 1951 (see table 3). From August 2, 1946, to December 31, 1952, over 32,000 shipments of radioisotopes and over 2,000 shipments of concentrated stable isotopes had been made. An additional 1,600 shipments of radioisotopes were made in the same period to 33 foreign countries.[22] The single largest selling isotope was iodine–131, with a total of over 12,000 shipments by the close of 1952, followed by phosphorus–32, with about 9,000 shipments. In tems of radioactivity shipped, cobalt–60 led the field, with about 2,200 curies (a curie is a quantity of radioactive material that disintegrates at the rate of 37 billion atoms per second); iodine–131 followed, with about 1,200 curies. Radioactive polonium–210 was initially produced for distribution by the AEC in 1952. The isotope, produced in a reactor by neutron bombardment of bismuth, was of higher purity than polonium derived from the radioactive decay of radium and was made in two forms: As a neutron source it was mixed with beryllium and enclosed in a cylinder of nickel and as an alpha source was plated on a strip of platinum.[23]

[18] Kline, Mitchell H., Evaluation of Monazite Placer Deposits: Atomic Energy Commission Rept. RMO-908, April 1952, 16 pp.
Kronstadt, R., and Eberle, Allan R., Analytical Procedure for the Determination of Thorium: Atomic Energy Commission Rept. RMO-838, January 1952, 9 pp.

[19] Works cited in footnote 2, p. 6, and footnote 3, pp. 11–12.
Atomic Energy Commission, AEC Announces New Gaseous Diffusion Plant To Be Located in Pike County, Ohio: Press release, Aug. 12, 1952, 4 pp.

[20] Works cited in footnote 2, p. 6, and footnote 3, p. 11.

[21] Flagg, John F., and Zebroski, Edwin L., Atomic Pile Chemistry: Sci. Am., vol. 187, No. 1, pp. 62–67.

[22] Work cited in footnote 3, p. 38.

[23] Atomic Energy Commission, Reactor-Produced Polonium Now Available for Purchase: Press release, Aug. 1, 1952, 2 pp.

TABLE 3.—Radioisotopes shipped by the U. S. Atomic Energy Commission, by kinds, 1946–52, in number of shipments

Radioisotope	1946 [1]	1947	1948	1949	1950	1951	1952	Total
Iodine-131	68	495	978	1,537	2,353	3,183	3,867	12,481
Phosphorus-32	48	537	901	1,420	1,736	2,112	2,101	8,855
Carbon-14	47	108	124	192	259	342	431	1,503
Sodium-24	1	80	119	229	286	176	363	1,254
Sulfur-35	12	39	41	108	125	168	163	656
Gold-198 and gold-199	17	52	29	36	164	268	431	997
Cobalt-60	4	32	30	64	137	190	147	604
Potassium-42	6	31	24	75	123	132	107	498
Calcium-45	5	42	33	68	89	111	104	452
Iron-55 and iron-59	5	41	33	54	68	67	149	417
Strontium-89 and strontium-90	3	9	18	19	46	62	94	251
Other	30	186	314	568	848	1,014	1,145	4,105
Total	246	1,652	2,644	4,370	6,234	7,825	9,102	32,073

[1] Shipped by Manhattan District, Corps of Engineers, U. S. Army Service Forces.

Radium.—Domestic production of radium was relatively small in 1952 and obtained largely from the retreatment of consumers' wastes. Radium and its derivatives were produced by the Canadian Radium & Uranium Corp., New York, N. Y. Radium-bearing residues, produced in the United States in processing ore from the Belgian Congo for the recovery of uranium, were reported to have been exported to Belgium for extraction of the radium at the Oolen refinery of the Société Générale Métallurgique de Hoboken.[24]

Thorium.—A moderate increase was indicated in the domestic production of thorium compounds (chiefly nitrate and oxide) in 1952; principal producers were Lindsay Chemical Co., West Chicago, Ill.; Maywood Chemical Works, Maywood, N. J.; and Rare Earths, Inc., Paterson, N. J. Commercial production of thorium metal in the United States was relatively small; principal producers were Westinghouse Electric Corp. (Lamp Division), Bloomfield, N. J., and Metal Hydrides, Inc., Beverly, Mass. Thorium production statistics are not available under the regulations of the Atomic Energy Act of 1946. Equipment capable of producing a pound of thorium metal a day by fused-salt electrolysis was reported to be in operation.[25]

CONSUMPTION AND USES

Weapons.—Production of atomic weapons continued at the rate authorized by the President for 1952, with research directed toward improvement of current weapon models and development of new models to meet the requirements of the Armed Forces. In October the Army demonstrated publicly at the Aberdeen Proving Ground, Maryland, its 280-mm. cannon, for which an atomic projectile was developed jointly by the Army and the AEC. Two separate series of tests were held in 1952 in connection with the weapons development program—one during April, May, and June at the Nevada proving ground near Las Vegas and the other during November at Eniwetok Atoll in the Pacific. Federal and State civil-defense officials and representatives of the press, radio, newsreel, and television services ob-

[24] Nucleonics, World Progress in Atomic Energy—Belgium: Vol. 10, No. 12, December 1952, pp. 9–11.
[25] Sibert, Merle E., and Steinberg, Morris A., Investigations for the Production of Thorium Metal by Fused-Salt Electrolysis: Horizons, Inc., Tech. Progress Rept., Cleveland, Ohio, July 31, 1952, 55 pp.

served one of the detonations in April from a point within the bounds of the proving ground. In the course of the Nevada tests the Armed Services familiarized troops with the effects of atomic explosions and conducted simulated combat maneuvers.[26]

Before the November tests the AEC announced that the Department of Defense and the Commission would conduct tests at Eniwetok in the autumn months looking toward the development of atomic weapons, and that the tests would be conducted under full security provisions of the Atomic Energy Act.[27] On November 16 the AEC announced that, in furtherance of the President's announcement of January 31, 1950, the test program included experiments contributing to thermonuclear research and that scientific executives for the tests had expressed satisfaction with the results.[28]

Industrial Power.—No impending industrial development probably ever received more consideration in the technical and public press and on the part of various organized bodies than that accorded in 1952 to the industrial application of atomic energy. Only selected references to the voluminous literature on the subject that appeared during the year can be cited here.[29] [30] Estimates as to when commercial application of atomic energy would be made ranged generally from 5 to 10 years or more.[31]

---

[26] Works cited in footnote 2, p. 13, and in footnote 3, pp. 15–16.

[27] Atomic Energy Commission, AEC and DOD Announce Tests To Be Held at Eniwetok: Press release, Sept. 9, 1952, 1 p.

[28] Atomic Energy Commission, Announcement by the Chairman, United States Atomic Energy Commission: Press release, Nov. 16, 1952, 1 p.

[29] Boskey, Bennett, The Atomic Energy Act and the Power Question: Nucleonics, vol. 10, No. 10, October 1952, pp. 10–13.

Cisler, Walker L., Electric Power Systems and Nuclear Power (Private Industry and Atomic Power: A Symposium): Bull. Atomic Scientists, vol. 8, No. 8, November 1952, pp. 279–282.

Evans, George E., Wanted: Better Materials for Nuclear Reactors: Iron Age, vol. 169, No. 11, Mar. 13, 1952, pp. 93–97.

Glasstone, Samuel, and Edlund, Milton C., The Elements of Nuclear Reactor Theory: D. Van Nostrand Co., New York, N. Y., 1952, 416 pp.

Hafstad, Lawrence R., Atomic Energy—When? Where? How Much: Chem. and Eng. News, vol. 30, No. 37, Sept. 15, 1952, pp. 3808–3815; Industry and Future Problems in Atomic Energy: Address before 57th annual Congress of American Industry, New York, N. Y., Dec. 5, 1952; The Future Reactor Program: Nucleonics, vol. 10, No. 3, March 1952, p. 17.

Isard, Walter, and Whitney, Vincent, Atomic Power: An Economic and Social Analysis: Blakiston Co., New York, N. Y., 1952, 235 pp.

Isbin, H. S., Nuclear Reactor Catalog: Nucleonics, vol. 10, No. 3, March 1952, pp. 10–16.

Koshuba, W. J., and Calkins, V. P., Engineering Principles and Metal Requirements for Atomic Power Plants: Metal Progress, vol. 62, No. 1, July 1952, pp. 97–114.

Pitzer, Kenneth S., Power Progress Too Slow (Private Industry and Atomic Power: A Symposium): Bull. Atomic Scientists, vol. 8, No. 8, November 1952, pp. 287–288.

Putzell, Edwin J., Jr., The Prospects for Industry (Private Industry and Atomic Power: A Symposium): Bull. Atomic Scientists, vol. 8, No. 8, November 1952, pp. 275–277.

Thirring, Hans, Is It Wise to Use Uranium for Power: Bull. Atomic Scientists, vol. 8, No. 6, August 1952, pp. 171, 205–206.

Weinberg, Alvin M., Wanted: Smaller and More Reactors: Nucleonics, vol. 10, No. 11, November 1952, pp. 31–32.

Zinn, W. H., Basic Problems in Central-Station Nuclear Power: Nucleonics, vol. 10, No. 9, September 1952, pp. 8–14.

Zuckert, Eugene M., Policy Problems in the Development of Civilian Nuclear Power (Private Industry and Atomic Power: A Symposium): Bull. Atomic Scientists, vol. 8, No. 8, November 1952, pp. 277-279.

Nucleonics, AEC May Build Dual-Purpose Central-Station Nuclear Power Plant in Nevada: Vol. 10, No. 9, September 1952, p. 66.

Atomic Energy Industrial and Legal Problems: University of Michigan Press, Ann Arbor, Mich., 1952, 280 pp.

Nucleonics, Progress Report on Industrial Power: Vol. 10, No. 12, December 1952, pp. 40–41.

Scientific American, The Breeder Reactor: Vol. 187, No. 6, December 1952, pp. 58–60.

[30] Joint Committee on Atomic Energy, Atomic Power and Private Enterprise: 82d Cong., 2d sess., December 1952, 415 pp.

[31] Dr. Charles A. Thomas, president, Monsanto Chemical Co., said in his address of Nov. 10, 1952, before the National Academy of Science, in St. Louis, Mo.: "* * * if the present law could be changed and incentive contractual arrangements made with industry, the commercial production of electric power from atomic reactors may be no more than 4 or 5 years away."

Dr. Arthur Compton, chancellor, Washington University, St. Louis, Mo., said on Dec. 2, 1952, at the Chicago University conference, commemorating the tenth anniversary of the operation of the first nuclear pile, held at the University of Chicago, Chicago, Ill.: "* * * I would be surprised if we do not have some actual commercial applications of atomic power within 10 years. Those will be in the more expensive power areas. In large scale production of power, on an economic basis, my guess would be closer to 50 years."

The reports on dual-purpose reactors submitted to the AEC by the first four industrial teams[32] to survey reactor technology were said by the AEC in 1952 to indicate that large reactors might be built in a few years that could furnish economic power to the systems of the utilities in the groups if weapon-grade plutonium were produced and bought by AEC at Hanford costs.[33] Although the reports remained classified through 1952, the four groups released some declassified information relative to their views, which follows, in part:[34]

Monsanto Chemical-Union Electric Group.—This group is not yet ready to invest its money in the building of a power reactor. It has proposed that the AEC build a pilot plant for preliminary experimental work. In addition, it prefers delaying building a reactor until a satisfactory solution is found to the legal problems of private ownership of nuclear power and limitations on private patent rights.

Detroit Edison-Dow Chemical Group.—This group has made the very important statement that it does not feel that a definite price must be established in advance for the sale of byproduct plutonium, although it does not overlook the need to sell plutonium. * * * The objective of this group is the development of a fast breeder reactor * * * A principal objective of the group has been the selection of an approach consistent with the long-range requirements but capable of early development. * * * They believe that the best approach is early construction of a full-size unit.

Commonwealth Edison-Public Service Group.—This group feels that a large-scale project would be necessary to average down costs to achieve economic justification. Because utilities do not have venture capital, these companies feel that the Government should pay for the reactor part of the nuclear power plant and the companies should pay for the conventional power facilities outside of the reactor.

Bechtel Corp.-Pacific Gas & Electric Group.—This group has only stated that it is interested in breeder-type reactors.

In April 1952 the AEC announced that the Detroit Edison-Dow Chemical group, the first to report on the technology survey, would undertake an additional year of research and development.[35] Subsequently the AEC agreements with the other three groups were also extended. The AEC announced in September that it had approved a year's survey of reactor technology by a fifth group, comprising the Pioneer Service & Engineering Co. of Chicago and the Foster Wheeler Corp. of New York,[36] and in October that it had approved the association of the 11 following utility and industrial concerns with the Detroit Edison-Dow Chemical group: Cincinnati Gas & Electric Co., Cleveland Electric Illuminating Co., Consolidated Edison Co. of New York, Consumers Power Co., General Public Utilities Corp., New England Electric System, Philadelphia Electric Co., Public Service Electric & Gas Co. of New Jersey, Toledo Edison Co., Vitro Corp. of America, and Wisconsin Electric Power Co.[37]

During September, October, and November 1952 the Joint Committee on Atomic Energy, in a survey of atomic power developments, held 36 discussions with 82 individuals representing 36 private organi-

---

[32] Monsanto Chemical Co. and Union Electric Co., both of St. Louis; Detroit Edison Co., of Detroit, and Dow Chemical Co., of Midland, Mich.; Commonwealth Edison Co. and Public Service Co. of Northern Illinois, both of Chicago; and Bechtel Corp. and Pacific Gas & Electric Co., both of San Francisco.

[33] Work cited in footnote 3, p. 23.

[34] Nucleonics, Progress Report on Industrial Nuclear Power: Vol. 10, No. 12, December 1952, pp. 40–41.

[35] Atomic Energy Commission, AEC Accepts Dow-Detroit Edison Proposal for Continuation of Nuclear Power Production Study: Press release, Apr. 22, 1952, 2 pp.

[36] Atomic Energy Commission, AEC Accepts Pioneer Service—Foster Wheeler Proposal to Conduct Nuclear Power Production Study: Press release, Sept. 14, 1952, 2 pp.

[37] Atomic Energy Commission, 11 Companies to Join Dow-Detroit Edison for Joint Studies of Nuclear Power: Press release, Oct. 18, 1952, 3 pp.

zations and the Federal Government.[38] The survey was predicated on the assumption that (1) atomic power is technically feasible but of unknown economic interest, (2) it is important to explore fully the desirability of utilizing atomic energy for generation of electricity in the foreseeable future, and (3) the present rate of progress in this field suggests that some undetermined factors in the existing policy, managerial, legal, economic, and defense situation tend to prevent aggressive development. A record of the discussions, with many related data on the subject of atomic power, was assembled in a report by the Joint Committee.[39]

The National Security Resources Board recommended that the President direct the Atomic Energy Commission in consultation with the United States Department of the Interior and the Federal Power Commission, as well as other interested agencies, to draft for submission to the Congress an amendment to the Atomic Energy Act specifying the conditions—including patent rights, availability of fissionable materials, and allocation of costs between industrial power and weapons—under which private interests could operate commercially to benefit from their atomic power research, development, and production.[40]

The AEC announced on May 1, 1952, establishment of an Office of Industrial Development at its Washington, D. C., headquarters. The purpose of the new office was to aid in administering the industrial participation program, and to expand the areas in which all types of industry might find an interest in the national atomic energy program.[41]

The materials-testing reactor, constructed at the Commission's reactor-testing station near Arco, Idaho, became "critical" on March 31, 1952, was brought up to full power in May, and was put into service in August by the operating contractor. Effects of intense radiation on materials considered for use in structures, heat-transfer systems, and shields of new reactors will be studied with the materials-testing reactor, which contains more than 100 ports for the insertion of specimens to be exposed to neutron bombardment. Although the reactor operates primarily on thermal, or slow, neutrons, it can also subject specimens to neutrons with intermediate and fast energies.[42]

Criticality was reached on April 15, 1952, by the homogeneous reactor constructed at the Oak Ridge National Laboratory. The reactor was operated at low power in experiments to determine nuclear characteristics. Inasmuch as it is the first circulating fuel reactor, these data were considered especially important.[43] The first non-AEC reactor, known as the Raleigh research reactor, was under

---

[38] Nucleonics, Joint Congressional Committee Holds Series of Meetings on Atomic Energy; Discuss Atomic Power at Length: Vol. 11, No. 1, January 1953, p. 74.
Bulletin of the Atomic Scientists, Atomic Power and Private Enterprise—a Summary of the Joint Committee Report: Vol. 9, No. 4, May 1953, pp. 135–140, 144.
Atomic Energy Newsletter, vol. 8, No. 11, Jan. 13, 1953, p. 2.
[39] Work cited in footnote 30.
[40] National Security Resources Board, The Objectives of United States Materials Resources Policy and Suggested Initial Steps in Their Accomplishment, A Report by the Chairman of the National Security Resources Board Based on the Report of the President's Materials Policy Commission and Federal Agency Comments Thereon: Dec. 10, 1952, 101 pp.
[41] Atomic Energy Commission, AEC Establishes Office of Industrial Development Headed by Dr. William Lee Davidson: Press release, May 1, 1952, 2 pp.
[42] Atomic Energy Commission, New Testing Reactor Put Into Operation: Press release, Apr. 4, 1952, 2 pp.
Works cited in footnote 2, p. 14, and footnote 3, p. 20.
[43] Works cited in footnote 2, p. 17, and footnote 3, p. 20.

construction during 1952 by Consolidated Universities of North Carolina on the campus of North Carolina State College at Raleigh. Of the homogeneous type and generally similar to the water-boiler reactor at the Los Alamos Scientific Laboratory, the reactor will have a maximum capacity of 10 kilowatts.[44]

Construction of the land-based prototype of the submarine thermal reactor and power plant (see Uranium, Radium and Thorium chapter Minerals Yearbooks 1950 and 1951) was substantially completed in 1952 at the reactor testing station, Arco, Idaho. Work was also begun on the second submarine thermal reactor power plant destined for installation in the U. S. S. *Nautilus*.[45] Fabrication of the land-based prototype of the submarine intermediate reactor and its power plant, through the Knolls Atomic Power Laboratory at Schenectady, N. Y., began in 1952. Construction at West Milton, N. Y., 18 miles north of Schenectady, of the portion of the submarine hull in which the prototype nuclear power plant will be assembled and of the 225-foot-diameter spherical steel building to house the hull and reactor complex was well advanced at the close of the year.[46] In July 1952 the Department of the Navy announced that construction of a second nuclear submarine, the U. S. S. *Sea Wolf*, to be powered by the second model of the intermediate reactor, had been authorized.

Construction, at the reactor testing station in Idaho, of facilities related to eventual development of nuclear propulsion for aircraft was announced by the AEC in July 1952. Design and development of an aircraft propulsion reactor were in progress at Lockland, Ohio.[47] The Corps of Engineers, United States Army, was reported to be interested in possible military applications of nuclear power, particularly at overseas bases in the event of war and at permanent installations, such as those in the Arctic and other difficultly accessible regions.[48]

The third session of the Oak Ridge School of Reactor Technology opened in September 1952 with a record enrollment of 80 students. Thirty-one were student employees of Oak Ridge National Laboratory recruited from universities in the United States. The remaining 49 were on loan from industrial organizations and various Government agencies.[49]

Isotopes.—Over 1,100 institutions in the United States had been authorized to receive AEC-produced radioisotopes by the end of 1952, and over 300 institutions had been approved to receive concentrated stable isotopes. Industrial firms led the list of users, followed in order by medical institutions and physicians, colleges and universities, Federal and State laboratories, and private research laboratories.[50] The demand for isotopes has risen at a steady rate

---

[44] Work cited in footnote 2, p. 15.

[45] Work cited in footnote 2, p. 21.
Wallin, Homer N., and Derieux, James C., America's New Dreadful Weapon: Collier's, Dec. 20, 1952, pp. 13–16.

[46] Work cited in footnote 3, p. 22.
Life, Biggest Sphere for Atomic Sub Engine: Vol. 33, No. 24, Dec. 15, 1952, pp. 113-114.

[47] Atomic Energy Commission, AEC Announces Aircraft Propulsion Project for Reactor Testing Station: Press release, July 29, 1952, 1 p.

[48] Nucleonics, Army May Build Nuclear Power Plant: Vol. 10, No. 12, December 1952, p. 82.

[49] Nucleonics, Students at ORSORT Session Represent 16 Companies: Vol. 10, No. 11, November 1952, p. 105.

[50] Work cited in footnote 3, p. 38.
Aebersold, Paul C., Radioisotopes—Production, Distribution, and Utilization; Chap. in Atomic Energy Industrial and Legal Problems: University of Michigan Press, Ann Arbor, Mich., 1952, pp. 17–55.

each year (see table 3). No indication of leveling off is apparent in year-to-year figures on shipments which in 1952 were about 25 percent of shipments in the entire 6½ years of the program. Reactor-produced polonium-210, distributed by the AEC in 1952 for the first time, was not available in sufficient quantity to be used in luminous phosphors, static elimination devices, and other industrial purposes.[51]

The radioisotope, often referred to as the greatest new investigative tool since the microscope, seemed well on its way in 1952 to becoming as widely used.[52] Although more extensively employed in research than in applied fields, the use of radioisotopes in industry was shown to be expanding markedly, both as radiation sources and as tracers.[53] [54] In a review of their use in mineral-dressing research, radioisotopes were shown to have a wide range of application.[55] Development of a radioisotope battery with possibilities as a compact power source for industrial battery trucks, jet planes, and other applications was announced.[56]

Radium.—The quantity of radium sold for medical use in 1952 about equaled that sold in 1951; but the quantity under lease for such use increased substantially, principally in connection with the demand for multicurie lots for teletherapy. A moderate increase was reported in the quantity of radium under lease for radiographic use. Sales of radium salts in significant quantities were made in 1952 in the form of light sources, luminous compounds, static-elimination equipment, and radiation sources. Indications were that the use of radium salts in the clock and watch industry and the aircraft-instrument industry would decrease and that luminous markers for military applications would be made with radioactive isotopes rather than with radium. Possible application of static-elimination equipment was suggested in industrial grinding operations to avoid the use of additives and in the processing of metal powders that involves sieving, passage down a chute, or pneumatic carriage through ducts.[57] Demand for radium-bearing slimes, produced in the processing of uranium ores and used in oil-well casing as a marking compound, was steady in 1952 and totaled about 5,000 pounds. Practical applications of radiography in industry were reviewed in detail.[58]

---

[51] Work cited in footnote 23, p. 1.
[52] Aebersold, Paul C., Address before the American Management Association: Cleveland, Ohio, Dec. 4, 1952.
[53] O'Keefe, Philip, Where Radioisotopes Are Finding Industrial Use: Materials & Methods, vol. 36, No. 3, September 1952, pp. 87–89.
Technical Information Service, U. S. Atomic Energy Commission, Radioisotope Applications of Industrial Significance: Rept. TID-5078, Office of Tech. Services, U. S. Dept. of Commerce, Wash., D. C., April 1952, 89 pp.
Mining World (London), Use of Radioactive Isotopes in Industry: Vol. 238, No. 6090, May 9, 1952, pp. 473–474.
Engineering Extension Service and Institute for Atomic Research, Iowa State College, Second Annual Conference on Use of Radioisotopes in Industry: Ames, Iowa, April 30, 1952.
[54] Clauser, H. R., Practical Radiography for Industry: Reinhold Publishing Corp., New York, N. Y., 1952, 301 pp.
[55] Carr, John S., Radioactive Isotopes in Mineral-Dressing Research: Atomic Energy Research Establishment, Harwell, England, Rept. 912, 1952, 30 pp.
Gaudin, A. M., and Chang, C. S., Adsorption on Quartz, From an Aqueous Solution, of Barium and Laurate Ions: Min. Eng., vol. 4, No. 2, February 1952, pp. 193–201.
[56] E&MJ Metal & Mineral Markets, vol. 23, No. 38, Sept. 18, 1952, p. 7.
[57] Graves, J. D., Metals in Radioactive Static Eliminators: Met. Prog., vol. 62, No. 5, November 1952, pp. 94–96.
[58] Work cited in footnote 54.

TABLE 4.—Consumption of uranium and thorium compounds for nonenergy purposes in the United States, 1948-52, in pounds of contained U_3O_8 and ThO_2

[U. S. Atomic Energy Commission]

Industry	1948	1949	1950	1951	1952
URANIUM (U_3O_8 EQUIVALENT)					
Chemical (including catalytic)	1,993	2,426	2,835	2,016	3,048
Ceramic (including glass)	385	270	938	875	1,627
Photographic	225				
Electrical	200	103	33	88	226
Total U_3O_8	2,803	2,799	3,806	2,979	4,901
THORIUM (ThO_2 EQUIVALENT)					
Gas-mantle manufacture	36,697	44,621	48,471	31,132	25,427
Refractories and polishing compounds	1,634	1,847	1,889	3,382	1,157
Chemical and medical	1,767	596	2,097	6,246	11,064
Electrical	427	237	314	1,457	277
Total ThO_2	40,525	47,301	52,771	42,217	37,925

Thorium.—Domestic consumption of thorium compounds for nonenergy purposes decreased 10 percent in 1952 compared with consumption in 1951. As indicated in table 4, consumption for chemical and medical purposes was the only category of utilization that increased in 1952, an increase that was more than offset by decreased consumption in the manufacture of gas mantles, refractories and polishing compounds, and electrical equipment. A relatively small quantity of thorium metal, in the form of powder and sheet, was consumed in 1952 in the manufacture of electronic tubes, starter sheet for sun lamps, and alloys with other metals. Canada was reported to be producing uranium–233 in small quantities and operating a plant for separating it from irradiated thorium.[59]

PRICES

Uranium Ore.—Prices paid by the AEC in 1952 for uranium were the same as in 1951 (see Uranium, Radium and Thorium chapter, Minerals Yearbook, 1951). Three new ore-buying stations were established by the AEC in 1952, and plans for another were announced. The new station at Shiprock, N. Mex., which began receiving ores on January 7, 1952, was established primarily to purchase uranium-vanadium ores mined in the Lukachukai area of the Navajo Indian Reservation in northeastern Arizona.[60] In June the new station, situated 8 miles west of Grants, N. Mex., began buying ore mined in that general area.[61] A market for the uranium ores mined in the Black Hills area of South Dakota and adjacent areas in Wyoming was provided by the new station established at Edgemont, S. Dak., which began accepting ore on December 1, 1952.[62] Plans for the

[59] Nucleonics, vol. 10, No. 10, October 1952, p. 83.
[60] Atomic Energy Commission, AEC Announces Opening of Ore-Buying Station at Shiprock, N. Mex.: Press release, Grand Junction, Colo., Jan. 17, 1952, 1 p.
Work cited in footnote 2, p. 3.
[61] Engineering and Mining Journal, vol. 153, No. 8, August 1952, p. 139.
Work cited in footnote 3, p. 6.
[62] Atomic Energy Commission, Atomic Energy Commission Opening Uranium-Ore-Buying Station at Edgemont, S. Dak.: Press release, Grand Junction, Colo., Nov. 30, 1952, 1 p.
Work cited in footnote 3, p. 6.

construction early in 1953 of a new station near Green River, Utah, to stimulate production of uranium ore in southeastern Utah, were announced by the AEC toward the close of 1952.[63]

Uranium.—Small quantities of high-purity uranium metal were available throughout 1952 to AEC licensees at about $50 a pound. The metal, in the form of pencil-size rods about 4 inches long, was produced by Mallinckrodt Chemical Co., St. Louis, Mo., and distributed to all the major chemical companies, from which the metal was available to the licensees in its original rod form, as rolled sheets, or as foil.

Radium.—Radium was quoted throughout 1952 at $20 to $25 per milligram of radium content, depending on quantity; one source, however, offered radium element throughout the year at $16 to $21.50 per milligram, depending on quantity.

Isotopes.—Isotopes were available in 1952 through the Isotopes Division of the AEC in a slightly wider range than in 1951, with prices mostly unchanged.[64] In August 1952 the AEC announced the availability of polonium–210 and polonium-beryllium neutron sources for physical and biological research. Through its facilities at the Oak Ridge National Laboratory, the AEC offered in 1952 to industry and other interested groups a routine service of neutron activation analysis. Depending on the type of sample to be irradiated and the element for which analysis was made, the service cost about $20 to $70.[65] Beginning July 1, 1952, the AEC adopted a charge of 20 percent of production costs for radioisotopes to be used in the study, diagnosis, or treatment of cancer. In the first half of 1952 the AEC continued its earlier policy of making radioisotopes available for cancer studies and treatment free of charge for production costs.[66]

Thorium.—Thorium metal, in the form of powder, unsintered bars, sintered bars, sheet—0.005 inch and over, and sheet—0.002 to 0.0049 inch, was quoted in 1952 by one producer, f. o. b. producer's plant, in lots of less than 200 grams per item, at 45, 50, 65, 75, and 85 cents per gram, respectively; and, in lots of 200 grams or more per item, at 35, 40, 50, 60, and 70 cents per gram, respectively.

Average prices in 1952 for thorium nitrate and oxide were reported by a large producer, in 100-pound lots, f. o. b. producer's plant, as follows: Thorium nitrate, mantle grade—domestic price $2,20, export $3.35 per pound; thorium oxide, 97 percent ThO_2—domestic price $5.25 per pound; thorium oxide, photographic-lens grade, 99 percent ThO_2—domestic price $7.63 per pound.

FOREIGN TRADE [67]

Foreign uranium production and procurement programs, the AEC reported, progressed at a satisfactory rate in 1952, and plans for expansion and the development of new sources were underway.[68] The

[63] Engineering and Mining Journal, vol. 153, No. 10, October 1952, p. 153.
Work cited in footnote 3, p. 6.

[64] Atomic Energy Commission (Isotopes Division, Oak Ridge, Tenn.), Isotopes: Catalog and Price List 4, March 1951, 75 pp.

[65] Work cited in footnote 3, pp. 38–39.

[66] Atomic Energy Commission, AEC Will Charge 20 Percent of Production Cost for Radioisotopes Used in Cancer Studies: Press release, June 4, 1952, 3 pp.
Work cited in footnote 2, pp. 32–33.

[67] Figures on imports and exports (unless otherwise indicated) compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

[68] Work cited in footnote 3, p. 5.

major part of the foreign uranium received during the year came from Belgian Congo and Canada. Exports of radioisotopes by the AEC in the year ended November 30, 1952, totaled 422 shipments distributed among 24 different countries. Principal recipients, in order of decreasing number of shipments, were Japan, Canada, Brazil, and Cuba.[69] Data are not disclosed on imports and exports of uranium and thorium ores, concentrates, metal, alloys, and compounds.

The Atomic Energy Control Board of Canada reported nearly 1,000 shipments of over 70 different isotopes in the year ended March 31, 1952, including shipments to the United States, Great Britain, and various countries in western Europe and South America. Demand for cobalt isotopes was said to exceed facilities to produce them.[70]

The Atomic Energy Research Establishment, Harwell, England, shipped 3,053 consignments of radioactive isotopes, all by air transport, to 37 countries in the year ended June 30, 1952. The quantity was sufficient to cause British Overseas Airways Corp. to convert a fleet of Argonaut planes for wing-tip carrying, thus reducing transportation costs by more than 50 percent as the use of heavy lead containers was thereby avoided.[71]

As indicated in table 5, imports of radium salts and of radioactive substitutes increased markedly in 1952. A major part of the radium salts came from Belgium and consisted primarily of a multicurie source for use in teletherapy and supplies to augment stocks held in the United States. The increased imports of radioactive substitutes resulted largely from the receipt of several large sources of radioactive cobalt and iridium from Canada for use in radiography and teletherapy. Exports of radium by the United States in 1952 totaled 1,143 milligrams, valued at $25,368; Canada, Italy, and Brazil, in that order, were the principal recipients.

TABLE 5.—Radium salts imported for consumption in the United States, 1948–52

[U. S. Department of Commerce]

Year	Radium salts			Radioactive substitutes (value)
	Milligrams	Value		
		Total	Average per gram	
1948	77,018	$1,385,337	$17,900	$6,273
1949	98,032	1,719,656	17,500	370
1950	80,969	1,235,511	15,300	6,106
1951	89,805	1,225,564	13,600	5,399
1952	173,711	2,873,688	16,500	85,849

WORLD REVIEW

During 1952 the Disarmament Commission of the United Nations made little progress toward agreement between the free and the Cominform world on disarmament.[72] On January 11, the Sixth

[69] Work cited in footnote 3, p. 147.
Atomic Energy Commission, Eleventh Semiannual Report (Some Applications of Atomic Energy in Plant Science): January 1952, p. 151.
[70] Atomic Energy Control Board of Canada, Sixth Annual Report, 1951–52: Ottawa, Canada, 1952, 11 pp.
[71] Atomics (London), vol. 3, No. 11, November 1952, pp. 273–274.
Atomic Scientists News, vol. 2, No. 2, November 1952, p. 111.
[72] Cohen, Benjamin V., Whither Disarmament?: Department of State Bull., vol. 28, No. 710, Feb. 2, 1953, pp. 172–176.

342070—55——70

General Assembly of UN adopted the resolution presented by the First Committee on December 19, 1951, directing the Disarmament Commission to prepare proposals on the general subject of disarmament (see Uranium, Radium and Thorium chapter, Minerals Yearbook, 1951). The Commission convened at UN headquarters in New York on March 14, 1952, and on that date the United States presented a proposed plan of work, suggesting the five following major subjects for consideration: [73]

1. A verified census of all troops and arms, including atomic weapons.
2. Limitation of armaments, and elimination of atomic weapons and all instruments adaptable to mass destruction.
3. Negotiation of agreements on troops and arms permitted each state.
4. Enforcements and safeguards.
5. Procedure and timing of program.

Discussion of the work plan and of various proposals brought before the Commission prevailed throughout 1952. Shortly after the close of the year the United States joined with other states in cosponsoring a resolution continuing the Commission and requesting it to report to the General Assembly and to the Security Council no later than September 1, 1953.[74]

The military committee of the 14-nation North Atlantic Treaty Organization announced in December 1952 that an agreement had been reached on the use of atomic weapons in a revised strategic plan for the defense of Europe. Explanation was made that some of Europe's military leaders, feeling that financial resources would not permit NATO to meet its target of 98 divisions by the end of 1954, were looking toward atomic weapons as a means of reducing the demands for armed manpower.[75]

As a result of recommendations by delegates from the United States, United Kingdom, and Canada to the Fifth International Declassification Conference, held in Washington, D. C., during the fall of 1951, the AEC in April 1952 authorized declassification of additional data on the nuclear properties of uranium useful in the understanding of low-power nuclear reactors for atomic research. The information declassified included values for the fast fission constants for natural uranium and the resonance-absorption integral for natural uranium and its oxides, as well as the numerical values of the thermal neutron fission and capture cross sections for plutonium. Disclosed also was the fact that 3 neutrons are released per plutonium fission, as compared with 2½ neutrons released by uranium–235 under similar conditions. In addition, the thermal neutron absorption cross section of xenon–135 was declassified.[76] During the latter half of 1952 the AEC declassified all information on the "isotron" method of isotope separation and much of the technical information relating to the electromagnetic method of separation. The isotron method was

[73] Department of State Bulletin, Summary of Proposals Made to the Disarmament Commission: Vol. 27, No. 696, Oct. 27, 1952, p. 648.
[74] Gross, Ernest A., Disarmament as One of the Vital Conditions of Peace: Department of State Bull., vol. 28, No. 718, Mar. 30, 1953, pp. 476–479.
[75] Washington (D. C.), Post No. 27,938, Dec. 12, 1952, p. 1.
[76] Atomic Energy Commission, United States, United Kingdom and Canada, Release Additional Information Concerning Research Reactors. Press release, Apr. 7, 1952, 2 pp.
Work cited in footnote 2, p. 48.

not developed to the stage where it could be used to produce significant quantities of fissionable materials. The electromagnetic method was used during the war to produce uranium–235 but is now used to produce stable isotopes for research.[77]

A catalog of nuclear reactors published in 1952 indicated that over 20 reactors were in operation throughout the world, with 10 additional reactors in advanced stages of design or construction. At least 12 reactors were in operation in the United States, 4 in England, 2 in Canada, 1 in France, and 1 in Norway; a plutonium plant was said to be in operation in Russia.[78]

NORTH AND SOUTH AMERICA

Brazil.—A program of countrywide prospecting for uranium and thorium was begun in Brazil in 1952. Scintillometer aerial surveys were employed, and interesting deposits of uranium- and thorium-bearing minerals were found in the States of Minas Gerais and Espirito Santo.[79]

Canada.—Design and construction of the new C$30,000,000 heavy-water reactor, Canada's third, continued at Chalk River, Ontario, in 1952. Completion of the reactor, known as NRU, was scheduled for 1954 or 1955.[80] On December 12, 1952, the nuclear reactor at Chalk River, known as NRX, ruptured, and leakage of dangerously radioactive water necessitated evacuation of all workers at the laboratories there. The accident was attributed to corrosion of the aluminum tubes that carry cooling water to the uranium rods. A shutdown of the reactor for several months was anticipated.[81]

Establishment of a new Crown company, Atomic Energy of Canada, Ltd., was announced on February 13, 1952, to take over operation on April 1, 1952, of the Chalk River atomic energy project operated formerly by the National Research Council of Canada. The action was based on an expected increase in operations at Chalk River when reactor NRU is completed and on promising prospects for the early industrial application of atomic energy.[82] On July 25, 1952, announcement was made that radioisotopes produced at Chalk River, marketed formerly by the Crown company Eldorado Mining & Refining, Ltd., would be marketed, beginning August 1, 1952, by Atomic Energy of Canada, Ltd.[83]

Additional incentive to the search for radioactive ores in Canada was provided on May 6, 1952, when the Canadian Government extended from March 31, 1960, to March 31, 1962, the guarantee period for the purchase of uranium in ores and concentrates at a minimum price.[84]

In 1952 the mine of Eldorado Mining & Refining, Ltd., at Port Radium on the east shore of Great Bear Lake, in the Northwest

---

[77] Work cited in footnote 3, p. 47.
[78] Isbin, H. S., Nuclear Reactor Catalog: Nucleonics, vol. 10, No. 3, March 1952, pp. 10–16.
[79] Nucleonics, World Progress in Atomic Energy—Brazil: Vol. 10, No. 12, December 1952, pp. 31–33. Mining Journal (London), vol. 238, No. 6089, May 2, 1952, p. 446.
[80] Nucleonics, World Progress in Atomic Energy—Canada: Vol. 10, No. 12, December 1952, pp. 26–28.
[81] Chemistry and Industry (London), No. 6, Feb. 7, 1953, p. 122. Bulletin of the Atomic Scientists, vol. 9, No. 1, February 1953, p. 30.
[82] Office of the Prime Minister, Ottawa, Canada, Press Release: Feb. 13, 1952, 3 pp. Atomic Energy Control Board of Canada, Sixth Annual Report, 1951–52: 12 pp.
[83] Department of Defense Production, Ottawa, Canada, Press Release: July 25, 1952, 2 pp. Northern Miner, vol. 38, No. 19, July 31, 1952, p. 6 (806).
[84] Northern Miner, vol. 38, No. 7, May 8, 1952, p. 16 (508).

Territories, was again the source of virtually all the uranium ore produced in Canada. The crushing plant and mill at the property, destroyed by fire on November 9, 1951, were rebuilt and placed in operation in May 1952. A new leaching plant was completed and began treating mill tailings the same month. Although ore-treatment facilities were not available for almost 5 months in 1952, total uranium output was only slightly less than that in 1951 owing to the additional production made possible in 1952 by the new leaching plant. Development footage and exploratory diamond drilling totaled 8,186 and 49,759 feet, respectively, compared with 13,101 and 54,715 feet in 1951. Estimates made at the close of 1952 indicated that ore reserves were being maintained.[85]

At Hottah Lake, about 60 miles south of Great Bear Lake, Indore Gold Mines, Ltd., continued in 1952 underground exploration of its Pitch 8 group of claims and erected a 20-ton mill on the property. Toward the close of the year the company reported that production had begun and that mill capacity would be increased to 50 tons a day. Indore was said to be the first privately owned uranium company in Canada to reach the production stage since the end of World War II.[86] [87]

The most active uranium area in Canada in 1952 was the Goldfields (Beaverlodge) region, immediately north of Lake Athabaska, in northwest Saskatchewan, where several of the larger companies were completing initial exploration and development in preparation for ore-production operations early in 1953.[88] Eldorado Mining & Refining, Ltd., the principal company operating in the area, carried out an extensive program in 1952 that included preparation of stopes on the second, third, and fifth levels in the west ore body of the Ace mine and 4,924 feet of lateral development on the third, fourth, and fifth levels, which resulted in addition of a substantial quantity of new ore to the reserves of the property. The 5-compartment production shaft of the Fay zone was extended from a depth of 72 feet to the eighth level, at a depth of 1,079 feet. Driving of a haulageway on the sixth level of the Ace mine to connect with the production shaft was virtually completed as the year closed. A total of 490 feet of drifting was accomplished in the Fay and Ura zones after completion of 711 feet of crosscut from the second level of the production shaft. A concentrator, with an initial capacity of 500 tons a day but designed for expansion to 2,000 tons, was scheduled to be ready for production by April 15, 1953, and for the acceptance of custom ores.[89]

Private companies engaged in underground development during 1952 in the Goldfields (Beaverlodge) region included Nesbitt LaBine Uranium Mines, Ltd., which completed a three-compartment shaft on the Eagle Ace group of claims adjoining the Eldorado property on the north; Rix Athabaska Uranium Mines, Ltd., which started a three-compartment shaft in the second half of 1952 on the DD–L concession; Pitch-Ore Uranium Mines, Ltd., with an adit on claims south of the west end of the Eldorado property; Beaver Lodge

[85] Eldorado Mining & Refining, Ltd., Annual Report for the Year Ended Dec. 31, 1952: 12 pp.
[86] Lang, A. H., Uranium in Canada 1952: Canadian Min. and Met. Bull., vol. 46, No. 493, May 1953, pp. 309–314.
[87] Mining World, vol. 14, No. 13, December 1952, p. 72.
[88] Work cited in footnote 86.
[89] Work cited in footnote 85.

Uranium, Ltd., with an adit on claims in the Beaverlodge area; and National Explorations, Ltd., with an inclined shaft on the Pal group of claims in the Beaverlodge area. Companies engaged in surface exploration included Leadridge Mining Co., subsidiary of St. Joseph Lead Co.; Mining Corp. of Canada, Ltd.; Baska Uranium Mines, Ltd.; Goldfields Uranium Mines, Ltd.; Beta Gamma Mines, Ltd.; Dee Explorations, Ltd.; and Charlebois Lake Uranium Mines, Ltd. Gunnar Gold Mines, Ltd., discovered a substantial low-grade uranium deposit as the year closed.[90]

Much less activity prevailed in Ontario in 1952 in the search for uranium than in the last few years. An interesting discovery was made in November on the Manitou Islands in Lake Nipissing, near North Bay. Inspiration Mining & Development, Ltd., was said to have acquired an interest in the area.[91] An airborne scintillometer survey was made in 1952 of 575 square miles in the Sudbury district.[92] Uranium activity in British Columbia in 1952 was centered in the North Thompson region, principally at the property of Rexspar Uranium & Metals Mining Co., Ltd., about 70 miles north of Kamloops, where drilling and bulk sampling were in progress with the view of establishing a fluorite-uranium-rare earths operation.[93]

Successful methods used in searching for uranium deposits in Canada were described.[94] The original pitchblende in the Goldfields area was said to have been deposited apparently at relatively high temperatures and therefore is not restricted to a relatively shallow vertical range.[95] A summary of information on Canadian deposits of uranium and thorium was published that discussed the types and distribution of the deposits, age and origin of mineralization, the various areas, and individual properties.[96]

Chile.—The finding of uranium minerals in Chile during 1952 led to a further search for radioactive deposits in many Chilean mining districts.[97] The presence of possible deposits of uranium in the provinces of Atacama and Coquimbo was announced.[98]

EUROPE

The European Council for Nuclear Research was founded at Geneva in February 1952 by representatives of Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Sweden, Switzerland, and Yugoslavia. The Council decided upon three building projects—namely, a central laboratory for nuclear research, a 30-Bev cosmotron, and a 600-Mev synchrocyclotron.[99] At a conference held at Amsterdam on October 6, the Council selected Geneva as the site for the

[90] de Wet, J. P., Mineral Development in Saskatchewan in 1952: Canadian Min. Jour., vol. 74, No. 2, February 1953, pp. 83–88.

[91] Work cited in footnote 86.
Browning, J. C., Ontario Annual Review—1952: Canadian Min. Jour., vol. 74, No. 2, February 1953, pp. 94–100.

[92] Mining Engineering, vol. 5, No. 2, February 1953, p. 152.

[93] Work cited in footnote 86.
Northern Miner, vol. 38, No. 14, June 26, 1952, pp. 17–18.

[94] Lang, A. H., Uranium Ore Bodies—How Can More Be Found in Canada?: Canadian Min. Jour., vol. 73, No. 6, June 1952, pp. 57–65.

[95] Robinson, S. C., The Occurrence of Uranium in the Lake Athabaska Region: Canadian Min. and Met. Bull., vol. 45, No. 480, April 1952, pp. 204–207.

[96] Lang, A. H., Canadian Deposits of Uranium and Thorium (Interim Account): Canada Geol. Survey, Econ. Geol. Series 16, Ottawa, Canada, 1952, 173 pp.

[97] Engineering and Mining Journal, vol. 153, No. 2, February 1952, p. 190.

[98] Mining World, vol. 14, No. 4, April 1952, p. 59.

[99] Nucleonics, World Progress in Atomic Energy—Europe: Vol. 10, No. 12, December 1952, pp. 8–9.

nuclear research laboratory. Two factors favoring selection of the Swiss site, rather than those in France, Denmark, and the Netherlands, were the country's neutrality in the event of war and the availability of a large quantity of electric energy.[1]

France.—The second French nuclear reactor began operation at Saclay in early November 1952.[2] Known as P–2, the Saclay pile is a 1,500-kw. heavy-water reactor that will be capable of producing 300 to 400 grams of plutonium per year when placed in full operation. Plutonium production will, however, be secondary to isotope production and research. The cooling system of the new reactor is unique, in that nitrogen gas compressed to 10 times atmospheric pressure is used as the cooling medium. More power is said to be produced per ton of uranium with the new coolant than is possible with the other types in use.[3]

La Crouzille, in Haut Vienne, was the principal center of uranium-mining operations in France in 1952; production was expected to begin in 1953 at Grury, in Saône et Loire.[4]

Germany, West.—Uranium deposits in abandoned silver-nickel mines at Wittichen, near Freiburg, were considered by the Geological Institute of Baden to be worth mining. The ores were said to contain over 0.1 percent uranium, with the grade improving with depth.[5] Deposits of uranium were reported to have been found near Weissenstadt, and in the fluorspar mines at Woelsendorf and Nabburg.[6]

Italy.—An occurrence of uranium was reported to have been discovered at Savona Sair, near Genoa.[7]

Norway.—In the latter part of 1952 the 300-kw., heavy-water reactor at Kjeller began operating day and night to provide isotopes for medical and industrial use, principally cobalt–60.[8]

Sweden.—A shale deposit containing small lumps of hydrocarbon known as kolm was mined and milled in 1952 at Kvarntorp in connection with the earlier development of a process for recovering uranium from shale. Uranium content of the shale itself was about 200 grams per metric ton whereas the kolm contained up to 3,000 grams per ton. Separation of the kolm from the shale was accomplished by sink-and-float methods at a local concentration plant.[9]

The richest uranium deposit discovered in Sweden was reported to have been found at Skovde, near Billingen, in the form of a huge seam of kolm-bearing shale.[10]

Sweden's first reactor, a 100-kw. unit, was under construction at Stockholm in 1952 and expected to be operating in 1953. The reactor will be employed principally for research and the production of isotopes.[11]

Switzerland.—Swiss official sources indicated in 1952 that the country had developed plans for the construction of a heavy-water research reactor.[12]

[1] Atomic Energy Newsletter, vol. 8, No. 5, Oct. 21, 1952. p. 1.
Chemistry and Industry (London), No. 43, Oct. 25, 1952, p. 1061.
[2] Bulletin of the Atomic Scientists, vol. 8, No. 9, December 1952, p. 311.
[3] Nucleonics, World Progress in Atomic Energy—France: Vol. 10, No. 12, December 1952, pp. 12–13.
[4] Mining Journal (London), vol. 238, No. 6095, June 13, 1952, p. 618.
[5] Engineering and Mining Journal, vol. 153, No. 8, August 1952 p. 164.
[6] Mining World, vol. 14, No. 12, November 1952, p. 66.
[7] Metal Bulletin (London), No. 3697, May 30, 1952, p. 19.
[8] Nucleonics, vol. 10, No. 11, November 1952, pp. 111–112.
[9] Nucleonics, World Progress in Atomic Energy—Sweden: Vol. 10, No. 12, December 1952, pp. 23–25.
[10] Mining World, vol. 14, No. 7, June 1952, p. 60.
[11] Mining Journal (London), vol. 238, No. 6075, Jan. 25, 1952, p. 94.
[12] Nucleonics, World Progress in Atomic Energy—Switzerland: Vol. 10, No. 12, December 1952, p. 8.

U. S. S. R.—Uranium deposits in the Erzgebirge near Aue, Saxony, East Germany, were believed to have been exhausted in 1952, and recently discovered deposits in Thuringia were reported to be the new source of uranium for the Soviet Union.[13] Wismuth A. G., the Soviet monopoly that controls all uranium production in East Germany, transferred its headquarters to Saalfeld, Thuringia.[14] Four uranium mines near the towns of Buchovo, Kremikovzi, and Seslavkzi, in Bulgaria, were said to have been operated in 1952. Low-grade ore was sent to a processing plant at Buchovo and, after cleaning and sorting, was then shipped with the high-grade ore to the Soviet Union.[15] Resources of uranium ore near Gheorgheni, Transylvania, Rumania, were reported.[16] Operations at the Joachimsthal uranium mines, in western Czechoslovakia,[17] and at various uranium mines in East Germany [18] were described by refugees. The mineral wealth of the Soviet Union, as known or inferred, was said to approximate that of the United States.[19] Uranium resources, both satellite and domestic, of the Soviet up to 1950 were reviewed as follows: [20]

The uranium resources presently known for the Soviet sphere are far inferior to those available in Africa and North America. They are confined to the bismuth-uranium-cobalt-nickel ores of Eastern Germany, lean, complex, but seemingly extensive; the pitchblende deposit of Joachimsthal in Czechoslovakia, now heavily depleted; a copper-uranium-mica deposit in Bulgaria; and, domestically, low-grade but possibly extensive uranium-vanadium deposits in Central Asia and very small but good betafite deposits from Lake Baikal and other regions northeast to the Aldan Shield. While the German deposits appear to be the dominant producers today, the possibilities of the Central Asiatic and, especially, the Eastern Siberian ones cannot be dismissed. Authentic data on Soviet or satellite uranium outputs are naturally lacking; our *guess* is an upswing from not over 10 metric tons of U_3O_8 in 1945 to possibly 150 tons by 1950.

* * * **Satellite Uranium Resources.**—The ores of the Soviet Zone of Germany, primarily from Schmiedeberg, Silesia, require elaborate processing to separate 96.5 percent gangue and 3.5 percent of concentrate, which contains, in turn, 6.9 percent bismuth, 2.0 percent uranium oxide, 0.95 percent cobalt, and 0.35 percent nickel.[21] The output of this concentrate has varied greatly over the past 35 years. During the first World War, it reached a peak of some 400–450 metric tons annually, then dropped to 127 tons in 1922, and to only 4.1–7.7 tons between 1923 and 1929, inclusive.[22] Thereafter, production fluctuated widely: 114.6 tons in 1930, 66.6 tons in 1931, 109.5 tons in 1932—and 4.1 tons in 1935. German needs for bismuth and cobalt, as well as Nazi experimentation with atomic energy, led to a new upswing between 1939 and 1943, during which years an average of 340 tons of concentrate from 9,770 tons of ore, annually, was mined.[23] Data on U_3O_8 recovery from the concentrate are available only for 1939 to 1943, inclusive. During these years, production averaged 6.99 tons of uranium oxide, with a maximum of 9.50 tons in 1942. Press reports indicate considerable increases in activity in this area since the war.

The Joachimsthal pitchblende deposit in Czechoslovakia has long been a producer of uranium ore. Between 1922 and 1937, its output averaged 19.6 metric tons of U_3O_8, or 2.5 to 3 times as much pitchblende. Maximum production, in

[13] Mining World, vol. 14, No. 13, December 1952, p. 62.
[14] Mining World, vol. 14, No. 4, April 1952, p. 59.
[15] Work cited in footnote 13.
[16] Mining World, vol. 14, No. 6, May 1952, p. 61.
[17] Mining World, Russian Uranium Mine Secrets Revealed Recently by Escaped Slave Laborers: Vol. 14, No. 11, October 1952, p. 31.
[18] Engineering and Mining Journal, Soviet Uranium Mining: Forced Labor, "Five Cigarettes and a Glass of Beer Free": Vol. 153, No. 6, June 1952, p. 123.
[19] Shimkin, Demitri B., Minerals—a Key to Soviet Power: Harvard University Press, Cambridge, Mass., 1953, 452 pp.
[20] Work cited in footnote 19, pp. 147–150.
[21] Bureau of Mines, Mineral Trade Notes: Vol. 21, No. 2, Aug. 20, 1945, p. 12.
[22] Meisner, M., Weltmontstatistik [World Mining Statistics]: Vol. 2, 1920–1930, F. Enke, Stuttgart, 1932 p. 298; vol. 4, 1927–37, F. Enke, Stuttgart, 1939, p. 307.
[23] Work cited in footnote 21.

1936, totaled 32 tons of U_3O_8; minimum, 10 tons, in 1922–23.[24] Between 1939 and 1944, despite significant German efforts to maximize production, output fell, totaling only 110 tons of pitchblende with an aggregate content of some 35 tons of U_3O_8 for the six years.[25 26] It appears most likely that this deposit has been largely exhausted.

The Bulgarian uranium deposit, at Bukhovo, 25 km northeast of Sofia, has been described * * *.[27] It is associated with a granitic intrusion into Pre-Cambrian or Palezoic formations; copper-uranium-mica minerals are concentrated in the contact zone. In 1943, reserves were stated to comprise 25,000 metric tons (of ore?) with an average of 2 percent uranium.[28] It is not known whether this reasonably promising deposit has been mined to date.

Domestic Uranium Resources.—In 1949, I summarized the available information on uranium deposits within the Soviet Union.[29] As mentioned in this report, all the Turkestan (Central Asiatic) deposits bear urano-vanadium ores of unknown primary origin. Hydraulic deposition and association with oil-bearing Paleocene formations are, however, common features.[30] The average tenors of the ores found are low, 1.5 percent U_3O_8 at Tyuya Muyun; 0.12–0.2 percent at Taboshar and Maili-su, although secondarily enriched lenses may bear up to 50 percent U_3O_8. Thus far, only two of the deposits reported have definite commercial significance—the old mine at Tyuya Muyun, which produced 534 metric tons of hand-sorted ore in 1925–26, and Uigarsai. A later report,[31] indicates that, in the large Bala Sauskandyk (Kara-Tau) vanadium deposit * * *, the primary economic mineral is roscoelite, or vanadium mica. The percentage of uranium-vanadium ore in the deposit therefore appears to be very low, robbing it of much significance as a source of radioactive minerals.

The Eastern Siberian type of deposit, developed in the contact zone between Pre-Cambrian biotite gneisses and granitic pegmatites and characterized by betafite (calcium-uranium-niobium-tantalum) ores in association with phlogopite mica, and best typified at Slyudyanka, at the southern tip of Lake Baikal, has important potentialities. Nevertheless, no deposit of this type and of appreciable size is yet known.

United Kingdom.—Britain's first atomic bomb was exploded on Oct. 3, 1952, in the Monte Bello Islands, 50 miles off the northwest coast of Australia.[32] Construction of a lower power breeder-reactor, to be called ZEPHYR and to use fast or intermediate neutrons, was begun early in the summer of 1952 at Harwell, England. Design and feasibility studies also proceeded at Harwell on (1) a slow-neutron, enriched-uranium reactor, designed as a prototype power unit for special applications, such as ship propulsion; and (2) a slow-neutron, natural-uranium reactor, designed to develop power for electricity.[33] The British Information Service announced that an experimental unit of an atomic power station would soon be built.[34]

In the course of a survey of uraniferous deposits in Cornwall,[35] some ore was shipped from the Wheal Edward mine, in the St. Just area,[36] and a small diamond-drilling program undertaken at the South Terras mine, near St. Austell.[37]

---

[24] Work cited in footnote 22, vol. 2, p. 309; vol. 4, p. 313.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 24, No. 1, January 1947, pp. 32–35.
[26] Matthews, Allan F., Uranium and Thorium, Minerals Yearbook, 1946, p. 1228.
[27] Work cited in footnote 22, vol. 4, p. 319.
[28] Work cited in footnote 26, p. 1228.
[29] Shimkin, D. B., Uranium Deposits in the U. S. S. R.: Science, vol. 109, Jan. 21, 1949, pp. 58–60.
[30] Popov, V. I., [On the Discovery of Analogues of Carnotite Sandstones in Northern Fergana]: Sovietskaya Geologiya (Soviet Geology), No. 4/5, 1939b, pp. 32–39.
[31] Stender, V. V., Chemical and Electrochemical Methods in Nonferrous Metallurgy: Zhurnal Prikladnoi Kimiyi (Journal of Applied Chemistry), Izd. Akademiyi Nauk, Moscow, vol. 19, 1946, pp. 231–242.
[32] Bulletin of the Atomic Scientists, vol. 8, No. 8, November 1952, p. 292.
[33] Nucleonics, World Progress in Atomic Energy—Great Britain: Vol. 10, No. 12, December 1952, pp. 16–17.
[34] Bulletin of the Atomic Scientists, vol. 8, No. 9, December 1952, p. 312.
[35] Stein, Paul, A Survey of Uraniferous Deposits in Cornwall: Min. Jour. (London), vol. 238, No. 6078, Feb. 22, 1952, pp. 196–198.
[36] Stein, Paul, Mining Uranium at Wheal Edward, Cornwall: Min. Jour. (London), vol. 239, No. 6111, Oct. 3, 1952, p. 371.
[37] Chemistry and Industry (London), Uranium in Cornwall: No. 49, Dec. 6, 1952, p. 1204.

AFRICA

Belgian Congo.—The Shinkolobwe mine, of Union Minière du Haut Katanga, continued in 1952 to be the principal source of uranium for the free world.[38] A review of economic conditions in the Belgian Congo indicated that any early reduction was improbable in the rate at which the colony's mineral resources were being exploited.[39]

Madagascar.—A uranium deposit was discovered near Antsirabe, about 100 miles south of Tananarive, and a milling plant erected for the production of concentrates from ore to be mined from the deposit.[40] Extensive prospecting of the island for uranium, under a 5-year plan, was indicated.[41]

Morocco.—The uranium content of Moroccan phosphates and the possibility of commercial extraction of the uranium were investigated in 1952.[42] A series of measurements of the intensity of the beta and gamma radiation over the phosphate basins of Morocco showed that a strong radioactivity, owing to uranium, was associated with the phosphate deposits. The intensity of the radiation was directly related to the age of the phosphate layer.[43] Chemical and fluorimetric analyses of samples of North African phosphates from Tunisia to Morocco revealed an average uranium content (as the element) of 20 to 30 grams a ton, with extremes of 10 and 50 grams a ton.[44]

Nigeria.—Discovery was announced in 1952 of a pyrochlore-bearing granite of potential economic interest in the Kaffo Valley of northern Nigeria that covers an area of 195 acres and contains 0.012 percent U_3O_8 and 0.26 percent $(Nb, Ta)_2O_5$, on the basis of chemical assays of numerous samples taken from outcrops and from the bedrock in sampling pits. The deposit, estimated to average 707,500 tons per foot of depth, was discovered by members of the Geological Survey of Great Britain with the cooperation of the Nigerian Geological Survey. Sinking of 6 prospect shafts to a depth of 150 feet was recommended.[45] The mineralogy and petrology of the granite were described in a separate report.[46]

Northern Rhodesia.—Small tonnages of uranium-bearing ore were reported to have been found in the south end of the Mindola section of the Nkana copper mine, operated by the Rhokana Corp., Ltd. Exploration was undertaken to delimit the uranium-bearing ore.[47]

Sierra Leone.—A British expedition left Freetown on January 1, 1952, to explore Sierra Leone and Gold Coast for radioactive deposits. Carborne radiometric equipment was to be used.[48]

Southern Rhodesia.—A low-grade radioactive granite, containing thorite and uranium, was discovered near Beitbridge,[49] and a tantalum

---

[38] Waylett, William J., Uranium: Mining World, vol. 15, No. 5, Apr. 15, 1953, p. 79.
[39] Business Week, Atomic Age Closes in on the Jungle: No. 1171, Feb. 9, 1952, pp. 145, 146, 148.
[40] Mining World, vol. 14, No. 5, Apr. 15, 1952, p. 92.
[41] Nucleonics, World Progress in Atomic Energy—France: Vol. 10, No. 12, Dec. 1952, p. 13.
[42] Engineering and Mining Journal, vol. 153, No. 3, March 1952, p. 124.
[43] Lenoble, Andre, Salvan, Henri, and Ziegler, Valery, [Discovery of Uranium in the Phosphate Deposits of Morocco]: Compt. rend., vol. 234, No. 9, Feb. 25, 1952, pp. 976–977.
[44] Guntz, Antoine A., [On the Presence of Uranium in North African Phosphates]: Compt. rend., vol. 234, No. 8, Feb. 18, 1952, pp. 868–870.
[45] Mackay, R. A., and Beer, K. E. (with contributions by Rockingham, J. E.), The Albite-Riebeckite-Granites of Nigeria: Great Britain Geol. Survey, Atomic Energy Div., Rept. GSM/AED. 95, 1952, 25 pp.
[46] Beer, K. E., The Petrography of Some of the Riebeckite-Granites of Nigeria: Great Britain Geol. Survey, Atomic Energy Div., Rept. GSM/AED. 116, 1952, 38 pp.
[47] Rhokana Corp., Ltd., Annual Report for Year Ended June 30, 1952: P. 6. Rhodesian Mining Review, vol. 17, No. 13, Dec. 1952, p. 11.
[48] Chemical Age (London), vol. 46, No. 1695, Jan. 5, 1952, p. 25.
[49] Mining Journal (London), vol. 238, No. 6096, June 20, 1952, p. 648.

oxide-columbite deposit, containing uranium and thorium, was reported to have been found in the Enterprise district, about 10 miles from Salisbury.[50]

Union of South Africa.—Recovery of uranium as a byproduct in the treatment of the gold ores mined on the Witwatersrand began on October 8, 1952, when the plant erected for that purpose at Krugersdorp, 20 miles west of Johannesburg, by West Rand Consolidated Mines, Ltd., was placed in operation.[51] The event marked the successful application of the results of metallurgical research that began in 1947.

By the close of 1952, 14 additional gold mining companies—7 operating on the Witwatersrand in the Transvaal and 7 in the Orange Free State goldfield—had been authorized and were planning to produce uranium. Four of the 14 companies expected to begin production of uranium in 1953. The companies involved, in addition to West Rand Consolidated Mines, Ltd., were: In the Transvaal—Blyvooruitzicht Gold Mining Co., Ltd.; Daggafontein Mines, Ltd.; Luipaardsvlei Estate & Gold Mining Co., Ltd.; Randfontein Estates Gold Mining Co., Ltd; Stilfontein Gold Mining Co., Ltd; Vogelstruisbult Gold Mining Areas, Ltd.; and Western Reefs Exploration & Development Co., Ltd.; and in Orange Free State—Free State Geduld Mines, Ltd.; Harmony Gold Mining Co., Ltd.; President Brand Gold Mining Co., Ltd.; President Steyn Gold Mining Co., Ltd.; Virginia O. F. S. Gold Mining Co., Ltd.; Western Holdings, Ltd.; and Welkom Gold Mining Co., Ltd. Other gold-mining companies operating in the two areas were expected to apply for authorizations to produce uranium.[52]

The uranium will be recovered principally from slime produced currently at gold-ore milling plants; at a few properties, however, feed to the uranium-recovery plant will be supplemented by accumulated slime tailing produced in past years.[53] In accord with a three-nation agreement announced in December 1950, the uranium produced by the South African gold-mining companies will be sold to the United States and the United Kingdom.[54]

ASIA AND AUSTRALIA

Australia.—Establishment of an Australian Atomic Energy Commission was announced in 1952, to control all the Commonwealth's activities in connection with uranium and atomic energy. Scope of the Commission's interest will include the surveying and prospecting for uranium deposits, mining and refining of uranium ores, and scientific research directed toward the development of atomic energy for defense and industrial purposes.[55]

The tempo of exploration and exploitation of Australia's uranium resources increased substantially in 1952. Consummation of an

---

[50] Mining Journal (London), vol. 239, No. 6120, Dec. 5, 1952, p. 636.
[51] Mining World, South Africa's First Uranium: Vol. 14, No. 13, Dec. 1952, pp. 36–47.
[52] Mining Survey (Transvaal Chamber of Mines), Uranium in South Africa: Vol. 4, No. 3, March 1953, 32 pp.
Engineering and Mining Journal, Uranium Soars to Prominence in South Africa's Gold Fields: Vol. 154, No. 5, May 1953, pp. 72–76.
[53] Mining Journal (London), vol. 239, No. 6122, Dec. 19, 1952, p. 701.
[54] Atomic Energy Commission, Tenth Semiannual Report (Major Activities in the Atomic Energy Programs): July 1951, p. 8.
[55] Metal Bulletin (London), No. 3752, Dec. 16, 1952, p. 23.

agreement was reported in July whereby uranium from the Radium Hill davidite deposit, in the northeastern part of South Australia, would be sold to the Combined Development Agency, an organization through which the United States and the United Kingdom cooperate in the procurement of uranium.[56] A similar agreement applying to the Rum Jungle uranium-copper deposit, in Northern Territory about 40 miles south of Darwin, was imminent as the year closed.

Extensive improvements were either in progress or planned in 1952 that indicated early exploitation of the Radium Hill deposit on a substantial scale. Such improvements included, at Radium Hill, the sinking of a 12- by 16-foot shaft, with steel sets, to a depth of 700 feet [57] and installation of a heavy-medium separation unit; [58] erection of an extraction plant and refinery at Port Pirie, on Spencer Gulf, South Australia; and construction of a new rail line to link Radium Hill with Port Pirie.[59]

Rapid development of the Rum Jungle deposit, reported to be the most promising uranium area in Australia,[60] was undertaken in 1952 by Zinc Corporation, Ltd., in accordance with an agreement between the corporation and the Commonwealth Government. In declaring the Rum Jungle field a prohibited area, the provisions of the Defense Act were invoked for the first time by the Australian Government to protect a uranium deposit.[61] A preliminary account of the geology and type of mineralization in the Rum Jungle area was published.[62]

Evidence accumulated in 1952 that a 200-mile uraniferous belt, of outstanding importance, had been discovered between Darwin and Katherine, in Northern Territory. Over 50 occurrences were reported, and ground parties were verifying radioactive anomalies indicated by preliminary aerial surveys. The Finniss River and Edith River areas were said to be particularly promising.[63] Another significant uranium discovery was reported at Crockers Wells, about 40 miles northwest of Radium Hill, South Australia, as the result of a radiometric aerial survey covering an area of 2,000 square miles.[64] Other discoveries were reported to have been made at Nichol's Know, an old copper-mining area in South Australia, and at the Wilgi Mia ocher caves, in the Wold Range, Western Australia.[65]

An aerial radiometric survey was reported to have indicated the occurrence of uranium in southwestern Tasmania, south of Queenstown. Extensive geological prospecting was underway in the area on the part of Mount Lyell Mining & Railway Co., Ltd.[66]

[56] Mining World, Australia, Britain and U. S. Agree on Uranium: Vol. 14, No. 8, July 1952, p. 61.
[57] Chemical Engineering and Mining Review, vol. 44, No. 12, Sept. 10, 1952, p. 488.
[58] Chemical Engineering and Mining Review, Radium Hill to Become Major Uranium Producer: Vol. 44, No. 7, April 10, 1952, pp. 249–253.
Mining Journal (London), vol. 238, No. 6090, May 9, 1952, p. 471.
[59] Mining World, vol. 14, No. 12, November 1952, p. 60.
[60] Chemical Engineering and Mining Review, vol. 44, No. 6, March 10, 1952, p. 235.
Engineering and Mining Journal, vol. 153, No. 4, April 1952, p. 155.
[61] Mining World, vol. 14, No. 13, December 1952, p. 19.
[62] Sullivan, C. J., and Matheson, R. S., Uranium-Copper Deposits, Rum Jungle, Australia: Econ. Geol., vol. 47, No. 7, November 1952, pp. 751–758.
[63] Chemical Engineering and Mining Review, vol. 44, No. 12, Sept. 10, 1952, p. 488.
Engineering and Mining Journal, vol. 153, No. 11, November 1952, p. 170; vol. 153, No. 12, December 1952, p. 176.
[64] Engineering and Mining Journal, vol. 153, No. 12, December 1952, p. 176.
Mining Engineering, vol. 5, No. 2, February 1953, p. 154.
[65] Engineering and Mining Journal, vol. 153, No. 11, November 1952, p. 170.
Mining World and Engineering Record, vol. 163, No. 4256, Oct. 25, 1952.
[66] Mining World, New Mills and World-Wide Ore Discoveries Insure Uranium Adequacy for Hydrogen Bomb: Vol. 14, No. 12, November 1952, p. 43.

Ceylon.—Experiments carried out in 1952 at the pilot plant established by the Government of Ceylon at Katukurunda for the extraction of thorium from deposits of monazite sand were reported to have been promising. The sand was said to contain also a small quantity of uranium.[67]

India.—A low-grade radioactive mineral belt was reported in 1952 to have been discovered by a private company near Bhema, district of Manbhum, State of Bihar.[68] The Indian Atomic Energy Commission investigated small deposits of uranium and thorium ores that had been found in the State of Madras.[69]

The plant constructed at Alwaye, State of Travancore, for processing monazite sands was opened by the Prime Minister of India on December 24, 1952. Trial runs were to be conducted the next two months by the operating company, Indian Rare Earths, Ltd., for the extraction of the thoria and rare-earth minerals contained in the sands.[70] Proposed construction of a second plant was announced, to process uranium-bearing ores and the thorium-bearing residues from the Alwaye plant of Indian Rare Earths, Ltd. Société des Chimiques des Terres Rares, of Paris, according to reports, was to be associated with an Indian company in the operation of the second plant.[71]

---

67 Mining Journal (London), vol. 239, No. 6101, July 25, 1952, p. 92.
68 Mining World, vol. 14, No. 1, January 1952, p. 61.
69 Work cited in footnote 67, p. 92.
70 Chemical Age (London), vol. 67, No. 1745, Dec. 20, 1952, p. 850.
71 Bulletin of the Atomic Scientists, vol. 8, No. 9, December 1952, p. 311.
Atomic Energy Newsletter, vol. 8, No. 10, Dec. 30, 1952, p. 4.

Vanadium

By Hubert W. Davis [1]

FOR MANY years vanadium production in the United States resulted in byproduct uranium. However, since entry of the Atomic Energy Commission into the carnotite region of the Colorado Plateau for the purpose of obtaining uranium, by far the greater part of the vanadium production in the United States became a byproduct or coproduct of uranium.

Vanadium, although a strategic metal, is the least critical of all the alloying elements used for steel manufacture. Vanadium supply from production in the United States plus imports from Peru at present exceeds industry requirements, permitting accumulation of the present surplus in the National Stockpile.

The center of vanadium-ore mining in the United States continued to be the Colorado Plateau, which comprises chiefly southwestern Colorado and southeastern Utah but extends into Arizona and New Mexico. Some vanadium is recovered as a byproduct of phosphate rock mined in Idaho. Vanadium is also recovered as a byproduct of chrome ore at Glens Falls, N. Y., and of petroleum residues at Wood-Ridge, N. J.

Imports of vanadium concentrates in 1952 were 6 percent more than in 1951, but receipts of ferrovanadium were 83 percent less. Exports of ferrovanadium in 1952 were 140 percent more than in 1951.

The quotations on vanadium ore and ferrovanadium were unchanged throughout 1952.

For security reasons, publication of figures on production and consumption of vanadium ore in the United States has been suspended since 1947 at the request of the Atomic Energy Commission.

TABLE 1.—Vanadium in ores and concentrates produced in the United States, 1938–47 [1]

Year	Pounds	Year	Pounds
1938	1,613,155	1943	5,586,492
1939	1,984,068	1944	3,527,054
1940	2,162,916	1945	2,963,913
1941	2,513,051	1946	1,272,148
1942	4,439,130	1947	2,117,962

[1] Data for 1940–47 are receipts at mills and Government purchasing depots.

USES

About 90 percent of the vanadium used is consumed as ferrovanadium in the manufacture of tool steels, engineering steels, high-strength structural steels, nonaging rimming steels, and special wear-resistant cast irons. Ferrovanadium is used in welding-electrode coatings and as a deoxidizer, and some metal is utilized in magnets.

[1] Commodity-industry analyst.

Some vanadium oxide is also used in the production of tool steel. The largest uses of vanadium oxide and ammonium metavanadate are as catalysts, in glass and ceramic glazes, for driers in paints and inks, and for laboratory research. The use of metallic vanadium alone at present is limited largely to alloying with gold in dental alloys, copper and bronzes (such as for aircraft propeller bushings), and with aluminum for airframe construction.[2]

Vanadium is mainly used in steel for its grain-refining and alloying effects. In high-speed steels the vanadium content ranges from approximately 0.50 to 2.50 percent, although still higher percentages are sometimes used. Alloy tool steels, other than high-speed steels, contain 0.20 to 1.00 percent vanadium. The quantity of vanadium added to engineering steels is usually 0.10 to 0.25 percent. Most steels containing over 0.50 percent vanadium are for special purposes. Vanadium can be successfully used alone in an alloy of carbon steel; but in a wide variety of engineering and structural steels it is more usually employed in combination with chromium, nickel, manganese, boron, and tungsten. A high-temperature steel, which contains neither cobalt nor columbium but, instead, employs titanium and small, controlled quantities of vanadium, has been developed.[3] In additions from 0.10 to 0.15 percent, vanadium increases the strength of cast iron from 10 to 25 percent, and it adds a considerable degree of toughness.

PRICES

Since March 8, 1951, vanadium ore has been quoted at 31 cents a pound of contained V_2O_5. This quotation, however, disregards penalties based on grade of the ore or the presence of objectionable impurities—matters important to the refiners, inasmuch as impurities vitally affect recovery. Throughout 1952 vanadium pentoxide (technical grade) was quoted at $1.28 to $1.33 a pound of V_2O_5 and ferrovanadium at $3 to $3.20 a pound of contained vanadium (depending upon the grade of the alloy).

FOREIGN TRADE[4]

Imports of vanadium concentrates (all from Peru) in 1952 exceeded those of 1951 by 6 percent. Flue dust containing 939 pounds of vanadium was received from Venezuela in 1952 (none in 1951). Imports of ferrovanadium were 21,396 pounds (gross weight) valued at $22,132 in 1952 compared with 123,050 pounds valued at $100,261 in 1951. The 1952 imports comprised 17,920 pounds from United Kingdom and 3,476 pounds from Sweden. Vanadium ore and concentrates enter the United States free of duty; however, the rate of duty on ferrovanadium is 12½ percent ad valorem and on vanadic oxide, anhydride, salts, and compounds and mixtures of vanadium, 40 percent ad valorem.

---

[2] Iron Age, Vanadium: Vol. 170, No. 14, Oct. 9, 1952, p. 285.
[3] Steel Horizons, New Metals for the Atomic Age: Vol. 15, No. 1, 1953, pp. 4–5.
[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 2.—Vanadium ore or concentrates and vanadium-bearing flue dust imported for consumption in the United States, 1943–52

[U. S. Department of Commerce]

Year	Vanadium ore or concentrates			Vanadium-bearing flue dust		
	Pounds		Value	Pounds		Value
	Gross weight	Vanadium content		Gross weight	Vanadium content	
1943	22,117,131	2,052,620	$1,080,150	748,749	64,393	$53,553
1944	4,247,490	1,284,603	633,719	191,901	40,171	28,059
1945	8,776,328	1,550,479	725,362	133,795	26,293	19,378
1946	2,784,349	791,057	390,077	97,750	20,931	13,480
1947	3,274,548	983,869	448,076	143,124	71,819	15,483
1948	4,034,509	1,051,675	534,374			
1949	2,028,980	551,337	272,124			
1950	5,110,403	1,457,010	708,806	9,575	804	2,475
1951	3,893,900	982,878	526,941			
1952	4,338,660	1,043,797	599,203	12,285	939	2,425

Exports of vanadium ore and concentrates totaled 120,367 pounds (contained vanadium) valued at $280,216 in 1952 compared with 2,817 pounds valued at $6,581 in 1951. The 1952 exports comprised 4,032 pounds to Canada, 69,295 pounds to France, 27,776 pounds to Italy, and 19,264 pounds to West Germany. Exports of ferrovanadium totaled 293,162 pounds (gross weight) valued at $529,360 in 1952 compared with 122,344 pounds valued at $190,346 in 1951. The 1952 exports comprised 20,756 pounds to Austria, 162,564 pounds to Canada, 22,046 pounds to Brazil, 12,540 pounds to Belgium-Luxembourg, 66,056 pounds to Italy, 3,200 pounds to Taiwan, and 6,000 pounds to Yugoslavia. Exports of vanadium metal, alloys, and scrap were 103,036 pounds valued at $12,862 in 1952 compared with 1,712 pounds valued at $6,481 in 1951. The 1952 exports comprised 100 pounds to Canada, 9,771 pounds to Sweden, and 93,165 pounds to West Germany.

TECHNOLOGY

A combination of the beneficiating, smelting, and roast-leach processes described[5] may make it economically feasible to recover vanadium, as well as phosphorus, from a vast tonnage of western phosphate rock.

A method developed in the laboratory for successfully treating titaniferous magnetite ore from the deposit at Iron Mountain, Wyo., has been described.[6] The ore is roasted with 15 percent sodium carbonate to convert the vanadium to a water soluble form and fix the soda for the subsequent electric-smelting step. Approximately 90 percent of the vanadium is recoverable in a product assaying 80 percent V_2O_5.

A process developed in the laboratory and expanded to semi-pilot-plant scale for recovering titania, iron, and vanadium from two types

[5] Banning, L. H., and Rasmussen, R. T. C., Processes for Recovering Vanadium from Western Phosphates: Bureau of Mines Rept. of Investigations 4822, 1951, 44 pp.
[6] Back, A. E., and others, Treatment of Titaniferous Magnetite Ore from Iron Mountain, Wyo.: Bureau of Mines Rept. of Investigations 4902, 1952, 15 pp.

of titaniferous iron ores has been described by MacMillan and others.[7] Magnetite from the MacIntyre mine at Tahawus, N. Y., was successfully treated as follows:

(1) The ore was roasted at 1,050° to 1,080° C. with carbon and soda ash, thereby reducing the iron to metal sponge and retaining the titania in the slag. (2) The metallic iron was separated, after wet grinding, by magnetic or gravity means. (3) The slag fraction was air-roasted at 850° C. and leached with NaOH to recover Na_3VO_4. (4) The leached solids received a dilute-H_2SO_4 leach to remove interfering impurities, chiefly Na_2O and SiO_2. (5) Titania was dissolved from the leached solids of step (4) by a H_2SO_4-bake followed by a water leach. (6) Titania was precipitated by seeding and boiling the resulting solution. The spent liquor was used for the dilute-H_2SO_4 leach in step (4).

The recovery of vanadium from titaniferous magnetite has also been described by Cole and Breitenstein,[8] who state that "the recovery of over 80 percent of the vanadium values in titaniferous magnetite from the MacIntyre development at Tahawus, N. Y., was accomplished by an oxidizing roast with Na_2CO_3–NaCl addition."

In conjunction with the expansion program at the Uravan, Colo., mill of United States Vanadium Corp., a new process for treating high-lime ores is reported to be the most efficient for uranium-vanadium carnotite ores of the Plateau.[9] According to this article:

High-lime ores are reasonably plentiful in the region, but have never been mined because of economic factors. U. S. Vanadium believes the new process and installations will open new vistas, and many of the difficulties attached to using high-lime ores will be overcome. The probability is that the process will bring increased mining activity in the area. It involves a roasting, leaching, and precipitation cycle. After chemical reagents, such as salt, are added, the feed ore is fed into roasters several stories high. The ore is then leached, with the uranium and vanadium dissolved by alkaline solutions. Each mineral is then precipitated by further processing procedures. For some ores, roasting may not be required.

A method for the recovery of vanadium from chromate liquors has been described.[10] Recovery of a large part of the vanadium is in a form that contains about 85 percent pentoxide.

WORLD REVIEW

World production of vanadium ores is limited almost entirely to four countries—Northern Rhodesia, Peru, South-West Africa, and the United States. From 1943 through 1947 output from these sources ranged from 1,400 to 4,400 metric tons, with the United States the leading producer.

Vanadium has also been recovered commercially from phosphate rock, iron ore, chrome ore, magnetite beach sands, caustic soda solution employed in the Bayer process of refining bauxite, naphtha soot collected from the smokestacks of ships and industrial plants, and vanadiferous ashes derived from asphaltites.

Because complete information on the quantity of vanadium recovered as byproducts of iron ore and other raw materials is lacking, it is not possible to determine world production of vanadium from all

---

[7] MacMillan, R. T., and others, Soda Sinter Process for Treating Low-Grade Titaniferous Ores: Bureau of Mines Rept. of Investigations 4912, 1952, 62 pp.

[8] Cole, S. S., and Breitenstein, J. S., Recovery of Vanadium from Titaniferous Magnetite: Jour. Metals, vol. 3, No. 12, December 1951, pp. 1133–1137.

[9] Mining Engineering, U. S. Vanadium's Uravan, Colo., Mill Doubles Output: Vol. 4, No. 11, November 1952, pp. 1025–1026.

[10] Perrin, T. S., and others, Vanadium Recovery from Chromate Liquors: Ind. Eng. Chem., vol. 44, No. 2, February 1952, pp. 401–404.

sources. Consequently, table 3 reflects only the production of vanadium in ores and concentrates for the countries listed, plus the quantity recovered in the United States as a byproduct of phosphate rock.

TABLE 3.—World production of vanadium in ores and concentrates, 1943–52, in metric tons

[Compiled by Berenice B. Mitchell]

Country	1943	1944	1945	1946	1947	1948	1949	1950	1951	1952
Argentina	------	4	3	6	7	(1)	(1)	(1)	(1)	(1)
Northern Rhodesia	426	254	219	68	56	173	153	------	87	43
Peru	847	514	688	322	435	511	456	436	449	450
South-West Africa	577	385	420	430	282	187	163	295	529	624
United States (shipments) [2]	2,534	1,600	1,344	577	961	(3)	(3)	(3)	(3)	(3)
Total [4]	4,384	2,757	2,674	1,403	1,741	(5)	(5)	(5)	(5)	(5)

[1] Figure not available.
[2] Includes vanadium recovered as a byproduct of phosphate-rock mining.
[3] United States figures for 1948–52 withheld at request of Atomic Energy Commission.
[4] Total represents data only for countries shown in table and excludes vanadium in ores produced in French Morocco, Spain, and U. S. S. R., for which figures are not available; the total also excludes quantities of vanadium recovered as byproducts from other ores and raw materials.
[5] Bureau of Mines not at liberty to publish figure.

Argentina.—Vanadium occurs in small deposits widely scattered in the Provinces of Córdoba and San Luis. A small quantity of ore is mined for the production of 3 to 7 metric tons of vanadium pentoxide annually.

Northern Rhodesia.—The Rhodesia Broken Hill Development Co., Ltd., continued to be the only producer of vanadium in Northern Rhodesia. Output of vanadium oxide was 83 long tons averaging 91.09 percent V_2O_5 in 1952 compared with 167 tons averaging 91.32 percent V_2O_5 in 1951. Feed to the vanadium leach plant in 1952 was derived from various sources and totaled 4,502 short tons averaging 3.07 percent V_2O_5. Recovery of vanadium was 60.9 percent. According to the company:

> Full-scale production of vanadium continued until April, when the plant was shut down on completion of the current contract. Experimental leaches were conducted later in the year on flotation concentrates from mixed fines tailings, and a small additional production was declared.

Peru.—The famous Mina Ragra mine of the Vanadium Corp. of America in the Andes near Ricran, Department of Junin, has been an important source of vanadium since 1907, when production was begun. Output in Peru was 804 metric tons of V_2O_5 in 1952 compared with 801 tons of V_2O_5 in 1951.

South-West Africa.—The Abenab West lead-vanadium mine of the South West Africa Co., Ltd., was the only producer of vanadium in South-West Africa in 1952. According to the company, the demand for vanadium was maintained, and it was making every effort to increase its output of concentrates for the production of fused vanadium. Output of concentrates (recoverable V_2O_5) was 1,228 short tons in 1952. Exports of concentrates (recoverable V_2O_5) were 2,387 short tons in 1952, of which 1,776 tons went to Belgium, 314 tons to Holland, 195 tons to United Kingdom, and 102 tons to Germany.

Vermiculite

By Henry P. Chandler [1] and Nan C. Jensen [2]

DURING the past 30 years vermiculite has been developed from a mineralogical curiosity to an annual commercial volume exceeding 200,000 tons. The growth in public consciousness of the advantages of both temperature and sound insulation and of light construction have popularized its use.

DOMESTIC PRODUCTION

Almost the same tonnage of vermiculite was produced in the United States in each of the past 3 years (1950–52), and the value of the screened and cleaned material at the mine also was little changed.

The production is largely concentrated in Montana and South Carolina. Smaller quantities were produced in North Carolina and Wyoming. The Zonolite Co., 135 South La Salle Street, Chicago, Ill., operated mines at Libby, Mont., and Travelers Rest, S. C. American Vermiculite Co. produced at Spruce Pine, N. C., and Woodruff, S. C., the Variegated Vermiculite Mines at Green Mountain, N. C., and the Mikolite Corp. at Encampment, Wyo.

Currently vermiculite is produced in the United States from open pits, although formerly some was obtained by underground mining. The crude material is mined with power shovels, and selective mining is often necessary. After being concentrated, the vermiculite is dried in rotary kilns, care being taken to avoid temperatures high enough to disturb the combined moisture content. Final screening to commercial sizes follows. The mineral usually is shipped to exfoliating plants in box cars.

TABLE 1.—Screened and cleaned vermiculite sold or used by producers in the United States, 1943–47 (average) and 1948–52

Year	Short tons	Value	Year	Short tons	Value
1943–47 (average)	76, 669	$773, 592	1950	208, 096	$2, 122, 427
1948	138, 635	1, 387, 233	1951	209, 008	2, 093, 953
1949	168, 819	1, 686, 419	1952	208, 906	2, 081, 993

CONSUMPTION AND USES

In its unexfoliated state vermiculite has few uses; its principal applications are in the expanded form. Exfoliation usually takes place at temperatures between 1,600° and 2,000° F. The charge is subjected to heat for a few seconds and then cooled rapidly. No canvass of exfoliated-vermiculite production is conducted by the Bureau of Mines; however, assuming a 5-percent tonnage loss in processing, it is estimated that about 200,000 tons of exfoliated ver-

[1] Commodity-industry analyst.
[2] Statistical assistant.

miculite was produced in 1952. Value estimates have ranged up to $80 per ton f. o. b. plant, but it is considered probable that the national average is somewhat below this figure. Total product value therefore may be as much as $15,000,000 for this commodity. There are about 50 exfoliating plants in the United States, in 31 States and the District of Columbia.

Its low bulk density, comparatively high refractoriness, low thermal conductivity, and chemical inertness, make vermiculite satisfactory for many types of thermal and acoustic insulation. No official statistics on the use patterns of vermiculite are available. In exfoliated form its principal uses are as a loose fill in buildings, as an aggregate in lightweight concrete, for plaster and insulating concrete, in molded articles, for refractory insulation, and as a soil conditioner. Unexfoliated vermiculite is reported to have only a very few minor uses, such as filler in fire-resistant wallboard and in muds for oil-well drilling.

PRICES

In 1952 prices of screened, dried, and sized vermiculite f. o. b. mine, Montana, were reported by E&MJ Metal and Mineral Markets from $12 to $14 a short ton; South African crude, $30–$32 c. i. f. Atlantic ports.

FOREIGN TRADE

Nearly all of the imports of crude vermiculite came from deposits in the Union of South Africa, particularly from the Palabora District, Transvaal, and were used by exfoliating plants on the eastern seaboard of the United States. Recent exportations from South Africa to the United States were reported as follows, f. o. b. port of shipment, to which is appended their value in United States currency: [3]

	Short tons		*Value*	*Per ton*
1950	16, 531	S. A. £91,483	$256, 000	$15. 50
1951	9, 920	S. A. £50,780	142, 000	14. 31
1952	7, 998	S. A. £40,387	113, 000	14. 14

TECHNOLOGY

A semilightweight vermiculite-sand concrete has been developed for use in floors. The mix recommended consists of 1 part by volume of cement, 3 parts of vermiculite, and 2 parts of sand. Use of a floor covering on top of the concrete was recommended.[4]

Product applications and specifications for vermiculite concrete were discussed at a meeting of the Vermiculite Institute, and the institute's new set of specifications, developed over a test period of 5 years, was issued.[5]

A vermiculite information service center has been established to supply information relating to its use.[6]

---

[3] Richmonds South African All Mining Yearbook (Johannesburg), 1953, p. 517.
[4] Rock Products, Vermiculite-Sand Concrete: Vol. 55, No. 1, January 1952, p. 215.
[5] Rock Products, Product Applications and Specifications for Vermiculite Concrete: Vol. 55, No. 6, June 1952, pp. 142–144.
[6] Rock Products, Vermiculite Research: Vol. 55, No. 12, December 1952, p. 77.

The use of vermiculite for insulation in the transportation of hot steel ingots,[7] and for furnace insulations has been described in trade journals.[8]

Recovery of vermiculite from low-grade ores now considered to be waste material was the objective of a program inaugurated at one of the large mines. Low-grade ore in this instance is defined as material containing 35 percent or less vermiculite.[9]

The production and use of vermiculite throughout the World were discussed in a publication by the Colonial Surveys Office, London. Current methods of mining and ore dressing and the exfoliation processes at the various vermiculite plants were described in detail, and the occurrences of vermiculite in foreign countries were described.[10]

Next to the United States, the Union of South Africa is the world's largest producer of vermiculite. From a small beginning in 1938 its production reached 36,213 metric tons in 1952. Of this quantity 30,395 short tons, valued at S.A. £ 170,845 ($15.73 a ton) was exported.[11] Reserves in the Palabora area of the Transvaal are estimated at over 5 million tons.

Large deposits of vermiculite are known in the State of Minas Gerais in Brazil; some have been worked. In the U. S. S. R. vermiculite deposits are being operated near Lake Buldym in the southern Urals. Large reserves are said to be available.[12]

WORLD REVIEW

TABLE 2.—World production of vermiculite, by countries, 1948–52, in metric tons

[Compiled by Helen L. Hunt]

Country [1]	1948	1949	1950	1951	1952
Australia	153	165	122	56	63
Egypt				637	60
India			53	236	(2)
Kenya		5	4	3	(2)
Southern Rhodesia	16	962	711	502	
Union of South Africa	12,527	21,196	42,423	24,507	36,213
United States (sold or used by producers)	125,767	153,149	188,781	189,608	189,515
Total	138,463	175,477	232,094	215,549	[3] 226,000

[1] In addition to countries listed, vermiculite is produced in Brazil and U. S. S. R., but data are not available, and no estimates are included in the total.
[2] Data not available; estimate by author of chapter included in total.
[3] Estimate.

[7] Refractories Journal, Insulating a White-Hot Cargo: No. 4, (28th year), April 1952, p. 183.
[8] South African Mining and Engineering Journal, Vermiculite-Mix Insulations: Vol. 63, No. 3092, Part 1, May 17, 1952, p. 441.
[9] Mining and Industrial News, Zonolite Company Starts a New Program: Vol. 20, No. 4, April 1952, p. 7.
[10] Varley, E. R., Vermiculite: Mineral Resources Division, Colonial Geol. Surveys, London, Her Majesty's Stationery Office, 1952, 70 pp.
[11] Department of Mines, Union of South Africa, Quarterly Information Circular: October-December 1952, p. 63.
[12] Varley, E. R., Vermiculite: London, Her Majesty's Stationery Office, 1952, pp. 54–57.

ZINC

By O. M. Bishop [1] and Esther B. Miller [2]

IN JANUARY 1952 zinc was widely believed to be in such short supply that the President, on January 30, following the recommendation of the Office of Defense Mobilization, ordered the release of up to 15,000 tons of slab zinc between that date and June 30 for allocation to consumers, such zinc to be smelted from stockpile-owned concentrates. Shortly thereafter it became apparent that supplies were ample, as imports were entering the United States in record volume and consumption had declined. Demand was further reduced by the steel strike in June and July; between June 2 and October 27 zinc prices declined 7 cents, or 36 percent, causing curtailments and shutdowns at many marginal mines. The supply of zinc, including newly mined, secondary recovered in all forms, and imports, totaled 1,470,000 tons, whereas the total zinc consumed as slab, ore, and secondary metal plus exports was about 1,275,000 tons.

In 1952 domestic zinc smelters produced 960,000 short tons of slab zinc, 3 percent more than in 1951 and a quantity second only to the record 991,000 tons produced in 1943. Of the 1952 output 60 percent was from domestic ores, 34 percent from foreign ores, and 6 percent from scrap. Domestic mine production was at the annual rate of 721,000 tons in the first 6 months, declined to an annual rate of 610,000 tons in the latter half of the year, and totaled 666,000 tons, a decrease of 2 percent from the 681,000 tons of 1951. The decline in the second half of the year was brought about by shutdowns of certain marginal mines in Arizona, California, Idaho, Illinois, Nevada, New Mexico, and Utah and by strikes in New York, Illinois, and Utah. Montana, with 82,000 tons, led all the States in mine production of zinc, being followed, in order, by Idaho, New Jersey, Oklahoma, Colorado, New Mexico, Arizona, and Tennessee. Imports of zinc in ores and concentrates and imports of slab zinc were 449,000 and 115,000 tons, respectively, as compared with 303,000 and 88,000 tons in 1951. Consumption of slab zinc was 967,000 tons in 1950 and 934,000 tons in 1951 and declined to 853,000 tons in 1952. Stocks at primary and secondary smelters increased from 22,000 tons during the year to 85,000 tons. Stocks of zinc in transit to or at consumers' plants increased from 65,000 tons at the beginning of the year to 101,000 tons at the end.

Prime Western zinc was quoted at 19.5 cents per pound, East St. Louis, until June 2, when it dropped to 17.5 cents. Subsequent declines brought the price to 12.5 cents per pound on October 27 at which level it remained for the rest of the year. The average price received by producers in 1952 was 16.6 cents.

[1] Commodity-industry analyst.
[2] Statistical assistant.

The five-volume report of the President's Materials Policy Commission was released in 1952. The report, which was widely quoted and discussed, estimates the probable supply and demand of many necessary materials through 1975. Allowing for technologic advances and a free market economy "on the basis of peace and prosperity in the constant shadow of war" the report concludes that by 1975 annual zinc requirements of the United States in all forms would be 1,600,000 tons, which would be met by domestic mine production of 700,000 tons, secondary production of 100,000 tons, and imports of 800,000 tons.

TABLE 1.—Salient statistics of the zinc industry in the United States, 1943–47 (average) and 1948–52

	1943–47 (average)	1948	1949	1950	1951	1952
Production of primary slab zinc:						
By sources:						
From domestic ores.........short tons..	521,010	537,966	591,454	588,291	621,826	575,828
From foreign ores..................do....	300,376	249,798	223,328	255,176	259,807	328,651
Total..............................do....	821,386	787,764	814,782	843,467	881,633	904,479
By methods:						
Electrolytic............percent of total..	36	40	40	41	38	39
Distilled..............................do....	64	60	60	59	62	61
Production of redistilled secondary slab zinc..............................short tons..	50,110	62,320	55,041	66,970	48,657	55,111
Stocks on hand at primary smelters Dec. 31........................short tons..	179,814	19,179	90,710	7,948	[1] 21,343	81,344
Price:						
Prime Western at St. Louis:						
Average for period....cents per pound..	8.80	13.58	12.15	13.88	17.99	16.21
Highest quotation..................do....	10.50	17.50	17.50	17.50	19.50	19.50
Lowest quotation...................do....	8.25	10.50	9.00	10.00	17.50	12.50
Yearly average at London...........do....	6.95	14.38	14.41	14.89	21.46	18.71
Mine production of recoverable zinc: [2] short tons..	657,927	629,9.7	593,203	623,375	681,189	666,001
Tri-State district (Joplin) percent of total..	24	14	13	13	13	14
Western States.....................do....	47	58	60	59	58	58
Other..............................do....	29	28	27	28	29	28
World smelter production of zinc short tons..	1,710,000	[1] 1,881,000	[1] 2,010,000	[1] 2,170,000	[1] 2,312,000	2,424,000

[1] Revised figure.
[2] Includes Alaska.

GOVERNMENT REGULATIONS

Effective January 1, 1952, the National Production Authority amended zinc Order M–9 to reduce allowable receipts in any calendar month without allocation authorization from 20 to 10 short tons. The order was amended further on March 7, 1952, to change certain definitions and to consolidate in one order all definitions and sections formerly contained in NPA Orders M–15 and M–37, which were revoked simultaneously with the amendment. As amended, M–9 maintained slab zinc under allocation, limited the civilian uses of slab zinc, and prohibited undue accumulations of both slab zinc and zinc scrap. It also regulated all commerce in zinc scrap and provided that producers, importers, consumers, and dealers of slab zinc in quantities exceeding a stated quantity must file reports.

On May 15, 1952, Order M–9 was further amended by removal of provisions respecting allocation, delivery, and use of slab zinc and of restrictions on toll agreements and production of zinc dust. Six weeks later, on June 27, 1952, Order M–9 was revoked, but reporting remained on a mandatory basis.

On July 3 the Office of International Trade announced that quota restrictions on the quantity of slab zinc that might be exported had been removed, although export licenses continued to be required for exports to all countries but Canada.

GOVERNMENT PROGRAMS UNDER DEFENSE PRODUCTION ACT OF 1950

In 1950, under provisions of the Defense Production Act, the Defense Minerals Administration was established to stimulate production of critical minerals and metals needed for national defense. DMA was later succeeded, with respect to its exploration activities, by the Defense Minerals Exploration Administration and, with respect to procurement, by the Defense Materials Procurement Agency.

DEFENSE MINERALS EXPLORATION ADMINISTRATION

The objective of the Defense Minerals Exploration Administration is to encourage and increase the production of strategic and critical metals, including lead and zinc, through loans to explore possible domestic sources. The Government financed up to 50 percent of the total cost of approved exploration projects for lead and zinc. As of December 31, 1952, 151 minerals exploration projects involving lead and zinc were in force or executed. Government participation in these contracts amounted to $5,595,473, or about one-half the total value of the contracts. The value of DMEA participation in contracts involving lead and zinc occuring together or separately constituted about 46 percent of the total Government participation in exploration projects for all commodities. Table 2 lists all exploration contracts involving lead and zinc that were in force or executed as of December 31, 1952.

TABLE 2.—Defense Minerals Exploration Administration contracts involving lead and zinc, by States, through Dec. 31, 1952

Name of contractor	County	Government participation
ARIZONA		
Arizona Metals Co	Mohave	$23,050
Kusisto, Ike W	Yavapai	2,500
Magma King Manganese Mining Co	Pinal	11,550
Nash, James P	Santa Cruz	17,000
Owens, Sherwood B	Cochise	31,963
Reed & Reed	Mohave	10,000
CALIFORNIA		
Briggs, Harry E	Inyo	8,650
Fitzgerald, R. E	Amador	10,310
Foreman, L. D	Inyo	6,120
Glidden Co	Shasta	147,150
COLORADO		
Bachelor Development Co	Ouray	36,252
Cadwell Mining Co	Lake	44,961
Callahan Zinc-Lead Co	Gunnison	85,994
Do	do	15,305
Defender Mining Co	Custer	2,399
East Ridge Co	San Miguel	30,090
Erickson & Baer	Dolores	1,600
Kolego, Henry E	San Juan	7,300
Lead Carbonate Mines, Inc	do	17,500
Leadville Lead Corp	Park	50,400
Lupton Mining Co., Inc	Clear Creek	33,180
Do	do	8,000

TABLE 2.—Defense Minerals Exploration Administration contracts involving lead and zinc, by States, through Dec. 31, 1952—Continued

Name of contractor	County	Government participation
Moenke, W. F	Summit	$1,500
Montana Mining & Development Co	Clear Creek	7,500
Moreno Cripple Creek Corp	San Juan	38,000
Outlet Mining Co	Shoshone	5,618
Shelby Johnson Mines, Inc	Park	4,900
Silver Bay Mines, Inc	San Juan	10,750
Silver Bell Mines Co	San Miguel	39,560
Smith, John A	Clear Creek	12,500
Treasure Mountain Gold Mining Co	San Juan	37,600
United Mining & Leasing Corp	Gilpin	17,101
United States Metals Corp	San Juan	56,819
Do	do	19,300
Utze Lode Co	Chaffee	24,750
Do	do	10,000
IDAHO		
Bleazard, J. W. & G. S	Custer	4,200
Buchman, Louis, Breckson, J. S., Norden, J. A	do	29,495
Buckskin Mines Inc	do	6,100
Bunker Chance Mining Co	Shoshone	76,265
Champion Mine	Custer	15,825
Day Mines Inc	Shoshone	144,000
Enderlin, Elmer	Custer	4,500
Funnell & Majer Mining Co	Bonner	26,614
Garner, Wylie M. (Hoodoo mines)	Custer	7,000
Heller, L. S	Valley	300
Highland Surprise Consolidated Mining Co	Shoshone	100,000
Hope Silver-Lead Mines, Inc	Bonner	18,000
Hypotheek Mining & Milling Co	Shoshone	35,205
Idaho Mining Co	do	61,869
Nabob Silver Lead Co	do	71,725
Paymaster, Inc	Blaine	47,510
Rhode Island Mining Co	Shoshone	11,950
Sidney Mining Co	do	100,145
Signal Mining Co	do	10,500
Silver Star Queens Mines, Inc	Blaine	68,443
Snoose Mining Co	do	67,500
South Mountain Mining Co	Owyhee	24,430
Spokane Idaho Mining Co	Shoshone	94,271
Sun Valley Lead Silver Mines, Inc	Blaine	14,192
Sunset Minerals, Inc	Shoshone	45,523
United Minerals Reserve Corp	Blaine	52,000
Whitedelf Mining & Development Co	Bonner	81,975
ILLINOIS		
Ozark Mahoning Co	Hardin	24,300
IOWA		
Miller, J. E. & Lula M	Dubuque	14,850
MISSOURI		
American Zinc, Lead & Smelting Co	Franklin	32,500
Bootman & Boswell Mining Co	Lawrence	4,934
Dale Mining Co	Newton	3,888
National Lead Co	Madison	274,078
Peugnet, Amedee A	St. Francois	2,100
Do	do	1,800
Shelton Mining Co	Jasper	7,000
MONTANA		
Ambassador Mines Corp	Sanders	11,525
Bennett Mining Co	Cascade	50,000
Carlson, Albert F	Jefferson	12,450
Castle Lead & Zinc Co	Meagher	49,925
Commonwealth Lead Mining Co	Madison	25,290
Dance, Albert & Jewell	Broadwater	8,970
Elkhorn Consolidated, Inc	Jefferson	12,900
Linton Mines Inc	Missoula	26,270
Mulcahy, Wm	Jefferson	2,546
Pittsburgh Silver Mining Co	Mineral	5,585
Pohl, Edmund E	Broadwater	6,295
Romerio, Alberta	Jefferson	10,600
Stark, Lewis B	Cascade	25,000
West Montana Exploration & Development Co	Granite	42,925
Wegener, Roberta	Beaverhead	8,750
White Pine Lead Co	Jefferson	14,350
Young, James	Granite	1,500

TABLE 2.—Defense Minerals Exploration Administration contracts involving lead and zinc, by States, through Dec. 31, 1952—Continued

Name of contractor	County	Government participation
NEVADA		
Bristol Silver Mines Co	Lincoln	$90,814
Ely Valley Mines Inc	do	43,100
Grand Deposit Mining Co	White Pine	13,200
Hamilton Consolidated Mines	do	13,370
Keever, Frank B	Lander	10,114
Raymond Combined Mines Co	Lincoln	54,233
Snyder, George W	Lander	13,897
United Minerals Reserve Corp	Elko	26,750
Walker Corp	White Pine	66,155
NEW MEXICO		
Byrne, Verne	Santa Fe	12,369
Clark & Mathis	Luna	6,327
Mathis, R. W. & Lettie Mae	Grant	14,200
Peru Mining Co	do	112,500
United States Smelting, Refining & Mining Co	do	290,922
OKLAHOMA		
American Zinc, Lead & Smelting Co	Murray	78,000
SOUTH DAKOTA		
Belle Eldridge Gold Mines, Inc	Lawrence	5,800
TEXAS		
Carr Mining Co	Presidio	5,198
UTAH		
American Fork Consolidated Mines	Utah	8,019
Chief Consolidated Mining Co	Juab	231,710
Combined Metals Reduction Co	Tooele	111,000
Do	Salt Lake	27,550
Duke Page Auto Co	Juab	8,853
East Utah Mining Co	Wasatch	54,587
Ellihill Mining Co	Wayne	17,145
Harrington Mines Co	Beaver	62,620
Kentucky-Utah Mines Co	Washington	17,500
Lakeside Monarch Mining Co	Tooele	5,000
Naildriver Mining Co	Wasatch	42,063
New Park Mining Co	Summit	117,197
New Quincy Mining Co	do	11,929
Park Utah Consolidated Mines Co	Wasatch	89,994
Do	do	21,000
Privateer Mining Co	Utah	4,031
Silver King Coalition Mines Co	Summit	160,767
United Mining & Development Co. Inc	Tooele	8,274
United States Smelting, Refining & Mining Co	Salt Lake	308,678
WASHINGTON		
American Zinc, Lead & Smelting Co	Pend Oreille	60,000
Do	do	58,250
Black Warrior Mining Co	Chelan	25,124
Davis, C. O	Skagit	21,375
Farmer Mines Enterprises	Stevens	5,000
Goldfield Consolidated Mines Co	do	11,528
Jim Creek Mines, Inc	Pend Oreille	23,750
Mines Management, Inc	Stevens	29,575
Do	do	12,000
Nasbury, Theodore	do	3,780
Pacific North West Mining Co	do	18,642
Pioneer Mining Co	do	11,826
Spokane Mining Syndicate	Ferry	22,000
WISCONSIN		
Calumet & Hecla, Inc	Lafayette	155,215
D. H. & S. Mining Co	Iowa	14,577
Dodgeville Mining Co	do	5,000
Do	do	5,000
Do	do	4,020
Do	do	3,750
Do	do	3,750
Do	do	3,000
Eagle-Picher Co	Grant	95,615
Mayer & Thiede Mining Co	Lafayette	5,000
Scallion, E. P	Grant	3,750
Vinegar Hill Zinc Co	Lafayette	34,220
Do	do	7,820
Total		5,595,473

TABLE 3.—Contracts for expansion and maintenance of supply of zinc and lead under the Defense Production Act, as amended, as of Dec. 31, 1952

Type of contract, name of contractor, and location of project[1]	Quantities involved in short tons		Effective date of contract	Date production begins	Approximate term of contract	Commitment purchase price (per pound)
	Total	Contingent purchase commitment				
American Smelting & Refining Co., Van Stone mine, Stevens County, Wash. (floor price).	Zinc, 18,436	18,436	Mar. 5, 1952	Oct. –, 1953	3½ years	$0.155.
American Zinc, Lead & Smelting Co., Quick Seven mine, Jasper County, Mo. (floor price).	Zinc, 11,000	11,000	Dec. 29, 1951	Dec. –, 1952	3 years	$0.170.[2]
American Zinc Co. of Tennessee, North Friends Station, Jefferson County, Tenn. (floor price).	Zinc, 11,600	7,200	Nov. 5, 1951	Nov. –, 1952	do	$0.175.[2]
Appalachian Mining & Smelting Co., Bumpass Cove, Embreeville, Tenn. (floor price).	Zinc, 10,000	10,000	May 8, 1951	Nov. –, 1952	2½ years	$0.175.
Vernon C. Davis, Kickapoo & Thompson mineral leases, Iowa County, Wis. (floor price).	Zinc, 3,000	3,000	Apr. 2, 1952	Apr. –, 1953	3 years	$0.155.
Gibbonsville Mining & Exploration Co., Opal & Geraldine claims, Kellogg, Idaho (floor price).	Zinc, 790	790	June 12, 1952	Oct. –, 1952	2 years	$0.155.
	Lead, 2,460	2,460	do	do	do	$0.150.
MacArthur Mining Co., MacArthur mine, Baxter Springs, Cherokee County, Kans. (floor price).	Zinc, 2500	1,500	Dec. 4, 1951	May –, 1952	do	$0.175.
Mid-Continent Mining Corp., Alice mine, West Plains, Mo. (floor price)	Zinc, 7,400	7,400	July 16, 1952	Apr. –, 1953	2½ years	$0.160.
Vinegar Hill Zinc Co., Mulcahy property, Lafayette County, Wisc. (floor price).	Zinc, 5,000	5,000	June 30, 1951	June –, 1952	3 years	$0.175.
W. M. & W. Mining Co., Inc., Brewster land mine, Ottowa County, Okla. (subsidy).	Zinc, 5,750	None	June 27, 1952	Feb. 1, 1952	23 months	None.[3]
Compania, Minera de Huehuetenango, Guatemala, Central America (purchase).	Lead, 26,250	26,250	Feb. 5, 1952	Early 1954	7⅓ years	Market between $0.17342 and $0.20342.[3]
National Zinc Co., Inc., American company with concentrating to be done in Mexico and smelting in the United States (floor price).	Zinc, 20,000	20,000	Oct. 17, 1951	Oct. –, 1952	5 years	$0.165.
Volcan Mines., Peru, Trelio, Peru—foreign company, but smelting to be done in United States (purchase).	Zinc, 54,000	13,680	Sept. 24, 1951	Jan. –, 1953	5½ years	$0.175.

Loans (Certified by Defense Materials Procurement Agency under section 302, Defense Production Act):

Firm and location	Type of assistance	Commodity	Date approved	Proposed annual increase, in short tons	Loan authorized
Appalachian Mining & Smelting Co., Embreeville, Tenn.	RFC-DPA	Zinc	August 1951	5,000	$400,000
Chief Consolidated Mining Co., Juab County, Utah	RFC-DMPA	Lead Zinc	April 1952	3,800 5,200	120,000
Gibbonsville Mining & Exploration Co., Kellogg, Idaho	RFC-DMPA	Zinc Lead	June 1952	530 1,600	77,000
Homestead Mining Co., Platteville, Wis.	RFC-DMPA	Zinc Lead	January 1952	3,240 150	240,000
Mifflin Mining Co., Mifflin, Wis.	RFC-DPA	Zinc	July 1951	1,080	80,000
New Diggings Mining Co., Platteville, Wis.	RFC-DMPA	do	August 1952	2,400	54,000
Piquette Mining Co., Platteville, Wis.	RFC-DMPA	Lead Zinc	June 1952	390 3,100	144,000
Shelton Mining Co., Joplin, Mo.	RFC-DMPA	do	May 1952	700	85,000
Zinc Nacional, S. A., Mexico	Ex-Im-DMPA [4]	do	June 1952	6,500	337,500

[1] Floor price, subsidy, or purchase contracts, as noted.
[2] Includes escalator clause.
[3] Provides for subsidy.
[4] Export-Import Bank of Washington.

TABLE 4.—Certificates of necessity certified by Defense Materials Procurement Agency for assistance through tax amortization, by States through Dec. 31, 1952

Company	Type of project	Commodity	Proposed expansion (tons/year)	Date certified	Amount of depreciable assets (thousands of dollars)	Amount allowed for accelerated amortization
CALIFORNIA						
American Smelting & Refining Co., Selby	Slag fuming plant	Zinc	10,000	May 1951	$2,254	$1,352
Do	Smelter	Lead		June 1951	110	66
COLORADO						
Telluride Mines, Inc., Telluride	Mill	Zinc Lead	1,200 1,800	September 1951	245	147
New Jersey Zinc Co., Gilman	Mine and mill	Zinc Lead	6,600 1,340	January 1952	50	30
Colorado Standard Lead-Zinc Mines, Lake City	do	Zinc Lead	388 2,500	do	161	97
New Jersey Zinc Co., Canon City	Dust collection	Zinc	100	July 1951	100	60
Emperius Mining Co., Creede	Mine	do	250	October 1951	34	20
American Smelting & Refining Co., Leadville	Smelter	Lead		August 1951	84	50
IDAHO						
Bunker Hill & Sullivan Mining Co., Kellogg	Smelter and refinery	do		December 1951	1,376	826
American Smelting & Refining Co., Wallace	Mine and mill	do do	2,100	do May 1952	372 83	223 50
ILLINOIS						
American Zinc Co. of Illinois, Monsanto	Smelter	Zinc		December 1951	834	500
New Jersey Zinc Co., Depue	do	do		September 1951	114	68
Do	Fume collection	do	30	February 1952	200	100
KANSAS						
Eagle-Picher Co., Galena	Zinc oxide plant	do		June 1951	289	173
MISSOURI						
St. Joseph Lead Co., Indian Creek	Mill	Zinc Lead	2,800 17,500	August 1951	4,964	2,978
St. Joseph Lead Co., Hayden Creek	Concentrator	do	11,500	June 1951	785	471
St. Joseph Lead Co., Herculaneum	Smelter	Zinc Lead	7,200 1,000	do	1,808	1,085
MONTANA						
Anaconda Copper Co., Butte	do	Zinc	14,400	December 1951	1,645	987
NEBRASKA						
American Smelting & Refining Co., Omaha	do	do	325	July 1951	105	63
Do	do	Lead		August 1951	52	31

NEW JERSEY						
New Jersey Zinc Co., Ogdensburg	Mill	Zinc	20,000	September 1951	3,015	1,809
American Smelting & Refining Co., Newark	Alloy mfr	do		do	1,736	1,042
NEW YORK						
St. Joseph Lead Co., Balmat	Mine and mill	do	13,000	June 1951	833	500
Belmont Smelting & Refining Co., Kings County	Alloy mfr	Lead		December 1951	450	225
OKLAHOMA						
Blackwell Zinc Co., Blackwell	Sintering plant	Zinc		September 1951	3,304	1,982
PENNSYLVANIA						
New Jersey Zinc Co., Palmerton	Smelter and refinery	do		do	868	521
Do	Fume collection	Zinc Lead	190 100	February 1952	350	210
New Jersey Zinc Co., Friedensville	Mine and mill	Zinc	39,000	January 1952	8,678	5,207
New Castle Chemical Co., New Castle	Dust collection, etc	do		February 1951	91	46
TENNESSEE						
United States Steel Co., Jefferson City	Mine and mill	do	8,000	June 1951	863	518
American Zinc Co., North Friends Station	Mine	do	3,600	do	299	179
Appalachian Mining & Smelting Co., Embreeville	Mill	do	5,000	November 1951	395	237
TEXAS						
American Smelting & Refining Co., Corpus Christi	Refinery	do		June 1951	67	40
Do	Smelter	do		do	775	465
American Smelting & Refining Co., Amarillo	Dross treatment	do		do	75	45
American Smelting & Refining Co., Corpus Christi	Smelter	do	24,000	do	7,015	4,209
American Zinc Co. of Illinois, Dumas	Dust collection	Zinc Lead	200 190	do	407	244
VIRGINIA						
New Jersey Zinc Co., Austinville	Mill	Zinc Lead	3,200 400	September 1951	1,103	662
New Jersey Zinc Co., Ivanhoe	do	Zinc Lead	12,000 1,500	do	1,143	686
WASHINGTON						
American Smelting & Refining Co., Van Stone	do	Zinc Lead	7,800 750	December 1951	1,598 113	959 57
WISCONSIN						
Vinegar Hill Zinc Co., Shullsburg	Mine	Zinc Lead	3,100 300	September 1951	196	118
Total		Zinc Lead	182,383 40,980		49,039	29,338

DEFENSE MATERIALS PROCUREMENT AGENCY

The Defense Materials Procurement Agency is one of the agencies created under authority of the Defense Production Act of 1950 to increase and maintain supplies of critical materials. The Defense Materials Procurement Agency is responsible for making purchase contracts (including subsidies and floor prices to high cost producers) and granting priority ratings for production machinery and equipment and for recommending production-expansion and operating loans and certificates of necessity for accelerated tax amortization. The expansion program is not confined to domestic producers; a number of foreign contracts to bring in additional supplies of lead and zinc have been negotiated. The Defense Materials Procurement Agency also has the authority to certify access-roads projects for mines producing strategic and critical metals and minerals. Funds are appropriated by the Congress as a part of the Bureau of Public Roads appropriations. Tables 3, 4, and 5 show Defense Materials Procurement Agency projects as of August 31, 1952.

TABLE 5.—Roads certified for construction by the Mining Requirements Division, Defense Materials Procurement Agency, up to Sept. 1, 1952

Mine or mining company	Location	Length of road (miles)	Cost	Type of ore
Cashier Crescent mine	Montezuma, Colo	3	$2,400	Lead-copper.
Crested Butte Mining & Milling Co.	Crested Butte, Colo	4	38,000	Zinc.
Lupton Mining Co	Clear Creek County, Colo	.12	1,950	Lead-zinc.
Moreno Cripple Creek Corp	Silverton, Colo	2.2	8,900	Lead-zinc-copper.
Nabob Development Co	Clear Creek County, Colo	2.3	5,500	Lead.
Nevada Monarch Mining Co	Lincoln County, Nev	5	22,000	Copper-lead.
Ross Basin Mining Co	San Juan County, Colo	.4	4,000	Lead-zinc.
Sun Valley Lead-Silver Mines, Inc.	Blaine County, Idaho	10	66,000	Do.
Van Stone mine	Northport, Wash	8.12	68,135	Do.
Venture Leasing Co	Silverton, Colo	1.9	8,000	Lead-zinc-copper.
Zero Tunnel (Smith)	Clear Creek County, Colo	1	1,330	Zinc.

DOMESTIC PRODUCTION

Statistics on zinc production are compiled both on a mine and on a smelter basis. The mine-output data, based upon the zinc content of ores and concentrates produced (adjusted to account for average smelting losses), form an accurate measure of domestic zinc output from year to year. Smelter production of slab zinc from domestic ores represents a more accurate figure of zinc metal recovery but differs from the mine recovery figure because of a timelag between mine or mill shipments and smelter production and because considerable zinc concentrate is not smelted but rather is utilized directly in making zinc pigments and chemicals. The two production figures will check within the limits of statistical error when the basic differences in the two quantities are considered.

MINE PRODUCTION

Zinc mining in the United States is largely concentrated in six areas—the Tri-State area of southeastern Kansas, southwestern Missouri, and northeastern Oklahoma; Tennessee-Virginia; Sussex County, N. J.; St. Lawrence County, N. Y.; northern Illinois and Wisconsin; and the Western States (principally Montana, Idaho, Colorado, New Mexico, Arizona, Utah, Washington, Nevada, and California, in descending order of production in 1952).

Mine production of recoverable zinc (including that recovered as zinc pigments and salts directly from ore) decreased from 681,000 tons in 1951 to 666,000 in 1952, a decline of 2 percent. The decrease in output was the direct result of curtailments and shutdowns resulting from a succession of price declines between June 2 and October 27. Had the production rate of the first 6 months been maintained, the year's production would have been 720,000 tons.

The combined Western States supplied 58 percent of the total output, the States east of the Mississippi River 28 percent, and the West Central States (Arkansas, Kansas, Missouri, and Oklahoma) 14 percent, or the same percentage distribution as in 1951.

TABLE 6.—Mine production of recoverable zinc in the United States, 1943–47 (average) and 1948–52, by States, in short tons

State	1943–47 (average)	1948	1949	1950	1951	1952
Western States and Alaska:						
Alaska	5	22	2	6	1	----------
Arizona	37,458	54,478	70,658	60,480	52,999	47,143
California	6,505	5,325	7,209	7,551	9,602	9,419
Colorado	38,943	45,164	47,703	45,776	55,714	53,203
Idaho	83,224	86,267	76,555	87,890	78,121	74,317
Montana	30,717	59,095	54,195	67,678	85,551	82,185
Nevada	19,084	20,288	20,443	21,606	17,443	15,357
New Mexico	46,151	41,502	29,346	29,263	45,419	50,975
Oregon	----------	----------	6	21	3	1
South Dakota	24	29	----------	----------	----------	----------
Texas	13	----------	----------	----------	24	3
Utah	38,297	41,490	40,670	31,678	34,317	32,947
Washington	12,186	12,638	10,740	14,807	18,189	20,102
Total	312,607	366,298	357,527	366,756	397,383	385,652
West Central States:						
Arkansas	104	31	1	8	50	26
Kansas	51,648	35,577	29,433	27,176	28,904	25,482
Missouri	25,704	6,463	5,911	8,189	11,476	13,986
Oklahoma	79,090	43,821	44,033	46,739	53,450	54,916
Total	156,546	85,892	79,378	82,112	93,880	94,410
States east of the Mississippi River:						
Illinois	8,059	12,980	18,157	26,982	21,776	18,816
Kentucky	455	639	935	731	3,457	3,280
New Jersey	79,174	76,332	50,984	55,029	62,917	59,190
New York	34,630	34,566	37,973	38,321	40,051	32,636
Tennessee	34,449	29,524	29,788	35,326	38,639	38,020
Virginia	17,608	15,882	13,166	12,396	7,332	13,409
Wisconsin	14,399	7,864	5,295	5,722	15,754	20,588
Total	188,774	177,787	156,298	174,507	189,926	185,939
Grand total	657,927	629,977	593,203	623,375	681,189	666,001

TABLE 7.—Mine production of recoverable zinc in the United States,[1] 1951–52, by months, in short tons

Month	1951	1952	Month	1951	1952
January	60,086	59,377	August	54,545	49,209
February	54,512	59,145	September	50,382	49,291
March	60,795	60,972	October	60,613	54,243
April	56,277	61,354	November	57,483	49,782
May	59,114	62,751	December	57,041	52,263
June	56,872	57,079			
July	53,469	50,535	Total	681,189	666,001

[1] Includes Alaska.

Montana was again the leading zinc-producing State, although output of the mines declined 4 percent to 82,000 tons. Of this quantity, about 95 percent was produced by the Anaconda Copper Mining Co. from mines in the Summit Valley (Butte) district and from the East Helena lead smelter slags. The remainder was largely from the Jack Waite and Mike Horse properties of the American Smelting & Refining Co. The Mike Horse mine, which has been a substantial producer of lead and zinc for many years was closed in December because of low metal prices and the substantial exhaustion of ore reserves.

Idaho was second among the States in mine production of recoverable zinc, with an output of 74,000 short tons. Ninety-five percent of the production was from the Coeur d'Alene region, Shoshone County. Eight properties, in the region, all producing over 2,500 tons of recoverable zinc, furnished 77 percent of the total. In the order of output they were Star, Bunker Hill, Page, Morning, Sidney (Sidney Mining Co.), Frisco Group (Federal Mining and Smelting Co.), Tamarack (Day Mines, Inc.), and Bunker Hill slag dump.

Colorado zinc output declined 5 percent to 53,000 tons but was still larger than in any of the years from 1918 through 1950. Mines in Eagle County produced 49 percent of the total, San Miguel County 18 percent, Lake County 16 percent, and 13 other counties 17 percent.

New Mexico was sixth among the States as zinc output increased 12 percent above that of 1951 to 51,000 tons. Ninety-five percent of the zinc was produced by the Ground Hog, Bayard, Oswaldo, Kearny, Hanover, and Pewabic mines in the Central district of Grant County. Depressed metal prices resulted in the closing of the Oswaldo (October 4), the Hanover (October 11), and the Pewabic (December 23). The Kearny production was curtailed somewhat in the latter half of the year.

Zinc output in Arizona declined 11 percent below the 1951 production to 47,000 tons, owing to the closing of the San Xavier zinc-lead-silver mine in August, the suspension in August of mining zinc-copper ores at the Magma mine, and a substantial decrease in the output of the United Verde mine.

Utah produced 33,000 tons of zinc in 1952, a 4-percent decrease from 1951 and 14 percent less than the 1942–51 average. The United States and Lark property in the West Mountain (Bingham) district remained by far the largest producer. Other large producers were the New Park, Park Utah Consolidated, Chief Consolidated, Butterfield group, Ophir, and West Calumet mines. Labor strikes at the Chief Consolidated and Park Utah Consolidated mines and closing of the Silver King Coalition mine explained the lessened production.

Zinc production in Washington of 20,000 short tons was an alltime record—11 percent above 1951, the previous record year. The major mines were the Pend Oreille, Grandview, Deep Creek, Holden, and Van Stone.

Zinc output from Nevada decreased 12 percent from the 1951 level to 15,000 tons. Chief producing mines were the Pioche group of the Combined Metals Reduction Co. and the Ely Valley mine of Ely Valley Mines, Inc. The Ely Valley mine was closed because of low prices in August 1952.

California output of zinc dropped 2 percent during 1952 to 9,000 tons. Almost the entire production came from the Darwin group, Inyo County; the Afterthought mine, Shasta County; and the Penn mine, Calaveras County. The Afterthought mine of the Coronado Copper & Zinc Co. was closed in August 1952 owing to ore depletion.

The West Central States, comprising Arkansas, Kansas, Missouri, and Oklahoma, increased output of recoverable zinc slightly to 94,000 tons despite closing of 107 mines and 5 mills of the Tri-State district in the second half of the year. Of the total output, 91,000 tons was from the Tri-State district, which has produced approximately 11,000,000 tons of recoverable zinc since 1872 and has been the leading zinc-mining district every year but 1950 since about 1885. The 10 leading zinc producers in the district in 1952, in order of output, were: The Eagle-Picher Co. (Oklahoma, Kansas); American Zinc, Lead & Smelting Co. (Oklahoma, Missouri); St. Louis Smelting & Refining Division of National Lead Co. (Kansas); Buffalo Mining Co. (Oklahoma); Potter-Sims Mines, Inc. (Missouri); Dale Mining Co. (Missouri); Federal Mining & Smelting Co. (Oklahoma, Missouri); Bilharz Mining Co. (Kansas); Helen H. Mining Co. (Oklahoma, Kansas); and the Sooner Milling Co., Inc. (Oklahoma).

Zinc output from mines in States east of the Mississippi River decreased 2 percent from that of 1951 to 186,000 short tons. Zinc mine output in New York declined almost a fifth because of a labor strike between July 1 and September 14 at the Balmat and Edwards mines. Strikes also closed several zinc-producing mines in the southern Illinois and western Kentucky zinc-fluorspar area during part of June and July. Increased production in northern Illinois and Wisconsin resulted from relatively continuous operations at most established mines and the opening of the Hancock, Mulcahy, Birkett, and Andrews mines. Mine output in Virginia was normal or about twice the 1951 production as the Austinville mine in Wythe County operated 12 months, compared to 6 months in 1951. The principal zinc-producing companies in this group of States were the New Jersey Zinc Co. (Franklin and Sterling Hill mines in New Jersey and Austinville mine in Virginia); St. Joseph Lead Co. (Balmat and Edwards mines in New York); the American Zinc Co. of Tennessee (Athletic, Grasselli, Jarnagin, Mascot No. 2, and North Friends Station mines in Tennessee); United States Steel Corp., Tennessee Coal & Iron Division (Davis-Bible group mines in Tennessee); Tennessee Copper Co. (in Tennessee); the Vinegar Hill Zinc Co., Tri-State Zinc, Inc., Calumet & Hecla, Inc., and Eagle-Picher Co. (in northern Illinois and Wisconsin); and the Alcoa Mining Co., Minerva Oil Co., and Ozark-Mahoning Co. (in southern Illinois and western Kentucky).

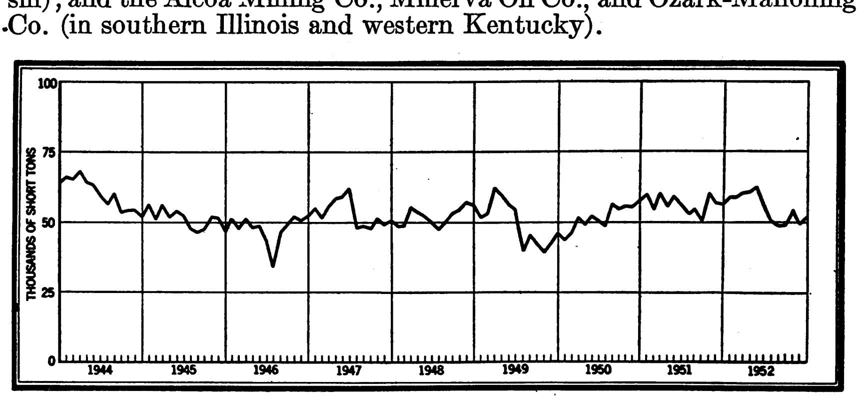

FIGURE 1.—Mine production of recoverable zinc in the United States, 1944–52 by months, in short tons.

TABLE 8.—Twenty-five leading zinc-producing mines in the United States in 1952, in order of output

Rank	Mine	District	State	Operator	Type of ore
1	Butte Hill mines	Summit Valley (Butte)	Montana	Anaconda Copper Mining Co	Copper-zinc-lead.
2	Franklin and Sterling Hill	New Jersey	New Jersey	New Jersey Zinc Co	Zinc.
3	Eagle Group	Red Cliff	Colorado	Empire Zinc Division, New Jersey Zinc Co	Do.
4	Balmat	St. Lawrence County	New York	St. Joseph Lead Co	Zinc-lead.
5	United States and Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co	Do.
6	Ground Hog	Central	New Mexico	American Smelting & Refining Co	Zinc.
7	Star	Hunter	Idaho	Sullivan Mining Co	Zinc-lead.
8	Austinville	Austinville	Virginia	New Jersey Zinc Co	Do.
9	Rialto Group	Tri-State	Oklahoma	American Zinc, Lead & Smelting Co	Do.
10	Mascot No. 2	Eastern Tennessee	Tennessee	American Zinc Co. of Tennessee	Zinc.
11	Bayard Group	Central	New Mexico	U. S. Smelting, Refining & Mining Co	Do.
12	Iron King	Big Bug	Arizona	Shattuck Denn Mining Corp	Zinc-lead.
13	Bunker Hill and Sullivan	Yreka	Idaho	Bunker Hill & Sullivan Mining & Concentrating Co	Do.
14	Pioche	Pioche	Nevada	Combined Metals Reduction Co	Do.
15	Davis-Bible Group	Eastern Tennessee	Tennessee	United States Steel Corp	Zinc.
16	Page	Yreka	Idaho	Federal Mining & Smelting Co	Zinc-lead.
17	Oswaldo	Central	New Mexico	Kennecott Copper Corp	Zinc.
18	Calumet	Wisconsin	Wisconsin	Calumet & Hecla Consolidated Copper Co	Zinc-lead.
19	Resurrection Group	California (Leadville)	Colorado	Resurrection Mining Co	Do.
20	Pend Oreille	Metaline	Washington	Pend Oreille Mines & Metals Co	Do.
21	Edwards	St. Lawrence County	New York	St. Joseph Lead Co	Zinc.
22	Bautsch	Northern Illinois	Illinois	Tri-State Zinc Co., Inc	Do.
23	Grandview	Metaline	Washington	American Zinc, Lead & Smelting Co	Zinc-lead.
24	Morning	Hunter	Idaho	Federal Mining & Smelting Co	Do.
25	Treasury Tunnel	Upper San Miguel	Colorado	Idarado Mining Co	Copper-zinc-lead.

The 25 leading zinc-producing mines in the United States in 1952, listed in table 8, yielded 60 percent of the total domestic zinc output; the 3 leading mines 23 percent; and the 6 leading mines 32 percent.

Detailed information on the production of zinc mines in the United States by districts, counties, and States may be found in volume III of the Minerals Yearbook for 1952.

TABLE 9.—Mine production of recoverable zinc in the United States, 1943–47 (average) and 1948–52, by districts that produced 1,000 tons or more during any year 1948–52, in short tons

District	State	1943–47 (average)	1948	1949	1950	1951	1952
Tri-State (Joplin region)	Kansas, southwestern Missouri, Oklahoma.	155,687	84,839	78,628	80,558	91,553	90,512
Summit Valley (Butte)	Montana	14,387	52,625	47,982	63,511	80,500	75,968
Coeur d'Alene	Idaho	77,914	83,801	74,370	86,103	74,989	70,316
New Jersey	New Jersey	79,174	76,332	50,984	55,029	62,917	59,190
Central	New Mexico	40,708	35,140	26,376	26,897	41,884	48,043
Eastern Tennessee [1]	Tennessee	34,449	29,524	29,788	35,326	38,639	38,020
Upper Mississippi Valley	Northern Illinois, Iowa,[2] Wisconsin.	17,504	14,061	17,846	26,793	31,403	34,716
St. Lawrence County	New York	34,630	34,566	37,973	38,321	40,051	32,636
Red Cliff	Colorado	19,793	16,355	17,450	19,956	29,200	26,000
West Mountain (Bingham)	Utah	17,053	22,077	22,311	16,120	18,286	20,395
Austinville	Virginia	17,018	15,882	13,166	[1] 12,396	[1] 7,332	13,409
Pioche	Nevada	15,335	18,612	18,651	19,655	14,350	12,493
Big Bug	Arizona	4,390	5,832	8,798	10,416	9,688	10,862
Upper San Miguel	Colorado	1,506	3,486	6,004	8,881	9,228	9,811
California (Leadville)	do	6,344	5,726	6,455	7,392	8,144	8,487
Kentucky-Southern Illinois	Kentucky, Southern Illinois.	5,409	7,422	6,541	6,642	9,584	7,968
Park City region	Utah	9,662	10,320	8,359	7,425	10,209	7,746
Coso	California	655	4,497	4,062	5,237	4,720	5,479
Warren (Bisbee)	Arizona	16,418	27,669	35,393	20,707	4,511	4,791
Verde (Jerome)	do		459	4,350	7,800	10,155	4,360
Cochise	do	1,473	2,875	1,760	1,025	3,243	4,266
Pioneer (Superior)	do	2,044			2,595	6,240	4,175
Harshaw	do	2,050	2,875	2,947	4,193	4,076	3,924
Eureka (Bagdad)	do	253	2,321	2,304	1,478	2,504	3,520
Pima (Sierritas, Papago, Twin Buttes).	do	3,786	5,758	7,177	5,802	5,414	3,472
Old Hat (Oracle)	do	3,477	3,796	5,195	4,603	3,583	3,368
Tintic	Utah	3,277	3,680	6,082	5,985	3,410	2,951
Smelter (Lewis and Clark County).	Montana	10,553	3,417	1,463	2,358	2,428	2,807
Pioneer (Rico)	Colorado	3,799	3,180	1,354	1,365	2,527	2,734
Warm Springs	Idaho	3,298	1,545	1,635	1,236	1,860	2,142
Magdalena	New Mexico	4,259	4,856	2,263	1,677	2,276	2,122
Yellow Pine (Goodsprings)	Nevada	621	434	447	643	1,332	1,464
Aravaipa	Arizona	169	1,098	783	921	1,404	1,315
Flint Creek	Montana	59	24	8	120	392	1,084
Heddleston	do	1,472	1,437	2,026	892	1,395	1,066
Patagonia (Duquesne)	Arizona	1,004	350	555	368	601	1,049
Creede	Colorado	6	88	671	873	892	1,024
Animas	do	949	748	1,029	961	1,183	986
Sneffels	do	[3] 415	815	1,053	810	1,094	931
Rush Valley and Smelter (Tooele County).	Utah	6,966	3,552	2,188	1,219	1,608	916
Tomichi	Colorado	666	1,983	1,456	963	1,011	874
Campo Seco	California	1,699		363	326	884	829
Ophir	Utah	308	786	1,004	374	341	670
Pinos Altos	New Mexico	456	1,056	243	144	213	110
Ten Mile	Colorado	2,335	10,338	9,716	2,925	16	12
Chelan Lake [4] [5]	Washington	1,631	3,289	2,724	2,430	1,879	(6)
Cow Creek [5]	California	36	(6)	(6)	(6)	(6)	(6)
Metaline [5]	Washington	8,752	5,985	6,496	11,032	12,753	(6)
Northport [5]	do	1,668	3,271	1,412	1,304	3,496	(6)
Smelter (Cascade County) [5]	Montana			1,278			

[1] Includes very small quantity produced elsewhere in State.
[2] No production in Iowa since 1917.
[3] 1942–46 average.
[4] Includes Peshastin Creek and Wenatchee River districts.
[5] This district is not listed in order of 1952 output.
[6] Quantity withheld to avoid disclosure of individual company operations.

SMELTER PRODUCTION

During 1952, 18 primary zinc-reduction plants were operating; 9 operated with horizontal retorts exclusively, 4 with vertical retorts exclusively (1 wholly electrothermic and 1 partly so), and 5 with electrolytic methods.

Horizontal-Retort Plants.—The total number of retorts reported at active horizontal-retort primary plants in 1952 was 55,800, a 2-percent increase from the 54,600 retorts reported in 1951. Of the total retorts reported, 51,800 (93 percent) were in use at the close of 1952, compared with 52,500 (96 percent) in use at the end of 1951. The reports disclosed that 96 additional retorts were under construction.

Vertical-Retort Plants.—Four vertical-retort, continuous-distilling plants operated during 1952. Three of these used the New Jersey Zinc Co. fuel-fired vertical retorts, and the fourth is an electrothermal vertical retort plant developed by the St. Joseph Lead Co. The New Jersey Zinc Co. operated an electric furnace on an experimental basis between July 1951 and through much of 1952 and began constructing additional units in late 1952. The total number of vertical retorts of all types increased from 89 as of the end of 1951 to 91 at the close of 1952. Of these 80 were in operation on December 31, 1952.

Electrolytic Plants.—Five electrolytic zinc-reduction plants with a total of 3,370 electrolytic cells were operated in 1952, the same as in 1951. Of this cell capacity, 3,340 were in use at the end of 1952, the same as at the end of 1951. One hundred fifty six new electrolytic cells were under construction at the end of 1952.

Smelting Capacity.—Irrespective of additions or subtractions of smelter recovery units, statistics on domestic smelting capacity vary from year to year, owing to changes in metallurgical practices at the various plants. According to reports to the Bureau of Mines, the active zinc-reduction plants in the United States as of the end of 1952 had a stated annual capacity of 1,112,000 tons of slab zinc under normal operating conditions. This figure, which compares with 1,083,000 tons reported capacity at the end of 1951, indicated the 1952 smelter output was 86 percent of capacity, or the same as in 1951. Horizontal and vertical retort plants operated at 84 percent of the 680,000 tons reported capacity (86 percent of a 651,000-ton capacity in 1951), electrolytic plants at 94 percent of a 375,000-ton reported capacity (90 percent of 375,000-ton capacity in 1951), and secondary smelters at 64 percent of 57,000-ton reported capacity (57 percent of 56,700-ton capacity in 1951).

Waelz Kilns.—The following companies operated Waelz kilns in 1952:

Arkansas: Fort Smith—The Residue Co.
Illinois:
- Danville—The Hegeler Zinc Co.
- Fairmont City—American Zinc Co. of Illinois
- La Salle—Matthiessen & Hegeler Zinc Co.

Kansas: Cherryvale—National Zinc Co., Inc.
Oklahoma: Henryetta—Eagle-Picher Co.
Pennsylvania:
- Donora—American Steel & Wire Division, United States Steel Corp.
- Palmerton—New Jersey Zinc Co.

Slag-Fuming Plants.—The following companies operated slag-fuming plants in 1952 to produce impure zinc oxide, which was further treated to recover the zinc as slab zinc:

Idaho: Kellogg—Bunker Hill & Sullivan Mining & Concentrating Co.
Montana: East Helena—Anaconda Copper Mining Co.
Texas: El Paso—American Smelting & Refining Co.
Utah: Tooele—International Smelting & Refining Co.

During 1952 these 4 plants treated 626,200 tons of hot and cold slag, which yielded 104,200 tons of oxide fume containing 73,300 tons of recoverable zinc. Corresponding figures for 1951 were 606,100, 108,100, and 74,700 tons, respectively. New slag-fuming facilities were under construction at the Herculaneum, Mo., smelter of St. Joseph Lead Co. and at the Selby, Calif. smelter of the American Smelting & Refining Co.

Active Zinc-Reduction Plants.—During 1952 the New Jersey Zinc Co. continued constructing additional Sterling-process furnaces for electrothermic reduction of zinc ores at its Palmerton, Pa., plant. The initial furnace installation, which has capacity for 35 tons of zinc per day, was operated experimentally throughout most of the year.

As a result of electric power shortages in the Pacific Northwest, the Sullivan Mining Co., owned jointly by Hecla Mining Co. and Bunker Hill & Sullivan Mining & Concentrating Co., curtailed production of its electrolytic zinc plant near Kellogg by about 20 percent in late September. Continued drought brought further curtailment by the Defense Electric Power Administration on November 17, and production was reduced to 3,500 tons monthly, or about 70 percent of capacity, for the remainder of the year.

The only other interruption to production was that occasioned by the steel strike, which shut down operations at the Donora, Pa., smelter of the American Steel & Wire Division of the United States Steel Corp. from June 2 to July 25, 1952.

A list of zinc-reduction plants operating in the United States in 1952 follows:

Primary Zinc Distillers

Horizontal-retort plants

Arkansas: Fort Smith—Athletic Mining & Smelting Co.
Illinois:
Fairmont City—American Zinc Co. of Illinois
La Salle—Matthiessen & Hegeler Zinc Co.
Oklahoma:
Bartlesville—National Zinc Co., Inc.
Blackwell—Blackwell Zinc Co.
Henryetta—Eagle-Picher Co.
Pennsylvania: Donora—American Steel & Wire Div. of United States Steel Corp.
Texas:
Amarillo—American Smelting & Refining Co.
Dumas—American Zinc Co. of Illinois

Vertical-retort plants

Illinois: Depue—The New Jersey Zinc Co.
Pennsylvania:
Josephtown—St. Joseph Lead Co.
Palmerton—The New Jersey Zinc Co. of Pennsylvania
West Virginia: Meadowbrook—Matthiessen & Hegeler Zinc Co.

Electrolytic plants

Idaho: Kellogg—Sullivan Mining Co.
Illinois: Monsanto—American Zinc Co. of Illinois
Montana:
Anaconda—Anaconda Copper Mining Co.
Great Falls—Anaconda Copper Mining Co.
Texas: Corpus Christi—American Smelting & Refining Co.

Secondary Zinc Distillers

Alabama: Fairfield—W. J. Bullock, Inc.
California:
Los Angeles—American Smelting & Refining Co., Federated Metals Division
Torrance—Pacific Smelting Co.
Illinois:
Beckemeyer—American Smelting & Refining Co., Federated Metals Division
Hillsboro—American Zinc, Lead & Smelting Co.
Sandoval—Sandoval Zinc Co.
New Jersey: Trenton—American Smelting & Refining Co., Federated Metals Division
New York: Tottenville—Nassau Smelting & Refining Co.
Oklahoma: Sand Springs—American Smelting & Refining Co., Federated Metals Division
Pennsylvania:
Bristol—Superior Zinc Corp.
Philadelphia—General Smelting Co.
West Virginia: Wheeling—Wheeling Steel Corp.

SLAB ZINC

The output of primary slab zinc in 1952 was 904,000 tons, or 3 percent greater than 1951 production and the second greatest output on record. Slab zinc from domestic ores declined 7 percent compared with the 1951 output, but that from foreign ores increased 26 percent.

Production of redistilled slab zinc increased 13 percent but remained well below the record output of 67,000 tons in 1950. Of the 55,000 tons of redistilled secondary slab zinc produced in 1952, 19,000 tons (34 percent) was produced at primary smelters and 36,000 tons (66 percent) at secondary plants.

In addition to primary distilled and redistilled secondary zinc, 3,197 tons of remelted secondary slab zinc was recovered by remelting purchased scrap (4,454 tons in 1951). Zinc rolling mills and other large consumers of slab zinc recovered large quantities of slab zinc from scrap generated in their own plants, but metal so recovered is not measured statistically.

In addition to redistilled and remelted unalloyed secondary zinc, large quantities of secondary zinc are recovered each year in the form of alloys (brass, zinc-base die-cast alloy), zinc dust, zinc pigments, and zinc salts. More information on secondary zinc is given in the Secondary Metals—Nonferrous chapter of this volume.

Of the 1952 output of primary zinc, 61 percent was distilled and 39 percent produced electrolytically.

Production of Special High Grade, Regular High Grade, and Prime Western increased 5, 4, and 6 percent, respectively, in 1952, but output of Intermediate and Brass Special declined 14 and 19 percent, respectively. Selected grade showed a negligible percentage increase. Of the total 1952 output (comparable 1951 figures in parentheses) 42 (41) percent was Prime Western, 31 (30) percent Special High Grade, 19 (19) percent Regular High Grade, 5 (7) percent Brass Special, 2 (2) percent Intermediate, and 1 (1) percent Selected.

TABLE 10.—Primary and redistilled secondary slab zinc produced in the United States, 1943–47 (average) and 1948–52, in short tons

Year	Primary			Redistilled secondary	Total (excludes zinc recovered by remelting)
	From domestic ores	From foreign ores	Total		
1943–47 (average)	521,010	[1] 300,376	821,386	50,110	871,496
1948	537,966	249,798	787,764	62,320	850,084
1949	591,454	223,328	814,782	55,041	869,823
1950	588,291	255,176	843,467	66,970	910,437
1951	621,826	259,807	881,633	48,657	930,290
1952	575,828	[1] 328,651	904,479	55,111	959,590

[1] Includes a small tonnage of foreign slab zinc further refined into high-grade metal in the United States.

TABLE 11.—Distilled and electrolytic zinc, primary and secondary, produced in the United States, 1943–47 (average) and 1948–52, in short tons

CLASSIFIED ACCORDING TO METHOD OF REDUCTION

Year	Electrolytic primary	Distilled	Redistilled secondary [1]		Total
			At primary smelters	At secondary smelters	
1943–47 (average)	298,806	522,580	22,153	27,957	871,496
1948	312,477	475,287	28,070	34,250	850,084
1949	326,152	488,630	22,782	32,259	869,823
1950	342,085	501,382	28,411	38,559	910,437
1951	336,087	545,546	16,251	32,406	930,290
1952	351,106	553,373	18,861	36,250	959,590

CLASSIFIED ACCORDING TO GRADE

Year	Grade A		Grade B (Intermediate)	Grades C and D		Grade E (Prime Western)	Total
	Special High Grade (99.99% Zn)	Regular High Grade (Ordinary)		Brass Special	Selected		
1943–47 (average)	248,016	223,554	47,368	69,723	17,750	265,085	871,496
1948	248,346	196,482	38,892	45,946	4,723	315,695	850,084
1949	230,576	206,651	21,513	56,388	2,565	352,130	869,823
1950	271,678	192,075	21,571	46,730	4,021	374,362	910,437
1951	281,571	175,499	20,734	60,511	13,494	378,481	930,290
1952	295,801	182,125	17,903	48,817	13,608	401,336	959,590

[1] For total production of secondary zinc see chapter on Secondary Metals—Nonferrous.

TABLE 12.—Primary slab zinc produced in the United States, by States where smelted, 1943–47 (average) and 1948–52, in short tons

Year	Arkansas	Idaho	Illinois	Montana	Oklahoma	Pennsylvania	Texas and West Virginia [1]	Total	
								Short tons	Value
1943–47 (average)	26,465	37,487	143,828	205,068	103,609	199,483	105,446	821,386	$148,925,111
1948	15,586	42,064	93,229	207,717	137,844	171,276	120,048	787,764	209,860,330
1949	17,116	41,854	86,823	216,578	157,650	156,920	137,841	814,782	202,391,849
1950	20,688	53,922	108,301	216,104	145,117	162,539	136,796	843,467	240,050,708
1951	21,776	54,468	108,544	208,482	161,247	189,177	137,939	881,633	321,619,718
1952	21,644	54,340	115,331	214,980	161,242	193,811	143,131	904,479	300,829,715

[1] Includes Missouri, 1943–44 and 1947–52.

In 1952 Montana was again the largest producer of primary slab zinc, and Pennsylvania and Oklahoma were, respectively, second and third. All slab zinc produced in Montana and Idaho was produced electrolytically, that produced in Illinois and Texas was in part produced electrolytically and in part by distillation, but all of that produced in the other States was wholly by distillation.

BYPRODUCT SULFURIC ACID

Sulfuric acid is made from sulfur dioxide gases produced in roasting zinc-blende (sphalerite) concentrate at all zinc smelters where there is enough demand for sulfuric acid to warrant the plant investment and operation. At several such plants large quantities of elemental sulfur are also burned to increase acid-making capacity. The production of sulfuric acid at such plants from 1948 through 1952 is shown in table 13.

TABLE 13.—Sulfuric acid (basis, 100 percent) made at zinc-blende roasting plants in the United States, 1948–52

Year	Made from zinc blende [1]		Made from native sulfur		Total [1]		
						Value [2]	
	Short tons	Value [2]	Short tons	Value [2]	Short tons	Total	Average per ton
1948	529,478	$7,478,271	233,099	$3,292,261	762,577	$10,770,532	$10.97
1949	476,932	7,276,481	130,592	1,992,423	607,524	9,268,904	11.85
1950	609,571	8,829,236	243,743	3,530,464	853,314	12,359,700	11.25
1951	635,948	10,218,400	261,106	4,195,451	897,054	14,413,851	12.48
1952	664,714	11,031,494	224,671	3,728,613	889,385	14,760,107	12.89

[1] Includes acid from foreign blende.
[2] At average of sales of 60° B. acid.

ZINC DUST

Production of zinc dust in 1952 was 25,100 tons, or 21 percent less than in 1951. The zinc dust reported here is restricted to commercial grades that comply with close specifications as to percentage of unoxidized metal, evenness of grading, and fineness of particles and hence does not include zinc powder and blue powder. The zinc content of the dust produced in 1952 ranged from 94.95 to 99.73 percent and averaged 97.45 percent. Shipments of zinc dust totaled 24,198 tons, of which 588 tons was for foreign consignees. Producers' stocks of zinc dust almost doubled, going from 737 tons at the beginning of the year to 1,432 tons at the end of 1952.

The average price of zinc dust shipped to domestic consumers in 1952 was 19.48 cents a pound, compared with 21.2 cents in 1951. The raw materials used to manufacture zinc dust are reviewed in the Secondary Metals—Nonferrous chapter of this volume. Most of the production is from zinc scrap (principally galvanizers' dross), but some is recovered from zinc ore, slab zinc, and as a byproduct of zinc refining.

ZINC PIGMENTS AND SALTS

The principal zinc pigments are zinc oxide and lithopone and the principal salts the chloride and sulfate. These products are manufactured from various zinc-bearing materials, including ore, metal, scrap, and residues. In 1952 the production of lead and zinc pigments and zinc salts continued to decline, and the shipments of these products decreased from the 1951 level by the following percentages—zinc oxide, 4 percent; lithopone, 40 percent; zinc chloride, 14 percent; and zinc sulfate, 17 percent. Details of the production of zinc pigments and salts are given in the Lead and Zinc Pigments and Zinc Salts chapter of this volume.

CONSUMPTION AND USES

According to reports from approximately 750 plants, 853,000 tons of slab zinc was put into process in 1952, or 9 percent less than in 1951. The decrease was attributed to the steel strike (June 2 to July 25), which curtailed supplies of steel necessary to manufacture steel products for galvanizing and other products that use zinc die castings. Receipts of slab zinc at consumers' plants were 895,000 tons.

Galvanizing was again the largest field of zinc use, consuming 44 percent of the total in 1952. The quantity so consumed was approximately 6 percent less than in 1951, the declines being largely in job galvanizing items. The manufacture of zinc-base alloys (largely die castings) used 237,000 tons of slab zinc or 20 percent less than the previous year, owing principally to a 19-percent reduction in automobile production in 1952. Consumption of slab zinc for the manufacture of brass products increased to 156,000 tons or 9 percent above the 1951 rate as greater supplies of copper were available for brassmaking. The low level of slab-zinc consumption relative to the total zinc used in brass products is explained by the fact that 185,000 tons of secondary zinc largely recovered from copper-base scrap is recovered in brass and bronze ingot at secondary smelters.

The quantity of slab zinc consumed for rolled-zinc products in 1952 was 20 percent less than in 1951. In addition to slab zinc, the rolling mills remelt and reroll the metallic scrap produced from their fabricating operations. The scrap so treated totaled 11,100 tons compared with 11,600 tons in 1951. Purchased zinc scrap in the form of zinc clippings, old zinc scrap, and engravers' plates, totaling 3,200 tons, was also melted and rolled in 1952 (3,800 tons in 1951). Production of rolled zinc from both slab zinc and purchased scrap was 53,500 tons, a decrease of 19 percent from the 1951 total. Inventories of rolled zinc were 2,000 tons at the end of 1952, or the same as at the end of 1951. In addition to shipments of 43,000 tons of rolled zinc in 1952, the rolling mills processed 21,800 tons of rolled zinc in manufacturing 11,200 tons of semifabricated and finished products.

TABLE 14.—Zinc dust[1] produced in the United States, 1943–47 (average) and 1948–52

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average per pound			Total	Average per pound
1943–47 (average)	27,511	$5,906,472	$0.107	1950	28,922	$9,602,104	$0.166
1948	32,217	10,051,704	.156	1951	31,695	13,438,680	.212
1949	22,776	6,195,072	.136	1952	25,113	9,794,070	.195

[1] All produced by distillation.

TABLE 15.—Consumption of slab zinc in the United States, 1943–47 (average) and 1948–52, by industries, in short tons [1]

Industry and product	1943–47 (average)	1948	1949	1950	1951	1952
Galvanizing: [2]						
Sheet and strip	111,192	120,360	146,923	188,406	144,329	145,875
Wire and wire rope	44,244	49,906	39,231	47,317	51,792	48,645
Tubes and pipe	60,871	81,874	78,030	91,877	79,221	82,043
Fittings	11,947	14,037	11,487	15,948	21,186	10,366
Other	89,238	104,792	75,209	98,138	103,751	90,759
Total galvanizing	317,492	370,969	350,880	441,686	400,279	377,688
Brass products:						
Sheet, strip, and plate	159,415	51,813	43,157	68,737	67,815	71,706
Rod and wire	58,569	32,076	23,651	43,413	46,056	49,831
Tube	21,670	15,890	12,816	17,385	15,927	17,057
Castings and billets	10,885	4,228	2,620	4,170	7,098	7,262
Copper-base ingots	11,826	3,546	2,701	4,081	5,743	8,223
Other copper-base products	2,001	1,587	589	1,587	653	1,529
Total brass products	264,366	109,140	85,534	139,373	143,292	155,608
Zinc-base alloy:						
Die castings	134,946	230,995	199,665	285,022	282,812	225,877
Alloy dies and rod	8,343	3,171	2,024	2,929	11,135	9,235
Slush and sand castings	383	462	492	1,576	2,487	1,577
Total zinc-base alloy	143,672	234,628	202,181	289,527	296,434	236,689
Rolled zinc	77,144	76,672	55,200	68,444	64,085	51,318
Zinc oxide	17,471	15,657	10,292	18,187	18,223	17,205
Other uses:						
Wet batteries	1,774	1,368	1,359	1,527	1,749	1,396
Desilverizing lead	2,158	2,654	2,448	2,947	2,186	2,370
Light-metal alloys	1,148	1,125	1,060	1,356	3,132	3,266
Other [3]	3,838	5,522	2,887	4,087	4,591	7,243
Total other uses	8,918	10,669	7,754	9,917	11,658	14,275
Total consumption [4]	829,063	817,735	711,841	967,134	933,971	852,783

[1] Excludes some small consumers.
[2] Includes zinc used in electrogalvanizing and electroplating, but excludes sherardizing.
[3] Includes zinc used in making zinc dust, bronze powder, alloys, chemicals, castings, and miscellaneous uses not elsewhere mentioned.
[4] Includes 3,141 tons of remelt zinc in 1948, 2,394 tons in 1949, 3,035 tons in 1950, 4,505 tons in 1951, and 4,144 tons in 1952.

TABLE 16.—Rolled zinc produced and quantity available for consumption in the United States, 1951–52

	1951			1952		
	Short tons	Value		Short tons	Value	
		Total	Average per pound		Total	Average per pound
Production:						
Sheet zinc not over 0.1 inch thick	17,535	$10,536,341	$0.300	11,906	$7,210,737	$0.303
Boiler plate and sheets over 0.1 inch thick	2,211	1,112,648	.252	1,387	705,111	.254
Strip and ribbon zinc [1]	44,713	21,057,114	.236	38,750	16,728,827	.216
Foil, rod, and wire	1,629	1,014,227	.311	1,441	905,477	.314
Total rolled zinc	66,088	33,720,330	.255	53,484	25,550,152	.239
Imports	149	[2] 84,044	.282	47	23,557	.251
Exports	4,868	3,126,189	.321	3,031	1,935,410	.319
Available for consumption	60,774			50,688		
Value of slab zinc (all grades)			.182			.166
Value added by rolling			.073			.073

[1] Figures represent net production. In addition 11,627 tons of strip and ribbon zinc in 1951 and 11,107 tons in 1952 were rerolled from scrap originating in fabricating plants operated in connection with zinc rolling mills.
[2] Revised figure.

TABLE 17.—Consumption of slab zinc in the United States in 1952, by grade and industry, in short tons

Industry	Special High Grade	Regular High Grade	Inter-mediate	Brass Special	Selected	Prime Western	Remelt	Total
Galvanizers	13,179	22,877	10,503	11,067	976	316,527	2,559	377,688
Brass products	37,523	82,706	1,976	11,348	1,324	20,213	518	155,608
Zinc-base alloy	234,806	787	83	51	30	390	542	236,689
Rolled zinc	5,522	23,402	6,479	13,462	325	2,128		51,318
Zinc oxide				8,118		9,087		17,205
Other	4,516	1,486	617	838		6,293	525	14,275
Total	295,546	131,258	19,658	44,884	2,655	354,638	4,144	852,783

Table 17 shows the six commercial grades of refined slab zinc and purchased remelt zinc consumed by the various industries in 1952. Of the 853,000 tons of domestic and foreign zinc consumed, 42 percent was Prime Western, 35 percent Special High Grade, 15 percent Regular High Grade, and 5 percent Brass Special compared with 41, 38, 14, and 4 percent, respectively, in 1951. All grades were used for galvanizing, Prime Western being used principally in the hot-dip process and the higher grades being used chiefly in electrogalvanizing. Rigid specifications in brass manufacture dictate the use of higher grade metal, 77 percent of the total used in 1952 being Special High Grade and Regular High Grade.

CONSUMPTION OF SLAB ZINC BY GEOGRAPHIC AREAS[3]

Data on slab-zinc consumption, broken down by States and groups of States, have been available since 1940 and have been an annual feature of the Minerals Yearbook since 1948. During the 13 years, 1940–52, substantial shifts in the geography of consumption and the use pattern are observable as industry moved to a war-production base in 1940–41, reconverted to peacetime consumption in 1945–46, and again prepared for emergencies in 1950–52. The distribution of slab-zinc consumption by geographic divisions and States, both total and by major use categories, is shown in tables 18–23.

Consumption of Slab Zinc for All Uses.—From 1940–52 Illinois ranked first among the 42 zinc-consuming States and the District of Columbia, with an annual average of 140,000 tons. In 1945–51 Ohio was in second place but achieved first place in 1952. Pennsylsylvania has held either second or third place since 1940, and Connecticut, the second largest consuming State during World War II owing to the large consumption of zinc in the brass plants of the State, has been in fourth place since 1945. Between 1945 and 1952 Indiana was the fifth largest consumer, and Michigan or New York held either sixth or seventh place, but in 1952 Michigan attained fifth place. The greatest concentration of slab-zinc consumption by geographic divisions is in the region comprising Illinois, Indiana, Michigan, Ohio, and Wisconsin. This area, which has consistently ranked first since considerably before 1940, uses nearly half of the total slab zinc consumed in the United States. The region of least consumption is the Mountain States, including Arizona, Colorado, Idaho, Nevada, New Mexico, and Utah, which consumed about 0.3 percent of the total.

[3] This section is based partly on a detailed study by Ransome, Alfred L., Consumption of Slab Zinc in the United States by Industries, Grades, and Geographic Divisions, 1940–45: Bureau of Mines Inf. Circ. 7450, 1948, 30 pp.

TABLE 18.—Consumption of slab zinc in the United States, 1945–49 (average) and 1950–52, by geographic divisions and States [1]

Geographic division and State	1945–49 (average)		1950		1951		1952	
	Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
I. New England:								
Connecticut	66,912	4	70,115	4	69,926	4	65,350	4
Massachusetts	10,964	15	9,507	16	9,745	15	9,872	15
Maine	253	29	97	31	95	35	(2)	35
New Hampshire	50	34	(2)	36	(2)	37	(2)	39
Rhode Island	209	31	(2)	28	(2)	28	(2)	28
Total	78,388	3	80,014	3	80,348	3	75,984	3
II. Middle Atlantic:								
New Jersey	20,178	12	23,231	12	21,517	12	22,975	12
New York	44,310	6	55,070	7	57,809	6	52,738	7
Pennsylvania	119,568	3	139,400	3	137,056	3	126,083	3
Total	184,056	2	217,701	2	216,382	2	201,796	2
III. South Atlantic:								
Delaware	------	------	------	------	(2)	31	(2)	32
District of Columbia	51	33	(2)	34	(2)	36	(2)	37
Florida	45	36	------	------	(2)	33	(2)	33
Georgia	2,196	19	2,164	21	1,689	23	1,479	24
Maryland	23,130	10	36,649	10	28,878	9	29,077	9
North Carolina	------	------	------	------			(2)	38
South Carolina	47	35	(2)	32	------	------	(2)	36
Virginia	388	27	207	30	273	32	373	31
West Virginia	23,780	9	29,736	11	25,616	10	23,655	10
Total	49,637	4	68,825	4	57,032	4	55,350	4
IV. East North Central:								
Illinois	144,710	1	183,957	1	167,937	1	142,516	2
Indiana	61,708	5	67,449	5	58,191	5	53,444	6
Michigan	41,166	7	57,017	6	55,864	7	53,491	5
Ohio	126,970	2	152,008	2	158,685	2	143,350	1
Wisconsin	14,346	14	13,752	14	13,951	14	12,057	14
Total	388,900	1	474,183	1	454,628	1	404,858	1
V. East South Central:								
Alabama	20,660	11	37,061	9	25,502	11	23,241	11
Kentucky	8,027	16	(2)	15	(2)	16	(2)	16
Tennessee	1,208	23	(2)	23	(2)	25	(2)	25
Total	29,895	5	48,808	5	35,206	6	32,600	6
VI. West North Central:								
Iowa	6,617	17	4,680	17	4,480	18	4,632	18
Kansas	81	32	(2)	33	(2)	30	(2)	30
Minnesota	3,225	18	4,250	18	3,798	19	(2)	19
Missouri	16,100	13	16,500	13	19,472	13	14,734	13
Nebraska	1,347	22	(2)	22	(2)	24	(2)	23
Total	27,370	6	27,122	7	29,517	7	24,208	7
VII. West South Central:								
Arkansas	------	------	------	------	(2)	39	(2)	41
Louisiana	216	30	722	26	(2)	27	(2)	26
Oklahoma	822	25	1,261	24	(2)	22	1,921	22
Texas	1,951	20	3,289	19	4,959	17	5,230	17
Total	2,989	8	5,272	8	7,885	8	8,075	8
VIII. Mountain:								
Arizona	4	38	------	------	(2)	34	(2)	34
Colorado	1,548	21	2,474	20	(2)	21	(2)	20
Idaho	257	28	(2)	27	(2)	29	(2)	29
Montana	------	------	------	------	------	------	(2)	42
Nevada	------	------	------	------	------	------	------	------
Utah	38	37	(2)	35	(2)	38	(2)	40
Total	1,847	9	3,160	9	3,038	9	2,880	9
IX. Pacific:								
California	25,745	8	37,525	8	41,898	8	39,955	8
Oregon	397	26	244	29	1,051	26	767	27
Washington	1,047	24	1,245	25	2,481	20	2,166	21
Total	27,189	7	39,014	6	45,430	5	42,888	5
Grand total [1]	790,271	------	964,099	------	929,466	------	848,639	------

[1] Excludes remelt zinc and some small consumers of slab zinc.
[2] Nominal quantity consumed included with subtotal for division, as less than 3 companies reported.

TABLE 19.—Consumption of slab zinc for galvanizing in the United States, 1945–49 (average) and 1950–52, by States [1]

State	Geographic division	1945–49 (average)		1950		1951		1952	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	20,492	7	36,520	4	24,827	6	22,495	8
California	IX	14,231	8	21,208	8	23,756	8	22,516	7
Colorado	VIII	1,499	20	(2)	19	(2)	19	(2)	19
Connecticut	I	3,145	16	3,003	17	3,241	17	2,936	17
Florida	III	45	32	----	----	(2)	28	(2)	27
Georgia	III	2,190	18	(2)	20	(2)	22	(2)	22
Illinois	IV	41,217	3	55,276	3	46,510	3	46,633	3
Indiana	IV	25,915	4	35,375	6	31,570	4	30,865	4
Iowa	VI	89	30	89	30	294	27	268	28
Kentucky	V	8,008	9	(2)	9	7,945	9	7,852	9
Louisiana	VII	215	28	722	24	(2)	24	(2)	23
Maine	I	251	25	(2)	29	(2)	31	(2)	31
Maryland	III	21,273	6	36,136	5	28,486	5	28,656	5
Massachusetts	I	5,935	10	5,460	11	5,530	13	4,923	13
Michigan	IV	3,726	14	4,446	13	6,481	12	(2)	12
Minnesota	VI	3,224	15	4,250	14	(2)	16	2,939	16
Missouri	VI	3,960	13	4,087	15	6,720	10	3,598	15
Nebraska	VI	237	27	(2)	27	(2)	26	(2)	26
New Hampshire	I	23	34	----	----	----	----	----	----
New Jersey	II	5,069	12	4,546	12	5,519	14	5,354	11
New York	II	5,624	11	6,031	10	6,619	11	6,292	10
Ohio	IV	80,103	1	88,629	1	79,149	1	77,967	1
Oklahoma	VII	809	23	1,261	21	(2)	20	(2)	20
Oregon	IX	392	24	229	26	238	29	238	30
Pennsylvania	II	69,113	2	79,344	2	73,559	2	65,747	2
Rhode Island	I	199	29	(2)	25	(2)	25	(2)	25
South Carolina	III	42	33	(2)	31	----	----	(2)	32
Tennessee	V	961	21	(2)	22	941	23	736	24
Texas	VII	1,570	19	3,251	16	4,431	15	4,413	14
Utah	VIII	81	31	----	----	----	----	----	----
Virginia	III	249	26	185	28	(2)	30	(2)	29
Washington	IX	914	22	1,041	23	(2)	21	1,689	21
West Virginia	III	22,099	5	29,187	7	24,701	7	23,260	6
Wisconsin	IV	2,575	17	2,505	18	3,155	18	(2)	18
Total [1]	----	345,475	----	[3] 439,368	----	[3] 397,790	----	[3] 375,129	----

[1] Excludes remelt zinc. Includes zinc used in electrogalvanizing and electroplating, but excludes sherardizing.
[2] Quantity withheld to avoid disclosure of individual company operations.
[3] Includes States not individually shown (footnote reference 2).

Consumption of Slab Zinc for Galvanizing.—The iron and steel industry is the largest consumer of slab zinc, using it to galvanize or rustproof steel sheets, wire, tube, pipe, cable, chain, bolts, railway-signal equipment, building and poleline hardware, and a multitude of other items. The principal iron- and steel-producing States are thus also the principal consumers of zinc for galvanizing. From 1940 to 1943 Pennsylvania ranked first among the 34 States that consumed zinc for this purpose. In 1944 Ohio displaced Pennsylvania and has retained first place through 1952. Ohio, Pennsylvania, Illinois, and Indiana used 62 percent of the average annual domestic consumption of slab zinc for galvanizing from 1940 to 1945. In 1946 total zinc used for galvanizing in these States rose to 65 percent, but this declined to 63 percent in 1947 and 1948, 61 percent in 1949, 59 percent in 1950, 58 percent in 1951, and 59 percent in 1952.

Consumption of Slab Zinc for Brass Products.—Slab zinc consumed in brass products during 1952 increased 9 percent to 155,100 tons, a quantity only slightly higher than the 1946–52 annual average of 127,200 tons and only about half of the average annual of 294,800 tons of zinc used for brass making in the war years 1940–45. The concentration of brass-making facilities in the Connecticut Valley has placed Connecticut first among the States consuming slab zinc for that use, a position held for many years before the compilation of detailed statistics and one that it has continued to hold by a large margin from 1940 through 1952. Owing to changing use patterns and the construction of new plant facilities, there have been some changes in the rank of other leading States. In 1940–47 Michigan was in second place and Illinois ranked third. Beginning in 1948 and continuing through 1952 Illinois ranked second and Michigan was in third place. New York, which held third place from 1940 to 1942, dropped to seventh place in 1943, sixth place in 1944, 1945, and 1947, fifth place in 1950–51, and in all other years has been fourth. Other leading States are Ohio, Wisconsin, Pennsylvania, and Indiana.

TABLE 20.—Consumption of slab zinc for brass products in the United States, 1945-49 (average) and 1950–52, by States [1]

State	Geographic division	1945–49 (average)		1950		1951		1952	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	139	14	488	13	(2)	12	(2)	12
California	IX	947	12	1,311	11	1,927	11	3,509	11
Colorado	VIII	44	16	(2)	14	(2)	17	(2)	15
Connecticut	I	57,827	1	59,837	1	60,055	1	56,704	1
Delaware	III	------	------	------	------	(2)	15	(2)	14
District of Columbia	III	51	15	(2)	16	(2)	18	(2)	22
Florida	III	1	30	------	------	------	------	------	------
Georgia	III	6	24	(2)	21	(2)	26	(2)	25
Illinois	IV	16,554	2	15,978	2	16,460	2	19,173	2
Indiana	IV	3,148	10	3,183	9	4,232	9	7,232	7
Iowa	VI	2	29	------	------	(2)	28	------	------
Kansas	VI	38	19	(2)	19	(2)	23	(2)	18
Kentucky	V	19	20	------	------	(2)	16	(2)	16
Maine	I	3	27	(2)	24	(2)	29	(2)	30
Maryland	III	1,799	11	513	12	(2)	13	(2)	13
Massachusetts	I	3,392	9	2,785	10	2,973	10	3,724	10
Michigan	IV	14,597	3	15,084	3	14,649	3	17,869	3
Minnesota	VI	------	------	------	------	------	------	(2)	27
Missouri	VI	177	13	(2)	15	43	19	80	19
Nebraska	VI	3	28	------	------	------	------	------	------
New Hampshire	I	17	21	(2)	22	(2)	21	(2)	24
New Jersey	II	6,514	8	4,077	8	5,666	8	6,721	8
New York	II	10,819	4	9,627	5	9,390	5	11,100	4
Ohio	IV	10,638	5	11,016	4	10,831	4	10,339	5
Oregon	IX	6	25	(2)	18	(2)	25	(2)	23
Pennsylvania	II	6,556	7	7,155	7	6,483	7	(2)	6
Rhode Island	I	10	23	(2)	23	(2)	24	(2)	29
South Carolina	III	4	26	------	------	------	------	------	------
Tennessee	V	------	------	------	------	(2)	20	(2)	28
Texas	VII	15	22	(2)	17	(2)	22	(2)	20
Utah	VIII	1	31	(2)	25	(2)	30	(2)	31
Virginia	III	39	18	8	20	(2)	27	(2)	26
Washington	IX	43	17	------	------	------	------	(2)	21
West Virginia	III	------	------	------	------	(2)	14	(2)	17
Wisconsin	IV	9,013	6	7,449	6	7,461	6	6,519	9
Total [1]	------	142,422	------	[3] 138,739	------	[3] 142,360	------	[3] 155,090	------

[1] Excludes remelt zinc.
[2] Quantity withheld to avoid disclosure of individual company operations.
[3] Includes States not individually shown (footnote reference 2).

Consumption of Slab Zinc for Zinc-Base Alloys.—The automobile industry is the largest user of zinc-base alloys, principally for die-cast parts and assemblies, such as fuel pumps, carburetors, radiator grilles, windshield-wiper motors, and much of the interior and exterior hardware. Thus the region embracing Ohio, Michigan, and Wisconsin, in which the automobile and automobile accessory industries are centered, is the area of greatest slab-zinc consumption for zinc-base alloys. In 1952 this region consumed approximately 70 percent of the slab zinc entering zinc-base alloys.

TABLE 21.—Consumption of slab zinc for zinc-base alloys in the United States, 1945–49 (average) and 1950–52, by States [1]

State	Geographic division	1945–49 (average)		1950		1951		1952	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V			[2]	12				
California	IX	10,154	8	14,717	7	15,693	6	13,411	6
Colorado	VIII					[2]	16	[2]	16
Connecticut	I	4,490	10	5,535	10	5,044	10	4,400	10
Florida	III								
Illinois	IV	47,723	1	75,739	1	72,740	1	48,944	2
Indiana	IV	12,855	6	16,677	6	11,740	8	8,840	9
Kansas	VI	29	14			312	14	[2]	14
Kentucky	V					[2]	15	[2]	15
Maine	I								
Maryland	III	58	13						
Massachusetts	I	10	16	[2]	14	[2]	17	[2]	19
Michigan	IV	22,716	4	37,302	3	34,333	4	30,197	3
Missouri	VI	11,702	7	11,944	9	12,254	7	10,478	7
New Jersey	II	6,756	9	12,694	8	8,448	9	9,622	8
New York	II	23,169	3	33,356	4	35,825	3	29,990	4
North Carolina	III							[2]	18
Ohio	IV	35,766	2	52,051	2	68,321	2	54,623	1
Oklahoma	VII	13	15						
Oregon	IX					[2]	12	[2]	13
Pennsylvania	II	20,210	5	25,600	5	25,774	5	20,838	5
Texas	VII	354	12	[2]	13	[2]	13	[2]	12
Virginia	III	7	18	[2]	15	[2]	18	[2]	17
Washington	IX	8	17						
Wisconsin	IV	2,759	11	[2]	11	3,335	11	[2]	11
Total [1]		198,779		[3] 289,511		[3] 295,421		[3] 236,147	

[1] Excludes remelt zinc.
[2] Quantities withheld to avoid disclosure of individual company operations.
[3] Includes States not individually shown (footnote reference 2).

Consumption of Slab Zinc for Rolled Zinc.—Slab zinc consumed for rolled zinc continued in essentially the same geographic pattern from 1940 through 1952, but the quantity fluctuated widely, ranging from 49,000 tons in 1943 to 98,000 tons in 1945. During the war years 1940–45 the average annual consumption of slab zinc in this use was 70,000 tons; in the postwar years 1946–52 the average was 68,000 tons; and in 1952 it was 51,000 tons. Illinois and Indiana ranked first and second, respectively, except in 1951 and 1952, when Pennsylvania took second place and Indiana dropped to third place.

TABLE 22.—Consumption of slab zinc for rolled zinc in the United States, 1945–49 (average) and 1950–52, by States

State	Geographic division	1945–49 (average)		1950		1951		1952	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Connecticut	I	1,236	8	[1]	6	[1]	6	[1]	7
Illinois	IV	37,698	1	35,134	1	31,471	1	25,353	1
Indiana	IV	18,858	2	[1]	2	[1]	3	[1]	3
Iowa	VI	6,519	4	[1]	5	[1]	5	[1]	5
Massachusetts	I	1,606	7	[1]	7	[1]	7	[1]	6
New York	II	4,299	5	[1]	4	[1]	4	[1]	4
Pennsylvania	II	6,629	3	[1]	3	[1]	2	[1]	2
West Virginia	III	1,662	6	[1]	8	[1]	8	[1]	8
Total		78,507		68,444		64,085		51,318	

[1] Quantity withheld to avoid disclosure of individual company operations.

Consumption of Slab Zinc for Zinc Oxide.—Because only a small number of companies consume slab zinc in the manufacture of zinc oxide and because individual company figures by State may not be disclosed, slab zinc so used is included with the section on consumption of slab zinc for other uses.

Consumption of Slab Zinc for Other Uses.—The distribution, by States, of the quantity of slab zinc consumed for such purposes as slush castings, wet batteries, desilverizing lead, light-metal alloys (other than zinc-base alloys), zinc dust, chemicals, bronze powder, and zinc oxide is shown in table 23. The change in the total of such uses is largely due to the inclusion of zinc oxide with this group.

TABLE 23.—Consumption of slab zinc for other uses in the United States, 1945–49 (average) and 1950–52, by States [1]

State	Geographic division	1945–49 (average)		1950		1951		1952 [2]	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	30	16			(3)	27	(3)	25
Arizona	VIII	4	24			(3)	17	(3)	16
Arkansas	VII					(3)	26	(3)	26
California	IX	412	5	289	10	522	5	519	7
Colorado	VIII	6	23					(3)	29
Connecticut	I	213	10	297	9	(3)	13	(3)	15
Idaho	VIII	257	8	(3)	4	(3)	9	(3)	10
Illinois	IV	71	14	(3)	12	(3)	6	2,413	2
Indiana	IV	147	11	(3)	14	276	14	(3)	14
Iowa	VI	8	22	(3)	15	(3)	16	(3)	8
Kansas	VI	15	19	(3)	16	(3)	21	(3)	27
Kentucky	V								
Louisiana	VII	1	26			(3)	25	(3)	30
Maine	I								
Maryland	III					(3)	20	(3)	20
Massachusetts	I	21	17	11	17	9	23	(3)	18
Michigan	IV	128	12	(3)	13	401	11	(3)	13
Minnesota	VI	1	27			(3)	28	(3)	28
Missouri	VI	260	7	412	6	455	7	578	6
Montana	VIII							(3)	31
Nebraska	VI	1,106	3	(3)	3	(3)	3	(3)	4
Nevada	VIII								
New Hampshire	I	10	21						
New Jersey	II	1,838	2	1,914	2	1,884	2	1,278	3
New York	II	400	6	516	5	(3)	4	(3)	5
Ohio	IV	463	4	312	8	384	12	421	11
Oklahoma	VII					(3)	22	(3)	24
Oregon	IX							(3)	21
Pennsylvania	II	3,054	1	2,809	1	3,240	1	20,770	1
Tennessee	V	246	9	(3)	7	(3)	10	(3)	9
Texas	VII	12	20			(3)	19	(3)	19
Utah	VIII	4	25	(3)	18	(3)	24	(3)	22
Virginia	III	45	15	(3)	19	(3)	18	(3)	17
Washington	IX	81	13	(3)	11	(3)	8	(3)	12
West Virginia	III	19	18			(3)	15		
Wisconsin	IV			(3)	20			(3)	23
Total [1]		8,852		[4] 9,850		[4] 11,587		[4] 30,955	

[1] Excludes remelt zinc.
[2] Includes slab zinc used for zinc oxide.
[3] Quantity withheld to avoid disclosure of individual company operations.
[4] Includes States not individually shown (footnote reference 3).

STOCKS

National Stockpile.—On February 15, 1953, the Munitions Board made its semiannual Stockpile Report to the Congress. The report noted that stocks of zinc and of 37 other materials in the stockpile of critical and strategic materials had reached 60 percent or more of the total objective in 1952 and that, although further acquisitions would be made, under new and existing contracts such acquisitions would be at a reduced rate to minimize the effect when purchasing for the stockpile ceases.

Producers' Stocks.—Inventories of slab zinc at producers' plants at the end of 1952 totaled 85,000 tons, or almost 300 percent more than at the end of 1951. During the war years, 1940–45, the average year-end stocks on December 31 were 132,000 tons, whereas comparable stocks for the postwar years, 1946–52, averaged 68,000 tons. From 1940 to 1952 such year-end stocks varied from 9,000 tons in 1950 to 256,000 tons in 1945 and averaged 98,000 tons.

TABLE 24.—Stocks of zinc at zinc-reduction plants in the United States at end of year, 1948–52, in short tons

	1948	1949	1950	1951	1952
At primary reduction plants	19,179	90,710	7,948	[1] 21,343	81,344
At secondary distilling plants	1,669	3,511	936	637	3,677
Total	20,848	94,221	8,884	[1] 21,980	85,021

[1] Revised figure.

Consumers' Stocks.—On December 31, 1952, consumers' stocks of slab zinc were 92,000 tons, an increase of 83 percent from the beginning of the year. This stock together with 8,000 tons of slab zinc in transit to consumers' plants was approximately equal to 6 weeks' consumption at the average rate established in 1952.

TABLE 25.—Consumers' stocks of slab zinc at plants at the beginning and end of 1952, by industries, in short tons

Date	Galvanizers	Brass mills [1]	Die casters [2]	Zinc-rolling mills	Oxide plants	Others	Total
Dec. 31, 1951	[3] 20,551	[3] 14,859	[3] 10,181	3,538	320	[3] 1,135	[3 4] 50,584
Dec. 31, 1952	46,308	18,482	20,566	4,838	353	1,855	[4] 92,402

[1] Includes brass mills, brass ingot makers, and brass foundries.
[2] Includes producers of zinc-base die castings, zinc-alloy dies, and zinc-alloy rods.
[3] Revised figure.
[4] Stocks on Dec. 31, 1951 and 1952, exclude 479 tons (revised figure) and 508 tons, respectively, of remelt spelter.

PRICES

The price of Prime Western grade slab zinc was at the ceiling price of 19.5 cents per pound at East St. Louis from the beginning of the year to June 2, 1952, when increased supplies from domestic and foreign sources combined with lessened demand, resulting from the steel strike, forced price reductions in all grades. Prime Western grade was reduced to 17.5 cents per pound. Subsequent price drops to 16 cents on June 5, 15 cents on June 18, and 13.5 cents on August 6, stimulated the market somewhat, and the price rose to 13.75 cents on August 11, 14 cents on August 12, and 14.5 cents on September 12. On September 18 there was a decline to 14 cents and on September 22 to 13.5 cents. The price ranged between 13.5 cents and 12.5 cents a pound until October 27. On that date the market price at East St. Louis was established at 12.5 cents where it remained to the end of the year.

342070—55——73

TABLE 26.—Price of zinc concentrates and zinc, 1948–52

	1948	1949	1950	1951	1952
Joplin 60-percent zinc concentrates: [1]					
Price per short ton ... dollars	86.37	72.28	87.39	120.00	116.10
Average price common zinc at—					
St. Louis (spot)[1] ... cents per pound	13.58	12.15	13.88	17.99	16.21
New York [1] ... do	14.21	12.86	14.60	18.75	17.03
London [2] ... do	14.38	14.41	14.89	21.46	18.71
Price indexes (1947–49 average=100):					
Zinc (New York)	112	101	115	148	134
Lead (New York)	113	96	83	109	103
Copper (New York)	106	93	103	117	117
Straits tin (New York)	108	108	104	139	131
Nonferrous metals [3]	106	99	104	124	124
All commodities [3]	104	99	103	115	112

[1] Metal Statistics, 1953.
[2] E&MJ Metal and Mineral Markets English quotations converted into American money on basis of average rates of exchange recorded by Federal Reserve Board.
[3] Based upon price indexes of U. S. Department of Labor.

TABLE 27.—Average monthly quoted prices of 60-percent zinc concentrates at Joplin, and of common zinc (prompt delivery or spot) St. Louis and London 1951–52 [1]

Month	1951			1952		
	60-percent zinc concentrates in the Joplin region (dollars per ton)	Metallic zinc (cents per pound)		60-percent zinc concentrates in the Joplin region (dollars per ton)	Metallic zinc (cents per pound)	
		St. Louis	London [2]		St. Louis	London [2]
January	115.00	17.50	18.88	135.00	19.50	23.75
February	115.00	17.50	18.88	135.00	19.50	23.75
March	115.00	17.50	18.88	135.00	19.50	23.75
April	115.00	17.50	20.00	135.00	19.50	23.75
May	115.00	17.50	20.00	135.00	19.50	22.78
June	115.00	17.50	20.00	109.20	15.74	17.45
July	115.00	17.50	22.18	100.00	15.00	16.25
August	115.00	17.50	23.74	95.96	14.07	15.40
September	115.00	17.50	23.74	94.42	14.00	15.38
October	134.23	19.42	23.74	91.07	13.25	14.78
November	135.00	19.50	23.75	84.00	12.50	13.75
December	135.00	19.50	23.71	84.00	12.50	13.75
Average for year	[3] 120.00	17.99	21.46	116.10	16.21	18.71

[1] Joplin: Metal Statistics, 1953, p. 607. St. Louis: Metal Statistics, 1953, p. 601. London: E&MJ Metal and Mineral Markets.
[2] Conversion of English quotations into American money based on average rates of exchange recorded by Federal Reserve Board.
[3] Represents average price realized on total shipments for year.

The Office of Price Stabilization ceiling price of 19.5 cents for Prime Western grade remained in effect throughout the year. Ceiling prices were established for zinc on January 26, 1951, at the highest price (for each seller) at which sales were made between December 19, 1950, and January 25, 1951; and thus a number of ceiling prices were in effect. The bulk of Prime Western sales were at 17.5 cents, however, and that amount was the commonly quoted ceiling price at East St. Louis until October 2, 1951, when the Office of Price Stabilization authorized an increase of 2 cents a pound, which brought the East St. Louis ceiling price to 19.5 cents for Prime Western grade, with other grades selling at ceilings somewhat higher.

Trading in zinc futures on the New York Commodity Exchange, which was suspended July 27, 1951, was resumed on June 23, 1952; and similar trading on the London Metal Exchange was scheduled for resumption on January 3, 1953.

The official London price was £190 per long ton (23.75 cents per pound) until May 22 when the British Ministry of Materials set the price at £166 (20.73 cents). Subsequent declines in June, August, September, and October brought the price to £110 (13.75 cents) on October 29, where it remained for the rest of the year. Conversions of English quotations to United States currency are based on Federal Reserve Board rates of exchange and ranged from $2.78 to $2.80 7/8 per pound sterling. Prices at Antwerp and other European markets fluctuated from a high of about 30 cents in the first quarter of 1952 to as little as 9½ cents a pound in the fourth quarter.

TABLE 28.—Average price received by producers of zinc, 1948–52, by grades, in cents per pound

Grade	1948	1949	1950	1951	1952
Grade A:					
Special High Grade	13.72	12.76	14.30	18.79	17.04
Regular High Grade	13.40	12.29	14.16	18.48	16.42
Grade B: Intermediate	13.49	12.94	14.69	18.57	17.76
Grades C and D:					
Brass Special	13.33	12.75	14.47	18.20	17.07
Selected	13.05	12.87	17.37	18.00	16.73
Grade E: Prime Western	12.93	12.18	14.11	17.92	16.33
All grades	13.32	12.42	14.23	18.24	16.63
Prime Western; spot quotation at St. Louis [1]	13.58	12.15	13.88	17.99	16.21

[1] Metal Statistics, 1953, p. 601.

FOREIGN TRADE [4]

Imports.—Total imports (general imports) of zinc in ores and concentrates in 1952 increased 48 percent above the 1951 figure to 448,700 tons, a quantity second only to the 539,000 tons imported in 1943. Of the total, 45 percent came from Mexico, 33 percent from Canada, and 10 percent from Peru. The remaining 12 percent was chiefly from Spain, Bolivia, Guatemala, Union of South Africa, Yugoslavia, and Australia.

Total imports of slab zinc increased 31 percent above the 1951 level in 1952. Of the 115,200 tons imported, Canada supplied 61 percent, Mexico 16 percent, West Germany 6 percent, Belgium-Luxembourg 6 percent, and Italy 4 percent. Of the remaining 7 percent the principal supplying countries were the Netherlands, Yugoslavia, Peru, and Japan.

Exports.—Exports of zinc in zinc ore and concentrates and as metal in pig, slab, sheet, scrap, and dust totaled 66,300 tons valued at $28,651,315 in 1952 compared with 51,500 tons and $22,018,441 in 1951. In addition to the items listed in tables 31 and 32, considerable zinc is exported each year in brass, pigments, chemicals, and as coatings on galvanized steel. Export data on zinc pigments and chemicals are given in the Lead and Zinc Pigments and Zinc Salts chapter of this volume.

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.

The 57,700 tons of slab zinc exported in 1952 was an increase of 58 percent above the 1951 total of 36,500 tons. The United Kingdom, France, Brazil, and India were the chief importers, receiving 70, 12, 7, and 4 percent, respectively, of the total. Table 32 contains details of zinc slab and sheets exported.

TABLE 29.—Zinc imported into the United States, in ores, blocks, pigs, or slabs, by countries, 1950–52, in short tons [1]

[U. S. Department of Commerce]

Country	1950	1951	1952
Ores (zinc content):			
Argentina	8	5,546	603
Australia	2,366	2,825	2,398
Bolivia	3,810	7,849	14,418
Canada	77,525	[2] 96,568	148,970
Chile	40	1,088	33
Guatemala	473	6,539	9,989
Japan	-----	-----	1,389
Mexico	155,283	[2] 143,769	199,745
Peru	16,946	29,136	44,401
Philippines	42	86	1,664
Spain	17,738	4,392	16,647
Union of South Africa	3,794	2,655	4,917
Yugoslavia	-----	[2] 1,756	2,512
Other countries	548	666	1,013
Total ores	278,573	[2] 302,875	448,699
Blocks, pigs, or slabs:			
Belgium-Luxembourg	3,617	612	6,854
Canada	108,937	[2] 85,066	69,772
French Morocco	-----	440	-----
Germany	1,637	-----	[3] 7,068
Italy	2,679	-----	4,063
Japan	-----	-----	222
Mexico	26,293	760	18,686
Netherlands	2,005	254	3,976
Norway	7,939	882	110
Peru	1,205	-----	1,600
Poland-Danzig	358	-----	-----
United Kingdom	555	-----	-----
Yugoslavia	485	-----	2,788
Other countries	264	29	12
Total blocks, pigs, or slabs	155,974	[2] 88,043	115,151

[1] Data include zinc imported for immediate consumption plus material entering country under bond.
[2] Revised figure.
[3] West Germany.

TABLE 30.—Zinc imported for consumption in the United States, 1948–52, by classes [1]

[U. S. Department of Commerce]

Year	Ores (zinc content)		Blocks, pigs, slabs		Sheets		Old, dross, and skimmings [2]		Zinc dust		Total value [3]
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	
1948	133,814	$11,737,624	92,495	$24,911,454	120	$32,871	10,273	$1,181,495	41	$5,370	$37,868,814
1949	109,535	11,748,199	125,564	29,340,620	32	8,144	3,732	558,702	17	4,397	41,660,062
1950	237,564	24,313,625	155,332	38,759,435	211	92,862	2,862	688,176	472	80,564	63,934,662
1951	[4] 197,995	27,043,611	[4] 88,043	[4] 31,109,279	149	[4] 84,044	6,603	284,030	154	74,362	[4] 58,595,326
1952	543,283	105,480,600	113,051	36,218,735	47	23,557	3,492	536,310	133	38,932	142,298,134

[1] Excludes imports for manufacture in bond and export, which are classified as "imports for consumption" by the U. S. Department of Commerce.
[2] Includes dross and skimmings as follows: 1948—8,637 tons, $873,099; 1949—2,668 tons, $335,283; 1950—1,229 tons, $186,748; 1951—6,457 [4] tons, $242,998; 1952—3,022 tons, $390,245.
[3] In addition, manufactures of zinc were imported as follows: 1948—$16,056; 1949—$2,583; 1950—$142,369; 1951—$51,700; 1952—$11,719.
[4] Revised figure.

TABLE 31.—Zinc ore and manufactures of zinc exported from the United States, 1948–52

[U. S. Department of Commerce]

Year	Zinc ore, concentrates, and dross (zinc content)		Slabs, pigs, or blocks		Sheets, plates, strips, or other forms, n. e. s.		Zinc scrap (zinc content)		Zinc dust	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1948	3,547	$422,314	65,537	$15,852,819	7,344	$3,290,410	(1)	(1)	891	$299,494
1949	[2] 2,925	[2] 477,718	58,709	18,699,597	7,456	3,496,169	1,570	$224,291	690	261,484
1950	[2] 1,140	[2] 264,907	12,917	3,967,055	4,810	2,322,150	6,212	674,235	506	186,557
1951	[2] 3,090	[2] 792,800	36,510	15,592,994	6,579	4,360,689	4,613	871,302	723	400,656
1952 [3]	[2] 3,370	[2] 899,162	57,714	24,508,568	4,231	2,960,769	972	282,816	(4)	(4)

[1] Not separately classified before Jan. 1, 1949; formerly included with "Other forms, n. e. s."
[2] Effective Jan. 1, 1949 "dross" included with "scrap."
[3] Effective Jan. 1, 1952 zinc and zinc alloy semifabricated forms, n. e. c., totaling $191,746, were exported.
[4] Effective Jan. 1, 1952 "dust" included with "scrap."

TABLE 32.—Slab and sheet zinc exported from the United States, by destinations, 1949–52, in short tons

[U. S. Department of Commerce]

Destination	Slabs, pigs, and blocks				Sheets, plates, strips, or other forms, n. e. s.			
	1949	1950	1951	1952	1949	1950	1951	1952
Country:								
Argentina	--------	--------	--------	661	--------	--------	100	305
Austria	1,172	--------	466	986	9	--------	--------	--------
Belgium-Luxembourg	1,081	67	--------	--------	19	21	3	(1)
Brazil	2,286	830	3,967	4,089	85	74	310	621
Canada	10	24	1,702	171	2,958	2,778	2,668	1,686
Chile	425	190	466	365	90	18	70	66
Colombia	40	3	--------	1	214	322	369	147
Cuba	116	274	199	33	71	131	176	73
Denmark	2,794	641	80	--------	--------	--------	--------	--------
Egypt	--------	--------	--------	385	--------	--------	--------	--------
France	4,840	--------	933	6,689	(1)	(1)	367	--------
Germany	4,293	--------	215	[2] 607	49	--------	26	[2] 21
India	12,608	4,588	4,728	2,036	1,685	417	807	304
Indonesia	2	--------	--------	--------	50	9	9	2
Israel	19	105	3	60	54	70	97	55
Italy	319	224	--------	--------	--------	--------	--------	--------
Japan	--------	374	816	--------	--------	--------	45	3
Malaya	--------	--------	--------	--------	375	--------	--------	--------
Mexico	131	349	211	351	776	575	859	532
Netherlands	4,028	--------	--------	--------	230	1	1	--------
Pakistan	--------	--------	220	111	58	3	10	3
Philippines	3	4	5	3	63	54	140	43
Switzerland	1,432	112	823	498	99	11	20	23
Union of South Africa	--------	--------	1	--------	76	37	69	45
United Kingdom	22,811	4,941	20,024	40,423	40	98	25	41
Yugoslavia	--------	--------	1,244	--------	--------	(1)	--------	--------
Other countries	299	191	407	245	455	191	408	261
Total	58,709	12,917	36,510	57,714	7,456	4,810	6,579	4,231
Continent:								
North America	267	652	2,117	558	3,858	3,544	3,765	2,361
South America	2,760	1,026	4,440	5,189	505	481	1,098	1,236
Europe	42,994	6,035	23,789	49,270	[3] 517	[3] 158	[3] 489	152
Asia	12,687	5,204	5,814	2,309	[3] 2,463	[3] 587	[3] 1,147	432
Africa	1	--------	5	388	104	40	70	45
Oceania	--------	--------	345	--------	9	--------	10	5

[1] Less than 1 ton.
[2] West Germany.
[3] Revised figure.

Tariff.—The import duties established June 6, 1951, as a result of the Torquay Agreement provided for a reduction in the duty on ores and concentrates from 0.75 to 0.6 cent a pound of content, and on slab zinc and zinc dust from 0.875 to 0.7 cent a pound. The Torquay Agreements also provided a reduction in the tariff on zinc chloride and zinc sulfate from 0.75 cent a pound to 0.65 and 0.3 cent a pound, respectively. Otherwise tariff rates remained at the levels established January 1, 1948, by the Geneva Agreement, with zinc sheets at 1 cent a pound, plated or coated zinc sheets at 1.125 cents a pound, scrap zinc 0.75 cent a pound. The duty on zinc oxide and leaded zinc oxide containing not more than 25 percent lead was 0.6 cent a pound in dry powdered form and 1 cent a pound when ground in or mixed with oil or water. Lithopone carried a tariff rate of 0.875 cent a pound. As of October 2, 1950 the duty on zinc scrap was suspended until June 30, 1951 by Congressional action. Subsequently the suspension of duty on zinc scrap was continued until June 30, 1953.

The duties on slab zinc and zinc ores were suspended by an act of Congress (H. R. 5448) until March 23, 1953, or the end of the emergency, whichever should come first, but with the proviso that should the average price of zinc for any calendar month during the period of suspension fall below 18 cents a pound the President should be so advised by the Tariff Commission and not later than 20 days thereafter should order reimposition of the rates of June 6, 1951. On July 3, 1953, the Tariff Commission so notified the President and on July 23 duties on zinc were reimposed.

TECHNOLOGY

The following recently published Bureau of Mines Reports of Investigations relate to the exploration and beneficiation of zinc ores in whole or in part:

4907—Lead-Zinc Deposits of Southwestern St. Lawrence County, N. Y., by G. L. Neumann, 1952, 25 pp.
4908—Beneficiation of Sherman (Idaho) Pyromorphite Lead Ore by P. H. Floyd, W. A. Stickney, and R. R. Wells, 1952, 14 pp.
4909—Guymard Lead-Zinc Deposit, Orange County, N. Y., by G. L. Neumann, 1952, 10 pp.
4911—Diamond Drilling for Zinc Ore at Andover-Sulphur Hill Iron Mines, Sussex County, N. J., by G. L. Neuman, 1952, 13 pp.
4927—Concentration Tests on Various Base-Metal Ores, by A. L. Engel. 1952, 14 pp.

Recently issued Bureau of Mines Information Circulars that concern zinc are:

7627—Control of Metallurgical and Mineral Dusts and Fumes in Los Angeles County, Calif., by G. L. Allen, F. H. Viets, and L. C. McCabe, 1952, 79 pp.
7649—Filling with Unclassified Tailing in Modified Cut-and-Fill Stopes, Dayrock Mine, Wallace, Idaho, by P. H. Toepfer, 1952, 14 pp.

Federal Geological Survey publications, published recently, and relating to zinc, in whole or in part are:

Circular 168—Geochemical Studies in the Coeur d'Alene Mining District, Idaho, by V. C. Kennedy, 1952, 15 pp.
Bulletin 978–D—Zinc-Lead Deposit at Shawangunk Mine, Sullivan County, N. Y., by P. K. Sims and P. E. Hots, 1952, pp. 101–121.
Bulletin 978–E—The Wallapai Mining District, Cerbat Mountains, Mohave County, Ariz., by M. G. Dings, 1952, pp. 123–163.

Noteworthy zinc reduction processes described in 1952 include two articles [5] on the Sterling process of electric furnace smelting of zinc ores. During 1952, the Cerro de Pasco Corp. undertook plans to build Sterling-type smelting furnaces at Oroya, Peru. The first 35-ton-per-day unit is expected to come into production in late 1953. Additional Sterling furnaces were under construction at Palmerton, Pa.

The caustic electrolytic-zinc process,[6] which has been under development for several years by the Bureau of Mines and others was described in a paper presented before Montreal meeting of the Electrochemical Society in 1952. Zinc is extracted from oxidized ores with NaOR solution, and the zincate electrolyte purified with zinc powder and lime, before precipitation by electrolysis. The process appears to have merit for treating certain secondary materials and may be utilized in the reduction of roasted zinc sulfides as well as the naturally oxidized ores.

The suspension roasting process of the Consolidated Mining & Smelting Co. of Canada, Ltd., was the subject of a recent article.[7] The method is used in treating zinc concentrates and also can be used successfully without using extraneous fuel to roast other mineral sulfides, such as lead concentrates, copper concentrates, copper mattes and antimony sulfides.

The fluosolids process as developed for pyrometallurgical applications involving the roasting, calcination, or heat treatment of ores is described in a recent article.[8]

The fluosolids roasting process may be described as a radically new metallurgical process by which the reactions between gases and solids can be more readily accomplished at elevated temperatures and at accelerated rates not possible before. The process is finding applications in many fields. A typical operation is the roasting of sulfide zinc ores or concentrates to produce strong SO_2 gas and, at the same time, a calcine containing less than 1 percent sulfide sulfur and less than 2 percent total sulfur. The technique requires that the solids, to be reacted, be fluidized or partly suspended by an upward-moving gas stream. When so fluidized they are in a state of violent agitation and are evenly distributed throughout the fluid bed. Fluidized solids in this state obey many of the laws of hydraulics and are efficient heat-transfer systems. Close regulation of feed-gas rate and temperature is possible.

A recent paper [9] describes the process for deleading zinc concentrate at the Parral and Santa Barbara, Mexico, mills of the American Smelting & Refining Co.

A development that may in the future change the method of separating many minerals is under investigation by the Atomic Energy Commission.[10] It has been proposed that minerals be separated from one another on the basis of radioactivity induced in them by neutron bombardment. After the mineral has become artificially

---

[5] Handwerk, E. C., Mahler, G. T., and Fetterolf, L. C., The Sterling Process: Jour. Metals, vol. 4, No. 6, June 1952, pp. 581–586.
Engineering and Mining Journal, Sterling Furnace Smelts Zinc With Electric Arc, vol. 153, No. 7, July 1952, pp. 76–78.

[6] Baroch, Charles T., Hilliard, R. V., and Lang, R. S., The Caustic Electrolytic-Zinc Process, Jour. Electrochem. Soc., vol. 100, No. 4, April 1953, pp. 165–172.

[7] McBean, K. D., The Cominco Suspension Roasting Process: Min. Cong. Jour., vol. 38, No. 6, June 1952, pp. 36–39, 84.

[8] Copeland, G. G., New Fluo-Solids Experience: Min. Cong. Jour., March 1952, pp. 42–44, 54.

[9] Boeke, C. L., and Gunther, G. G., Deleading Zinc Concentrates at the Parral and Santa Barbara Mills: Min. Eng., vol. 4, No. 5, May 1952, pp. 495–498.

[10] Gaudin, A. M., Senftle, F. E., and Freyberger, W. L., How Induced Radioactivity May Help Separate Minerals: Eng. and Min. Jour., vol. 153, No. 11, November 1952, pp. 95–99, 174–176.

radioactive beta and gamma radiations are given off at rates that vary for different minerals. The initial level of activity of this induced radiation is also different for different minerals. Application of this phenomenon in separating such minerals as sphalerite from pyrite, apatite and calcite, galena from limestone, and franklinite and zincite from calcite is possible.

During 1951 and early 1952, when zinc was expensive and difficult to obtain, there was additional incentive to collect metal-bearing fumes and dusts, recover metal from solution and reduce losses wherever possible. Principles of dust collectors and their application to mining and metallurgical industries was the subject of a recent article [11] presented before the American Institute of Mining and Metallurgical Engineers. The importance of such equipment in reducing air pollution and recovering a valuable dust was reported in an article [12] on recovery of zinc dust in pipe-galvanizing operations at the Etna, Pa., plant of Spang-Chalfant Division of National Supply Co., where $6,000 was reported saved each month of the first 6 months of 1951. The new dust-recovery equipment was amortized in less than a year. A Bureau of Mines publication [13] also bears upon this same subject.

Ion-exchange techniques of recovering metals from dilute solutions are finding more extensive use as better ion exchange mediums are developed. A classification of the most important commercially available ion exchangers, their use and limitations, and flowsheets of various ion exchange processes were the basis of an article,[14] which includes an excellent bibliography. An example of zinc recovery in effect in 1952 includes recovery of zinc from a viscose-rayon plant acid waste. The waste solution contains approximately 300 parts per million of zinc sulfate in an acid solution. The zinc is recovered from the sulfonated resin cationic exchanger as a solution containing 6 to 8 percent zinc sulfate. Equipment for laboratory test and development work utilizing ion-exchange techniques was described in a manual [15] published by the Permutit Co.

During 1952 interest in cathodic protection with zinc anodes was stimulated by the study prepared for the American Zinc Institute by Ebasco Services, Inc., November 1951. The study describes various applications with special emphasis on the protection of underground pipelines. Underground corrosion of steel pipe has been estimated to cost $600 million annually in the United States. Such corrosion, which is largely an electrolytic phenomenon resulting from local differences in electrical potential on the surface of the pipe, can be greatly reduced by cathodic protection techniques.

Hard, zinc-rich coatings applied like paint [16] are used extensively by Fruehauf Trailer Co. and others to protect steel parts from corrosion. The new protective coating, developed when cadmium was in short supply, is more expensive than paint but less costly than cadmium. It gives good coverage and may be applied by brush, spray, or dip. Government restriction on both end uses and quantity

---

[11] Kane, J. M., and Walpole, R. H., Principles of Present-Day Dust Collectors and Their Application to Mining and Metallurgical Industries: Am. Inst. Min. and Met. Eng. Tech. Pub. 3427B, Feb. 20, 1952; also Min. Eng., vol. 5, No. 1, January 1953, pp. 85–88.
[12] Steel, Zinc Dust Recovery: Vol. 130, No. 20, May 19, 1952, pp. 93–94.
[13] Allen, G. L., Viets, F. H., and McCabe, L. C., Control of Metallurgical and Mineral Dusts and Fumes in Los Angeles County, Calif.: Bureau of Mines Inf. Circ. 7627, 1952, 79 pp.
[14] Mindler, A. B., and Paulson, C. F., Ion Exchange Finds Wider Use in Concentration and Recovery of Metals From Dilute Solutions: Jour. Metals, vol. 5, No. 8, August 1953, pp. 980–985.
[15] Permutit Co., Manual for Laboratory Use of Ion Exchangers: 1952.
[16] Iron Age, Zinc Protects Trailers' Parts From Corrosion: Vol. 169, No. 22, May 29, 1952, pp. 82–83.

of nickel for electrodepositing protective and decorative coatings in 1952 led to a search for alternate coatings. Although it is generally accepted that no completely satisfactory alternate has been developed, a bright zinc-copper alloy plating process, which produces a coating containing 75 to 90 percent zinc, is being marketed by several suppliers and has been rather well accepted by the plating industry. Advantages and limitations of these white brass plated coatings are discussed in a recent article.[17] An alkaline battery, using silver and zinc as the electrochemical couple, has been placed on the market. The new battery using the André-Yardney silver-zinc system is up to 5 times smaller and up to 6 times lighter than other conventional storage batteries of the same ampere-hour capacity. It is said to be

TABLE 33.—World mine production of zinc (content of ore),[1] by countries,[2] 1948–52 in metric tons [3]

[Compiled by Pauline Roberts]

Country [2]	1948	1949	1950	1951	1952
North America:					
Canada	251,682	261,506	284,153	309,450	332,731
Guatemala	(4)	(4)	332	6,500	8,200
Mexico	179,029	178,402	223,530	180,064	227,375
United States [5]	571,503	538,142	565,513	617,961	604,180
South America:					
Argentina	12,189	10,921	12,699	15,475	15,396
Bolivia (exports)	21,124	17,629	19,570	30,535	33,581
Peru	59,533	72,037	87,879	101,300	122,174
Europe:					
Austria	3,154	2,694	2,970	3,355	4,986
Finland [6]	2,500	2,500	2,100	3,000	7,000
France	5,395	10,907	12,419	13,283	14,600
Germany, West	28,920	57,816	70,153	75,294	80,680
Greece	1,400	1,695	3,184	8,435	7,300
Italy	73,292	74,562	87,026	100,733	113,023
Norway	6,320	6,603	5,702	5,468	5,600
Poland [7]	87,089	85,300	86,200	86,200	95,300
Spain [6]	47,000	50,000	64,000	74,000	83,000
Sweden	35,485	35,158	37,121	38,000	47,162
U. S. S. R.[6] [7]	110,000	110,000	128,700	148,000	186,000
United Kingdom	----	----	36	194	(4)
Yugoslavia	38,789	44,017	38,092	39,420	47,789
Asia:					
Burma	----	----	----	----	1,200
India [6]	----	300	300	1,100	2,000
Japan	33,132	44,268	52,032	64,416	86,448
Korea, Republic of	221	50	(4)	(4)	500
Philippines	----	----	50	150	1,600
Thailand (Siam)	5	70	270	520	500
Turkey [6]	2,400	200	60	500	1,200
Africa:					
Algeria	6,391	6,863	7,177	9,466	11,446
Angola	----	----	----	350	40
Belgian Congo	46,584	55,420	74,805	88,704	98,946
French Equatorial Africa	----	44	621	518	377
French Morocco	1,671	2,847	11,412	19,455	28,352
Nigeria	363	72	----	----	51
Northern Rhodesia [7]	22,526	23,217	23,080	22,953	23,257
South-West Africa	10,600	12,700	11,300	14,800	15,600
Tunisia	2,382	3,337	2,932	3,548	3,540
Australia	193,526	184,919	205,632	197,843	199,538
Total (estimate)	1,858,000	1,899,000	2,128,000	2,290,000	2,522,000

[1] Data derived in part from the Yearbook of the American Bureau of Metal Statistics, the United Nations Statistical Yearbook, and the Statistical Summary of the Mineral Industry (Colonial Geological Surveys, London).
[2] In addition to countries listed, Bulgaria, Czechoslovakia, East Germany, North Korea, and Rumania also produce zinc, but production data are not available; estimates by senior author of chapter included in total.
[3] This table incorporates a number of revisions of data published in previous zinc chapters.
[4] Data not available; estimate by senior author of chapter included in total.
[5] Recoverable.
[6] Estimate.
[7] Smelter production.

[17] Saltonstall, R. B., A Critical Look at White Brass Plated Coatings: Mat. and Meth., vol. 37, No. February 1953, p. 97.

particularly adapted to applications where size and weight are important factors.

Several geologic papers were published in the technical journals among which were:

Claveau, Jacques, and others, The Lead and Zinc Deposits of the Bou Beker-Touissit Area, Eastern French Morocco: Econ. Geol., vol. 47, No. 5, August 1952, pp. 481–493.

Huff, Lyman C., Abnormal Copper, Lead and Zinc Content of Soil Near Metalliferous Veins: Econ. Geol., vol. 47, No. 5, August 1952, pp. 517–542.

Oesterling, W. A., Geologic and Economic Significance of the Hutson Zinc Mine, Salem, Ky.: Econ. Geol., vol. 47, No. 3, May 1952, pp. 316–338.

Triplett, W. H., Geology of the Silver-Lead-Zinc Deposits of the Avalos-Providencia District of Mexico: Min., Eng., vol. 4, No. 6, June 1952, pp. 583–593.

Creasey, S. C., Geology of the Iron King Mine, Yavapai County, Ariz., Econ. Geol., vol. 47, No. 1, January-February 1952, pp. 24–55.

Powers, Harold, Scharon, LeRoy, and Tolman, Carl, Geophysical Case History, Fredericktown Lead District, Mo., Min., Eng.,vol. 5, No. 3, March 1953, pp. 317–320.

WORLD REVIEW

World mine production of zinc rose 10 percent in 1952 to an alltime record. World production tables 33 and 34 show that, although the United States in 1952 mined approximately a fourth of the world's zinc and smelted more than a third of its slab zinc, other countries in every continent mined and smelted important quantities of zinc.

TABLE 34.—World smelter production of zinc, by countries,[1] 1948–52, in metric tons [2] [3]

[Compiled by Pauline Roberts]

Country	1948	1949	1950	1951	1952
North America:					
Canada	178,329	186,920	185,398	198,290	201,711
Mexico	48,323	53,496	53,492	58,750	53,787
United States	714,644	739,154	765,176	799,800	820,525
South America:					
Argentina	1,602	2,651	[4] 7,530	[4] 8,600	[4] 8,600
Peru	1,464	1,261	1,262	870	5,216
Europe:					
Belgium [5]	153,928	176,565	177,326	200,886	186,799
France	53,875	58,916	71,531	74,557	80,064
Germany, West	[6] 41,352	86,916	122,796	140,640	147,216
Italy	26,397	26,602	38,119	47,227	54,829
Netherlands	13,588	15,614	19,752	22,605	25,905
Norway	42,000	41,090	43,173	40,825	38,385
Poland	87,089	85,300	86,200	86,200	95,300
Rumania	(7)	(7)	3,000	(7)	(7)
Spain	21,203	19,551	21,264	21,345	21,358
U. S. S. R.[4]	110,000	110,000	128,700	148,000	186,000
United Kingdom	73,138	65,124	71,418	70,851	69,839
Yugoslavia	7,167	9,903	12,315	13,223	14,463
Asia:					
China [4]	330	180	180	180	180
Japan	21,200	32,232	49,008	56,340	70,032
Africa: Northern Rhodesia	22,526	23,217	23,080	22,953	23,257
Australia	82,617	82,255	84,995	78,246	88,841
Total (estimate)	1,706,000	1,823,000	1,969,000	2,097,000	2,199,000

[1] In addition to countries listed, East Germany and Czechoslovakia produce zinc, but production data are not available; estimates by senior author of chapter included in total.
[2] Data derived in part from the Yearbook of the American Bureau of Metal Statistics, the United Nations Monthly Bulletin and the Statistical Yearbook, and the Statistical Summary of the Minerals Industry (Colonial Geological Surveys, London).
[3] This table incorporates a number of revisions of data published in previous zinc chapters.
[4] Estimate.
[5] Includes production from reclaimed scrap.
[6] American and British zones only.
[7] Data not available; estimate by senior author of chapter included in total.

NORTH AMERICA

Canada.—Mine output of zinc in Canada increased almost 8 percent above the 1951 level despite power shortages in British Columbia and a decline of 2.53 to 2.81 cents (Canadian) in the 1952 average quoted price per pound of various grades of zinc. As in other years, Consolidated Mining & Smelting Co., operating mines and a zinc smelter in British Columbia, was the largest producer, with an output of 161,400 short tons of zinc sold in refined or unrefined products. The tonnage of ore from the company Sullivan mine was 2,700,000 tons, as against 2,530,000 tons in 1951. During the year stripping operations were undertaken to expose approximately 2,000,000 tons of open-pit ore, which will be mined and hauled to a transfer raise that connects the bottom of the pit to the 3,900-foot level of the mine. The ore will be hauled on the 3,900-foot level to the broken ore storage, which supplies the crusher on the 3,800-foot level. Other company operations included the Bluebell lead-zinc mine on Kootenay Lake near Kaslo, British Columbia, where production was begun in April and had by the year end totaled 136,000 tons of crude ore; and the Tulsequah zinc-copper-lead mines in northern British Columbia, which were opened in 1951 and in 1952 produced 96,000 tons of ore. An expansion program at Tulsequah to bring the concentrator to 500-tons-per-day capacity was nearly completed in 1952. The annual company report states that the large zinc-lead property at Pine Point, Northwest Territory, continued to be explored with encouraging results. During 1952 about 41,000 feet of drilling further outlined large tonnages of ore, and a suitable area for shaft sinking was located and the shaft collar, head frame, power and change houses were completed. During the year the 66-ton-per-day-extension to the electrolytic zinc plant at Trail, British Columbia, was largely completed. The Britannia Mining & Smelting Co., Ltd., operated its Britannia mine in British Columbia throughout 1952 producing 860,000 tons of ore, of which 830,000 tons was concentrated to yield 25,600 tons of zinc concentrate and 23,200 tons of copper concentrate, which were shipped to the United States for reduction.

Quebec was the second most important zinc-producing Province, yielding 95,700 tons of recoverable zinc. In October 1952, Barvue Mines, Ltd., began producing zinc from its newly built 4,000-ton-per-day plant in Barraute Township. A recent article [18] described the development, mining, and metallurgy of the property. It was stated that the ore body, which extends from near surface to 700 feet in depth, contains 18,000,000 tons of ore averaging 3.3 percent zinc and 1.2 ounces of silver. The overburden that overlies the ore body was stripped hydraulically. Open-pit mining is planned to a depth of about 300 feet, after which an underground method using slope conveyor belts will probably be used. The zinc concentrate was in part shipped to the Arvida, Quebec, plant of the Aluminum Co. of Canada, where the sulfide sulfur content is reduced to about 0.3 percent in a "fluosolids reactor" before being shipped to the United States for smelting.

The Quemont Mining Corp., Ltd., property milled 775,000 tons of ore to produce 32,000 tons of zinc concentrate and 51,000 tons of copper concentrate. The zinc concentrate was shipped to the United States, and the copper concentrate was smelted at Noranda. Total

[18] Mining World, Barvue Mines, Ltd.: Vol. 15, No. 3, March 1953, pp. 40–45.

recoverable metals from the concentrates were 16,500 tons of zinc, 9,400 tons of copper, 96,900 ounces of gold, and 416,000 ounces of silver.

The Normetal Mining Corp., Ltd., milled 360,500 tons of ore averaging 7.49 percent zinc, 2.02 percent copper, 0.25 ounce of gold, and 2.3 ounces of silver to recover 43,000 tons of zinc concentrate and 30,000 tons of copper concentrate together containing 21,800 tons of zinc, 6,300 tons of copper, 4,100 ounces of gold, and 412,000 ounces of silver.

Still another Quebec producer, the Waite Amulet Mines, Ltd., produced 414,000 tons of ore from its mines, milling 418,000 tons to recover 16,000 tons of zinc, 14,500 tons of copper, 11,900 ounces of gold, and 283,000 ounces of silver, as well as pyrite concentrate.

The Hudson Bay Mining & Smelting Co., Ltd., at Flin-Flon, Manitoba, near the Saskatchewan border, continued to mine ore from both Saskatchewan and Manitoba to supply its Flin-Flon mill and zinc smelter. During the year 1,560,000 tons of ore was mined, of which 1,528,000 tons, containing 4.9 percent zinc and 2.51 percent copper, and appreciable gold and silver values, was milled, to yield approximately 60,000 tons of recoverable zinc. Actual slab-zinc production by the company electrolytic zinc plant was 61,783 tons in 1952. Ore reserves of properties owned or controlled by the Hudson Bay Mining & Smelting Co., Ltd., in the Flin-Flon area as of the end of 1952 approximated 17,100,000 tons, which contain 3.2 percent copper, 4 percent zinc, 0.075 ounce of gold, and 1.06 ounces of silver.

The Anacon Lead Mines, New Brunswick, milled 226,000 tons of ore in 1952 (219,000 tons in 1951) to recover 8,500 tons of zinc (6,100 in 1951) and 4,100 tons of lead (2,200 in 1951). Increased output was due to better recoveries and a substantial increase in the grade of ore treated. Ore reserves at the end of the year amounted to 1,050,000 tons compared with 1,100,000 tons at the end of 1951.

In 1952 a large zinc-lead-silver-copper ore body [19] was discovered a few miles south of Bathhurst by a prospecting syndicate, which has been incorporated as the Brunswick Mining & Smelting Co. The ore body had been outlined in part by diamond drilling and as of January 1953 was said to indicate 28,800 tons of ore per vertical foot with values of about 5.2 percent zinc, 1.61 percent lead, and 1.98 ounces of silver per ton. In addition to zinc, lead, and silver, quantities of copper, tin, and pyrite have been noted that may be of commercial importance. The economic aspects of the property are considered excellent because of nearby rail- and ocean-transportation, an ore body adapted to open-pit mining, and the financial strength of many of the claim holders, which include the Leadridge Mining Co. (St. Joseph Lead subsidiary), Timmons Corp., M. J. O'Brien, Ltd., Noranda Mines, New Jersey Zinc Explorations, Ltd., Frobisher, Ltd. (Ventures Exploration subsidiary), Anacon Lead Mines, and numerous others.

Greenland.—The lead-zinc deposits at Blyklippen, Mesters Vig, eastern Greenland, which were explored by adits in 1950 and 1951, were under active development in 1952 to determine if the extent and grade of ore would justify production. During the summer of 1952 a complete year-round camp and landing strip were built, and a new

[19] Engineering and Mining Journal, Huge New Brunswick Metal Find Sets off Exploration Boom: Vol. 154, No. 5, May 1953, pp. 101, 102, 104, 202, 206, 208.

adit was begun 325 feet below the level of the earlier exploration adit. Exploration continued throughout the 1952–53 winter. Development, has not proved the extent of the ore in the lower adit, but that in the upper level indicated an ore shoot 900 feet long by 30 feet wide with about 22 percent combined lead and zinc. Although the mine is only 7 miles from docking facilities, these are situated on a fjord, which is normally ice-free only 4 or 5 weeks a year.

Mexico.—American Smelting & Refining Co. completed construction of a slag-fuming plant at Chihuahua, Mexico, July 1952, and the plant was in operation the last 2 months of the year. Located near the lead smelter it will recover about 23,000 tons of zinc as fume from lead slags that contain about 10 percent zinc. The company operated its retort zinc smelter at Rosita, Coahuila, throughout the year at near capacity. Operating mines in Mexico, owned or leased by the A. S. & R. Co. and producing zinc ores, included the Charcas unit, San Luis Potosi; the Parral, Santa Barbara, Santa Eulalia, Montezuma Lead and Plomosas units, Chihuahua; Taxco unit, Guerrero; and the Aurora-Xichu unit in Guanajuato.

Another important producer of zinc ore in Mexico was the American Metal Co., Ltd., which produced zinc concentrates at the Avalos unit (Cia. Minera de Peñoles, S. A.) in Zacatecas; the Calabaza unit, Jalisco; and the Topia unit in Durango. During 1952 the American Metal Co. installed a Waelz kiln to effect a metallurgical concentration of zinc oxide ores at its Monterrey, Nuevo Léon, lead refinery.

The Esmeralda mine near Parral, Chihuahua, was operated throughout the year by Minas de Iquala, S. A., a subsidiary of the Eagle-Picher Co. The mine stoping cycle included the use of a drilling jumbo and power slusher. Such mechanization has increased ore-broken-per-man shift in the stopes to 24.6 tons. Further details of mining and the 1,000-ton-per-day lead-zinc flotation mill were published in a two part article [20] in Mining World.

SOUTH AMERICA

Bolivia.—The Bolivian revolution in April 1952 resulted in the formation of the Corporacion Minera de Bolivia to manage the 24 producing mines that were nationalized. Mine-production data are lacking, but, since no zinc reduction facilities exist in Bolivia and all production must be exported, exports are a measure of output. The zinc content of zinc concentrate exported increased 10 percent over that of 1951 to 33,600 metric tons.

Peru.—Mine production of zinc in Peru increased 21 percent in 1952 to 122,200 metric tons and smelter production rose from 900 to 5,200 metric tons. Exploration by the Cerro de Pasco Corp. and the American Smelting & Refining Co. continued on a large scale, and Mauricio Hochschild, Consolidated Guayana Mines, Ltd. (Ventures, Ltd. subsidiary), Peruvian Oil & Minerals, Ltd. (Kennecott Copper Corp. subsidiary), and La India (Nicaraguan subsidiary of Noranda Mines, Ltd.) were investigating mineral properties. Consolidated Guayana had the Santander zinc-lead property under option and was planning a mine, 500-ton concentrator, and hydroelectric plant. The Chavin or Santa Beatriz mine in which Guayana had an interest was being developed, and the company was seeking a

[20] Burns, R. L., Jumbos in Shrinkage Stopes Pay Off at the Esmeralda: Mining World, vol. 15, No. 9, August 1953, pp. 44–48; Minas de Iqualas 1,000-ton-per-day Mill at Parral Treats Esmeralda Lead-Zinc Ore: Min. World, vol. 15, No. 10, September 1953, pp. 52–55.

United States Government purchase contract for zinc and lead over a 3-year period. The Volcan Mines Co. completed its 350-ton per day concentrator in Ticlio. The mill can treat ore from either the Volcan lead-zinc-copper mine or the Carahuacra zinc-lead mine.

The Atacocha lead-zinc mines, which are served by 2 mills totaling 450 metric tons of daily crude-ore capacity, formed the basis of an article [21] published by the Denver Equipment Co. The article described the ore body and the mills, giving grade or ore, mill recovery, and details of the mill operation.

In 1952 the New Jersey Zinc Co. licensed the Sterling smelting process to the Cerro de Pasco Corp. for use in Peru. The process is an electrothermic method of smelting zinc ores, which has attracted attention due to indicated economies in capital and operating costs. The first unit of the new electrothermic zinc plant in Peru was expected to come into production about September 1953, and full production of 200 tons a day is expected by late 1957.

EUROPE

Belgium and France.—In 1952 the Belgian and French works of the Mines et Fonderies de Zinc de la Vielle-Montagne produced 126,000 metric tons of slab zinc, 32,800 metric tons of rolled zinc, and 11,600 tons of zinc oxide. The zinc ore for this operation was chiefly from Union Miniére du Haut-Katanga, Africa.

Germany, West.—A decline in domestic requirements and a 7 percent increase in mine production of zinc to 80,700 metric tons permitted somewhat larger exports of zinc in 1952. Zinc and lead ores were produced at Rammelsburg and Bad Grund in the Harz Mountains and in the Rhineland as well as Southern Germany near Heidelberg.

Italy.—The new electrolytic zinc plant of Soc. Anon. Piombo e Zinco at Nossa in the Italian Alps, with a capacity of 15,000 tons of metal per year was almost completed in 1952. This plant with the 7,000-ton Monteponi, 25,000-ton Crotone, and 18,000-ton Porto Marghera electrolytic plants and the 12,000-ton Vado Ligure retort plant totaled 77,000 tons of capacity. Sardinia was Italy's main source of zinc ore, supplying about 80 percent of requirements. Upper Friuli, near Tarvisio in northeast Italy, the Bergamo (Nossa) region, Upper Adige, and the Cadore region supplied the balance of zinc ore requirements. Concentration of lead-zinc ores by heavy-medium methods was widely employed both in Sardinia and mainland mines. The Pertusola Co. has been successfully beneficiating calamine by flotation at its two ore-dressing plants in Sardinia since 1951.

United Kingdom.—During 1952 stocks of slab and ingot zinc held by the British Government and consumers increased 126,000 long tons to 166,000 and similarly held stocks of concentrates increased by 20,000 to 58,000 long tons of zinc content. The increase in stocks resulted from the import of 229,000 long tons of ingots, blocks, and slabs and some 194,000 long tons of zinc in ore and concentrate form. Part of the increase in stocks was due to much lower zinc consumption in 1952. Total consumption of zinc in 1952 was 256,000 long tons compared with 284,000 in 1951 and 330,000 in 1950. The greatly

[21] Ore, Narcisco Tasaico (superintendent, Atacocha mines), Deco Trefoil, vol. 16, No. 2, March-April 1952, pp. 7–14.

improved supply situation led to the announcement that free trading in zinc on the London Metal Exchange would be resumed January 2, 1953, and that excess government-held stocks would be sold in an orderly fashion.

As in other recent years domestic zinc production in the United Kingdom has been small. Smelter production was 69,000 long tons, approximately the volume smelted in 1950 and 1951.

Yugoslavia.—A slightly greater tonnage of lead-zinc ores and somewhat richer ores resulted in a 21-percent increase in mine production in 1952. Most of the crude ore came from the Trepca mines and was milled and smelted at Svecan. The only other important lead-zinc mine was the Mezica mine. The Yugoslav Government reported the discovery of lead-zinc ores in the Kossovo-Metochia area near the Albanian border. Mining of the deposit is planned to begin in 1954.

A new electrolytic zinc plant of 12,000 tons annual capacity was being constructed at Sobac, Serbia. The plant also will produce 22,000 tons of sulfuric acid and 40 tons of cadmium annually. Other Yugoslav-zinc-reduction facilities were limited to 16,000 metric tons of retort capacity.

AUSTRALIA

Both mine and smelter production of zinc in Australia increased slightly above the 1951 level, but full capacity was not achieved because of continuing shortage of labor and equipment and the Australian requirement that Australian needs be supplied at a special "home-consumption price," which was in some instances below the cost of production. Mine output in 1952 was 200,000 metric tons, or about 8 percent of the world total. Producing States were New South Wales, Queensland, and Tasmania.

In New South Wales the New Broken Hill Consolidated, Ltd., mined 240,000 long tons of ore in 1952 compared with 212,000 tons in 1951. In September the company began to use its new haulage shaft and newly erected No. 1 mill section. Monthly capacity was 30,000 tons, but output was about 21,000 tons. Other Broken Hill producers (North Broken Hill, Ltd., Broken Hill South, Ltd., and the Zinc Corp., Ltd.) mined a combined tonnage of about 90,000 tons of crude ore per month. Additional locomotives obtained by the South Australian Railways during 1952 made it possible to ship current production of zinc and lead concentrates and part of the accumulated 70,000 tons of zinc concentrate from Broken Hill.

The Lake George Mines, Ltd., Captain's Flat, New South Wales, concentrated about 550 long tons of ore per day and had from the beginning of operations through the end of June 1952 milled 2,000,000 tons of ore to recover 319,000 tons of zinc concentrate, 219,000 tons of lead concentrate, 30,000 tons of copper concentrate, 275,000 tons of pyrite concentrate, and 1,800 tons of gold concentrate. The mine [22] was reported to be thoroughly mechanized, with the ore, which is mined in rill stopes, being moved by gravity or power scraper to grizzly-covered ore passes.

At Risdon, Tasmania, the Electrolytic Zinc Co., Ltd., produced 89,000 metric tons of slab zinc from Broken Hill concentrates and those produced at its own Read-Rosebery and Hercules mines on the

[22] Hungerford, T. A. G., Mining Operations at Lake George Mines, New South Wales: Min. Jour. (London), vol. 240, No. 6128, Jan. 30, 1953, pp. 128–129.

west coast of Tasmania. The capacity of the west coast concentrator was increased to 250,000 tons of ore per year during the year, and work went forward on the construction of a plant to recover zinc from leach-plant residues, as well as to increase sulfuric acid capacity and to build a new ammonium sulfate fertilizer plant at the Risdon smelter.

At Mount Isa, Queensland, Mount Isa Mines, Ltd., operated its No. 2 ore shaft and the new crushing plant for the lead-zinc concentrator with production at a normal rate. The company was considering installing a slag-fuming plant to extract zinc from more than 1,000,000 tons of accumulated lead slags, which contain approximately 14 percent zinc.

AFRICA

Africa produced 7 percent, or 182,000 metric tons, of the world zinc mine output in 1952, the production being chiefly from the Belgian Congo (99,000 tons), French Morocco (28,000 tons), Northern Rhodesia (23,000 tons), South-West Africa (16,000 tons), and Algeria (11,000 tons).

Belgian Congo.—The Union Minière du Haut Katanga Kipushi concentrator milling a uniquely rich copper-zinc ore with a recoverable zinc content of about 17 percent produced 188,000 tons of zinc concentrate (172,000 tons in 1951) containing 97,910 metric tons of zinc. The ore is from the Prince Leopold mine. The company reported reserves of such ore contain 1.8 million tons of zinc. In addition, the company had 400,000 to 600,000 tons of zinc in copper slags, which analyzed about 20 percent zinc. Construction of an electrolytic zinc plant with annual capacity of 36,000 tons at Kolwezi is expected to be completed by mid-1953.

French Morocco.—In 1952, 51,400 metric tons of zinc concentrate containing 28,300 metric tons of zinc was produced. Corresponding figures in 1951 were 36,600 and 19,400 tons. The Zellidja mine was the principal producer of zinc, with an output of 44,000 tons of concentrate from its Bou Beker deposits. The lead-zinc deposits of the Bou Beker Touissit area were described in August 1952.[23]

Northern Rhodesia.—Rhodesian Broken Hill, Ltd., the only producer of zinc and lead in Northern Rhodesia, increased output in 1952 to 23,300 metric tons of zinc and 12,800 metric tons of lead. The company completed enlargement of the electrolytic zinc plant in 1952, and the rate of production in 1953 is expected to be about 26,500 metric tons of zinc. A concession covering 9,000 square miles in the Broken Hill area was granted to Minerals Research of Africa, a subsidiary of the Rio Tinto Co., Ltd. The company will prospect for lead, copper, and zinc. The 1952 annual report of the Rhodesia Broken Hill Development Co., Ltd., gave an excellent summation of production, development, labor employed, and related material. The successful metallurgical processes on the complex lead-zinc-vanadium and copper ores were treated in a recent article.[24]

---

[23] Claneau, Jacques, Paulhac, Jean, and Pellerin, Jean, The Lead and Zinc Deposits of the Bou Beker Touissit Area, Eastern French Morocco: Econ. Geol. ,vol. 47, No. 5, August 1952, pp. 481–493.

[24] Talbot, H. L., and Chapman, F. H., How Northern Rhodesia Meets Rising Base Metal Demands: Eng. and Min. Jour., August 1953, pp. 82–87.

South-West Africa.—The Tsumeb mine, the only important producer of zinc in the territory at present, produces lead, copper, and zinc concentrates for export. During 1952, zinc concentrates produced contained approximately 15,600 metric tons of zinc. A mechanical loading plant was in process of erection at Walvis Bay and should be operating in early 1953; it will facilitate quicker loading of all concentrates. Diamond drilling between the 2,390 and 2,650 horizons was successful, and 2 holes indicate mineralization to the 3,120–3,370 horizons. The new De Wet shaft sinking, which was to a depth of 2,390 feet in November 1951, reached 3,113 feet at the end of 1952. Sinking will be continued to 4,150 feet. The Tsumeb [25] operatio v. as described in the May and June 1952 issues of the Mining World.

Nigeria.—The American Smelting & Refining Co. terminated its lease and profit-sharing agreement with the Mines Development Syndicate, Ltd., in late 1952 after 30 months of geologic exploration, trenching, and diamond drilling. The agreement covered a 400-square-mile area in southeastern Nigeria near Abokaliki. Indicated reserves were not as large as had been anticipated, and the water supply presented a serious problem. Mines Development Syndicate is expected to continue with the development.

ASIA

Burma.—Burma Mines, Ltd., operator of the Bawdwin silver-lead-zinc mine in the Shan States of northern Burma, continued to rehabilitate and work the mine. The concentrator, idle since 1940, was put into service in mid-July to treat stocked ore. During the last half of the year about 10,000 tons of ore was mined, which assayed about 13.5 ounces of silver, 15.3 percent lead, and 12 percent zinc. About 2,200 tons of zinc concentrate was produced.

India.—The Zawar lead-zinc mine in Udaipur, which produces about 175 tons of ore daily, was mechanized and a flotation mill to produce lead and zinc concentrates was erected. A total of 3,300 metric tons of zinc concentrate containing 2,000 metric tons of zinc was exported to Rotterdam.

Japan.—Mine output of zinc increased by approximately 35 percent over that of 1951 to 86,500 metric tons. Smelter production of slab zinc was 70,000 tons, of which 70 percent was produced by electrolysis and 30 percent by distillation. The Kamioka Mining & Smelting Co. in Fukuko Prefecture, Kyushu Island, completed a slag-fuming plant at its Miike zinc smelter in 1952. The plant treats 3,000 tons of slag monthly to recover 350 tons of zinc and 28 tons of lead. The Toho Aen Co. was erecting a plant to treat slags at its Annaka zinc smelter in Gumma Prefecture on Honshu Island. In 1952 the plant will treat 1,000 tons of slag per month to recover 180 tons of zinc.

[25] Metz, John, and Ong, J. N., The Tsumeb Story, Min. World, vol. 14, No. 6, May 1952, pp. 21–26 and 74; also vol. 14, No. 7, June 1952, pp. 34–39.

Zirconium and Hafnium

By Robert F. Griffith [1]

ZIRCONIUM

ZIRCONIUM is a comparatively new metal, which promises greatly expanded usefulness. Interest in zirconium metal increased in 1952 as industry became more aware of its unusual combination of properties. Because it has good structural properties and excellent corrosion resistance, and because it readily allows the passage of slow neutrons (low thermal neutron absorption cross section), zirconium is used as a material of construction for nuclear-reactor plants. One of the significant developments in 1952 was the execution of a contract by the Atomic Energy Commission with Carborundum Metals Co., Akron, N. Y., for the production of 150,000 pounds of zirconium sponge annually for 5 years at less than $15 a pound. As an alloy constituent, zirconium imparts highly desirable properties to steel, magnesium, and other metals. The production of corrosion-resistant zirconium alloys received considerable attention in 1952.

Although over 80 percent of the United States zircon supply is used in refractories, ceramics, and foundry applications, the most spectacular use of zircon (the principal source mineral of zirconium) during the past 2 years has been in the production of metallic zirconium. Zircon reserves are large, and mine-production capacity in the United States is more than ample to satisfy demands. The supply of zirconium metal, however, is limited by existing processing capacities and resultant high price of the metal.

Government controls on quantities of zirconium used in steel production were relaxed on August 27, 1952, by an amendment to National Production Authority Order M-80.

As a result of hafnium-free zirconium produced at the Electrodevelopment Laboratory of the Bureau of Mines, Albany, Oreg., larger quantities of hafnium were available for research. Additional information on hafnium has been confined to the concluding section of the chapter.

DOMESTIC PRODUCTION

Mine Production.—Domestic production of zircon decreased 5 percent in 1952 compared with the record high production in 1951. This slight decrease reflected market conditions rather than production capacity. Three operating companies in Florida marketed zircon in 1952: Rutile Mining Co. of Florida, South Jacksonville; Humphreys Gold Corp., Starke (operating for E. I. duPont de Nemours & Co.

[1] Commodity-industry analyst.

on a contract basis); and Florida Ore Processing Co., Melbourne. Quantitative data are not available for publication.

Zircon produced as a result of monazite-dredging operations in Idaho was not marketed because of unfavorable freight rates and market conditions.

Refinery Production.—The principal producers of materials containing zirconium are listed below:

Producer and plant location:	*Products*
F. W. Berk & Co., Woodbridge, N. J	Zirconium compounds.
Ceramic Color & Mfg. Co., New Brighton, Pa.	Oxide and silicate.
Corhart Refractories Co., Louisville, Ky	Refractories.
De Rewal International Rare Metals Co., Philadelphia 5, Pa.	Low-hafnium zirconium oxide and metal powder; zirconium compounds.
Electro Metallurgical Co., Division of Union Carbide & Carbon Corp., New York 17, N. Y. (plants at Niagara Falls, N. Y., Sheffield, Ala., and Alloy, W. Va.)	Zirconium alloys.
Foote Mineral Co., Philadelphia 44, Pa	Zirconium metal, compounds, refractories, porcelain enamels, and ground zircon.
The Massillon Refractories Co., Massillon, Ohio	Zircon crucibles, brick, and special shapes.
Metal Hydrides, Inc., Beverly, Mass	Zirconium-metal powder, zirconium hydride, and various alloys.
Metal & Thermit Corp., New York 17, N. Y.	Zirconium compounds for ceramics, refractories, etc.
Norton Co., Worcester, Mass	Fused stabilized zirconia refractories.
Orefraction, Inc., Pittsburgh 8, Pa	Granular and milled zirconium silicate.
Rohm & Hass Co., Philadelphia 5, Pa	Zirconium sulfate solution (tanning agent).
Stauffer Chemical Co., New York 17, N. Y	Zirconium tetrachloride.
Titanium Alloy Manufacturing Division (TAM) of National Lead Co., Niagara Falls, N. Y.	Zirconium metal sponge, briquets, ingots and shapes; alloys; compounds; ground zircon; and stabilized zirconia refractories.
Vitro Manufacturing Co., Pittsburgh 4, Pa.	Pottery, enamels, and porcelains.
Westinghouse Electric Corp., Pittsburgh, Pa.	Zirconium metal.
Bureau of Mines, Albany, Oreg	Do.

The Carborundum Metals Co., Inc., a subsidiary of the Carborundum Co., Niagara Falls, N. Y., began constructing a plant at Akron, N. Y., to produce zirconium and hafnium metals for the Atomic Energy Commission. The Rust Process Design Co., Pittsburgh, Pa., designed the plant, which will cost an estimated $2.5 million and will produce 150,000 pounds of sponge metal annually. Production was scheduled to begin in July 1953. Zircon sands from Florida will be treated in an electric furnace to make carbide. This phase of the process will be handled by Carborundum Co. in existing facilities. The zirconium carbide will be processed to zirconium chloride; the chloride will be purified, then reduced to metal. The process is a modification of the Kroll process developed at the Bureau of Mines station at Albany, Oreg. The Titanium Alloy Manufacturing Division of National Lead Co. produced Kroll process zirconium metal for general industrial use.

The Bureau of Mines station, Albany, Oreg., was the principal producer of zirconium metal in 1952; over 200,000 pounds of clean zirconium sponge was produced. A plant fire on October 22, 1952, which began in a dust collector on a sand-blasting machine, caused considerable damage and curtailed production to some extent.

CONSUMPTION AND USES

Consumption of zircon in the United States in 1952 is estimated to have been about 40,000 tons. The largest use was in the manufacture of refractories, followed in order by foundry facings, foundry sand, and blasting grain; porcelains; miscellaneous compounds; metal and alloys; pottery; and glass.

Zircon is used commercially with and without processing; for foundry and some ceramic applications it is only sized and possibly ground. Zircon refractories are desirable because of their resistance to abrasion, low thermal expansion, and resistance to certain molten metals, acidic chemicals, slags, and glasses. Conversion of zirconia (ZrO_2) from the monoclinic to the cubic form has produced a super-refractory with excellent resistance to thermal shock.[2] Among zirconium chemicals, the sulfate is probably the largest tonnage item. Used in tanning white leather, white zirconium oxide is precipitated in the leather fibers. Zirconyl acetate and ammonium zirconyl carbonate are used to render textiles water repellant. Zirconium carbonate is used in salves and ointments and as an antiperspirant. A new-type electric light has, as its light source, a film of molten zirconium metal at the end of a small tube packed with zirconium oxide. This molten film radiates relatively little heat, yet the lamp has over 10 times the brightness of ordinary tungsten lamps.[3]

The current largest use of metallic zirconium is as a material of construction for nuclear-reactor plants. The low absorption cross section of zirconium, which allows the passage of slow neutrons, thus conserving them for their primary function of maintaining a chain reaction, is exceeded among the metals only by beryllium, bismuth, and magnesium. The structural performance and other desirable properties of these metals are inferior to zirconium.[4] High-purity zirconium, "zirmet," is used in power, transmitting, and long-life receiving tubes.[5] Other uses for ductile metallic zirconium are based for the most part on its excellent corrosion resistance.

Use of zirconium in ferrous and nonferrous alloys is increasing. Zirconium can be substituted for manganese in steel.[6] Additions of zirconium to sand-cast magnesium-thorium alloys have a beneficial effect on strength at elevated temperatures.[7]

---

[2] Metal Progress, vol. 62, No. 6, December 1952, p. 68.
[3] American Metal Market, vol. 59, No. 70, Apr. 10, 1952.
[4] Iron Age, vol. 170, No. 14, Oct. 9, 1952, pp. 281–287.
Evans, George E., Wanted: Better Materials for Nuclear Reactors: Iron Age, vol. 169, No. 11, Mar. 13, 1952, pp. 93–97.
[5] Foote Prints, Foote Mineral Co., vol. 24, No. 2, 1952, pp. 27–30.
[6] Metal Progress (abs.), Zr and Ti Substitutions for Manganese in Steel: Vol. 61, No. 2, February 1952, pp. 162–164.
[7] Leontis, T. E., Effect of Zirconium on Magnesium-Thorium and Magnesium-Thorium-Cerium Alloys: Trans. Am. Inst. Min. and Met. Eng., Jour. Metals, vol. 4, No. 6, June 1952, pp. 633–642.

STOCKS

Industry stocks of zircon concentrates (plus 65 percent ZrO_2) were about 9,000 tons at the close of 1952, down about 1,500 tons from 1951 year-end stocks. Approximately 25 percent of annual consumption was available from stocks. This apparent shortage caused little concern because ample supplies of zircon continued to be readily available. Stocks of other zirconium minerals were insignificant.

Zircon is acquired for the National Stockpile only through transfer of Government-owned stocks. Stockpile quantitative data are not available for publication.

PRICES

E&MJ Metal and Mineral Markets quoted zircon concentrates (65 percent ZrO_2), c. i. f. Atlantic ports, at \$47–\$50 per long ton in January 1952; \$42–\$45, April 10; and \$42–\$43, September 18. These prices were largely nominal, and individual transactions and contracts were negotiated.

Zirconium-metal powder was quoted January through November at \$7–\$8 per pound, depending on quantity; and December 11, \$7 per pound, no reference to quantity. Ductile zirconium metal made by the iodide-reduction process and fabricated forms from that stock produced by Foote Mineral Co. were quoted as follows: Zirconium crystal bar, \$70 per pound for 100 pounds and up, \$90 per pound for quantities less than 100 pounds; zirconium wire (annealed), 0.070- to 0.003-inch diameter, \$327 to \$793 per kilogram; zirconium swaged rod (unannealed), 7/16- to 5/64-inch diameter, \$200 to \$210 per kilogram; and zirconium sheet, 0.015- to 0.002-inch thick, \$289 to \$450 per kilogram. Prices for ductile zirconium produced by the Titanium Alloy Manufacturing Division, National Lead Co., and forms fabricated from that stock remained unchanged in 1952. Prices quoted were as follows: Zirconium-metal sponge and briquets, \$10 per pound; hot-rolled plate and bars, base price, \$27 per pound; hot-rolled strip, base price, \$28 per pound; cold-rolled strip, base price, \$35 per pound; cold-drawn wire, 0.060- to 0.375-inch diameter, \$42.50 to \$32.50 per pound, 0.015- to 0.030-inch diameter, \$0.08 and \$0.15 per foot, respectively. Zirconium tetrachloride was quoted at \$0.34 per pound, f. o. b. Niagara Falls, N. Y., in lots of 1 ton to a carload.

Zirconium alloys, contract price, were quoted by Electro Metallurgical Co., Division of Union Carbide & Carbon Co. f. o. b. railroad freight cars at destination as follows: Zirconium-ferrosilicon, 12–15 percent Zr, \$0.08 to \$0.1075, 35–40 percent Zr, \$0.2025 to \$0.2525, depending on quantity and size; zirconium briquets (11 percent Zr, 38 percent Si), \$0.075 to \$0.10 per pound, depending on quantity; and nickel-zirconium (40–50 percent Ni, 25–30 percent Zr) \$1.25 to \$1.35 per pound, depending on quantity.

The Oil, Paint and Drug Reporter quoted zirconium compounds, per pound, in large lots, f. o. b. New York, as follows: Acetate, January \$0.265, June \$0.23; carbonate, \$0.305; hydride, January \$12, June \$7.50 to \$10, December \$7.25 to \$11.50; nitrate, \$4.50 to \$7; and oxide, \$1.50.

In addition to the principal producers of zirconium products, other buyers of zircon concentrates include: Berkshire Chemicals, Inc., New York 7, N. Y.; International Titanium Corp., New York 17, N. Y.; Metallurg, Inc., New York, 17, N. Y.; Pacific Graphite Co., Inc., 40th and Linden, Oakland, Calif.; and Frank Samuel & Co., Inc., Philadelphia 7, Pa.

FOREIGN TRADE

Australia continued to be the principal source of zirconium ore imported for consumption in the United States during 1952. A small quantity, less than 10 percent of the total, came from Brazil. Imports from Australia have been in the form of clean zircon concentrates containing 66 percent ZrO_2 and in mixed zircon-rutile concentrates containing 65 percent zircon, or 43 percent ZrO_2. Since 1949 the trend has been toward separating the heavy minerals before shipment. In 1952, 80 percent of the zircon imported from Australia was in the form of clean zircon concentrates. Twenty-seven pounds of special quality zirconium metal, valued at $500, was imported from the United Kingdom and France.

Exports of zircon concentrates in 1952, principally to Canada, totaled 584 short tons valued at $42,221; 20 tons were exported to Mexico and 1 ton to France. Exports of zirconium metal, alloys, and primary forms totaled 51,151 pounds, valued at $42,677. Canada was the major recipient. Zirconium powder, metal, alloys, and primary forms were retained on the positive list of products requiring export licenses to foreign destinations (except Canada).

TABLE 1.—Zirconium ore (concentrates)[1] imported for consumption in the United States, 1948–52, by countries, in short tons

[U. S. Department of Commerce]

Year	Australia [2]	Brazil	Canada	India	Total	
					Short tons	Value
1948	14,320	3,553	2	279	18,154	$571,161
1949	18,839	1,994			20,833	636,529
1950	15,988	697	141		16,826	431,107
1951	25,208	2,084			27,292	664,428
1952	21,935	1,972			23,907	630,559

[1] Concentrates from Australia are zircon or mixed zircon-rutile-ilmenite, and those from Brazil are baddeleyite or zircon. All other imports are zircon.
[2] Imports of zircon, rutile, and ilmenite from Australia until early 1948 were largely in the form of mixed concentrates. These mixed concentrates are classified by the U. S. Department of Commerce arbitrarily as "zirconium ore," "rutile," or "ilmenite." Total zircon content of the zirconium ore (as shown in this table) and of the rutile and ilmenite concentrates (*see* Titanium chapter) are estimated as follows: 1948 13,873 tons; 1949, 14,623 tons; 1950, 15,098 tons; 1951, 24,577 tons; and 1952, 21,500 tons.

Producers of zirconium products in foreign countries include Dominion Magnesium, Ltd., Toronto, Canada; Murex Co., Rainham, Essex, England; Blackwell's Metallurgical Works, Ltd., and Imperial Chemical Industries, Ltd., Liverpool, England; and Goodlass Wall & Lead Industries, Ltd., Newcastle-upon-Tyne, England. Australia is the principal source of zircon for the English companies.

TECHNOLOGY

The specific gravity of zircon (4.7) enables it to be concentrated with other heavy minerals by gravity methods. Clean zircon is produced from heavy-mineral concentrates by a combination of drying, screening, electrostatic, and electro-magnetic processes. Zircon, in contrast to ilmenite, rutile, garnet, and many other heavy minerals, is nonconductive and can be separated, with monazite, by electrostatic methods. Monazite, which is slightly magnetic, can be separated from zircon by electromagnets. To obtain clean zircon, the zircon-rich tailings from the electrostatic-electromagnetic processes are again subjected to gravity concentration (spirals or tables) to eliminate light, nonconductive minerals, such as quartz and feldspar. The enriched product is then usually dried at 1,200° F. to remove organic stainings and treated in high tension separators and induced roll magnetic separators to remove residual conductive and magnetic minerals. A 99-percent zircon product is usually obtained by these methods.

Anhydrous zirconium tetrachloride, the starting material in the magnesium-reduction (Kroll) process for production of ductile zirconium, is now produced by direct chlorination of a zirconium oxide-carbon mixture.[8] The zirconium oxide used in this process is obtained from crude $ZrCl_4$, which has been processed to remove the hafnium. Crude $ZrCl_4$ is prepared by smelting zircon sand with an excess of carbon, followed by chlorination of the resultant zirconium carbide.

Zirconium metal is also produced by reduction of $ZrCl_4$ by sodium (Hunter process), by reduction of ZrO_2 by metallic calcium (developed by the Westinghouse Corp.), and by the iodide process (Van-Arkel-de Boer, used by the Foote Mineral Co.).[9]

High-temperature experiments with zirconium and zirconium compounds conducted by the Bureau of Mines were described,[10] and a report on the mechanical properties of zirconium was published by Sylvania Electric Products, Inc., Atomic Energy Div., December 9, 1952.

Zirconium alloy investigations received considerable attention in 1952.[11] A patent was issued for a pyrophoric alloy of lead and zirconium, which alloy when subjected to a sudden heavy impact is pulverized and set afire. Applications in ammunition as a tracer, as a means for igniting an incendiary mixture, and as an aid to spotting bullet impacts are reported.[12]

---

[8] Stephens, W. W., and Gilbert, H. L., Chlorination of Zirconium Oxide: Trans. Am. Inst. Min. and Met. Eng., Jour. Metals, vol. 4, No. 7, July 1952, pp. 733–737.

[9] Merriman, A. D., The Metallurgy of Zirconium, Its Extraction, Fabrication, and Properties: Metal Treatment and Drop Forging (London), vol. 19, No. 83, pp. 365–371; No. 84, pp. 413–417.

[10] Kroll, W. J., Carmody, W. R., and Schlechten, A. W., High-Temperature Experiments with Zirconium and Zirconium Compounds: Bureau of Mines Rept. of Investigations 4915, 1952, 31 pp.

[11] Hayes, E. T., Carpenter, R. L., Cavett, A. D., Kato, H., O'Brien, W. L., and Paasche, D. G., Bureau of Mines Zirconium Alloy Investigation: WADC-TR-52-236 (available from Document Service Center, Knott Bldg., Dayton, Ohio), November 1952, 32 pp.
Frost, P. D., Zirconium-Cerium Master Alloys for Magnesium: Battelle Memorial Inst., Columbus, Ohio (Contract NOa(s) 51-001-c), July 1952, 2 pp.
Schwope, A. D., and Chubb, W., Small Additions Raise Strength of Zirconium at Elevated Temperatures: Jour. Metals, vol. 4, No. 11, November 1952, pp. 1138–1140.
Ayres, Charles F., Zirconium: Light Metal Age, vol. 10, Nos. 9, 10, October 1952, pp. 10–20.

[12] Alexander, Peter P. (assigned to Metal Hydrides, Inc.), Zirconium-Lead Alloy: U. S. Patent 2,611,316, Sept. 23, 1952.

Increased interest in zirconium metal, alloys, and compounds resulted in the description of several zirconium analytical methods.[13]

RESERVES

Zircon is unique among rare-metal minerals in that deposits from which zircon can be extracted economically are plentiful. Zirconium is classed as a rare metal not because of its relative scarcity in the earth's crust (0.02 to 0.03 percent), but because of the difficulty in extracting the metal from its ores. Zirconium is the ninth most common metal in the earth's crust and thus more abundant than copper, lead, zinc, nickel, and some other familiar metals. A fortunate aspect of zircon is that its specific gravity and resistance to abrasion enable it to be concentrated in placer deposits from which it may be extracted cheaply.

Known placer deposits in Florida, California, Idaho, and Oregon are estimated to contain 15 million tons of zircon. These reserves could be increased substantially if the demand for zircon warranted intensive, exploratory campaigns.

Zircon reserves in other parts of the world are known to be extensive. Quantitative data, however, are lacking. In Australia, a 75-mile stretch of beach between Stradbroke Island, Queensland, to Lennox Head, New South Wales, is reported to contain 1 million tons of zircon in high-grade deposits containing more than 300 pounds of heavy minerals per ton.[14] Extremely large reserves of lower-grade material are known to exist.

Reserves of baddeleyite (ZrO_2), in Brazil are estimated to be on the order of 2 million tons. Large deposits of zircon are also known in the States of Baia, Espírito Santo, and Rio de Janeiro. Deposits have been found in British, Dutch, and French Guiana and other countries of South America but have not been developed.

Large deposits of zircon are known to occur in India, at the mouth of the Nile River in Egypt, and in beach sands in French West Africa.

WORLD REVIEW

Australia.—Plans to exploit large, low-grade (2–3 percent heavy minerals) sand deposits at Stradbroke Island, Queensland, by dredging were initiated by the Zinc Corp., 95 Collins St., Melbourne.[15] The deposits are estimated to contain 10 to 15 pounds each of zircon and rutile per ton of sand.

Belgian Congo.—An abundance of zircon has been found in certain alluvials of the following rivers: Yebu, Aruwimi, Ituri, Lowa, Ulindi, Zalya, Luizi, Kalasangashi, Musele, Mayama, and the Lulua. These deposits have not been exploited.[16]

---

[13] Horton, A. D., Spectrophotometric Determination of Zirconium: Oak Ridge National Laboratory (AECD-3482; CF-52-12-62), declassified Dec. 22, 1952, 16 pp.

Oesper, Ralph E., Dunleavy, Raymond A., and Klingenberg, Joseph J., Rapid Method for Determination of Small Amounts of Zirconium: Anal. Chem., vol. 24, No. 9, September 1952, pp. 1492–1494.

Dhar, S. K., and Das Gupta, A. K., Colormetric and Volumetric Estimation of Zirconium: Jour. Sci. Ind. Research (India) Bii, November 1952, pp. 500–501.

Determination of Selected Metals: Chem. Age, vol. 66, No. 1714, May 17, 1952, p. 750.

[14] Gardner, D. E., Mineral Sources of Australia, Summary Rept. No. 1, Zirconium: Commonwealth of Australia, Bureau of Mineral Resources, Geology, and Geophysics, rev. July 1951.

[15] Mining Journal (London), vol, 239, No. 6118, Nov. 21, 1952, p. 569.

[16] Murdoch, Thomas G., The Undeveloped Mineral Resources of the Belgian Congo: Am. Consulate Elisabethville, Belgian Congo, State Dept. Dispatch 22, Feb. 12, 1952, 12 pp.

Brazil.—Baddeleyite (ZrO_2) occurs in the Pocos de Caldas district, a mountainous plateau of acidic, igneous rocks at about 3,600 feet elevation. The principal deposits are in an elliptical area about 20 by 15 miles in the States of São Paulo and Minas Gerais approximately 130 miles north of the city of São Paulo. About 3,000 tons are exported annually to the United States, England, Norway, and Germany. About 200 tons are consumed annually in São Paulo, Brazil, by the refractory and ceramic industry.

Egypt.—About 1,200 tons of zircon concentrates (64 percent ZrO_2) are produced annually from large black sand deposits at the mouth of the Nile River.

French West Africa.—Zircon is produced as a coproduct with ilmenite from beach deposits of Senegal and Casamance.

United Kingdom.—An estimated 10,000 tons of zircon was consumed by the refractory industry in England in 1952. Murex, Ltd., Rainham, England, installed facilities to produce zirconium sheet up to 22 inches wide by 5 feet long for use in the chemical industry.[17] A plant for the production of zirconium compounds for use in the ceramic and refractory industries was completed at Newcastle-upon-Tyne by Goodlass Wall & Lead Industries, Ltd.[18]

HAFNIUM

Hafnium, a metallic element discovered in 1923, was little more than a laboratory curiosity until 1951. The metallurgical development of processes to produce hafnium-free zirconium metal has resulted in the availability of larger quantities of hafnium for experimental purposes.

Source.—Hafnium and zirconium have many similar properties and occur together in ore minerals. Known Zr-Hf minerals geneally contain much more zirconium than hafnium. Recent studies of zircon from many parts of the world indicate that zircon usually contains 1–1.5 percent hafnium. Altered zircon (for example, the mineral cyrtolite) may contain as much as 17 percent hafnium. There are no known commercial deposits of altered zircon minerals; however, unaltered zircon reserves represent a substantial potential source of hafnium. The hafnium content of the crust of the earth has been estimated to be greater than mercury, columbium, tantalum, or silver. Many high-hafnium minerals exhibit marked radioactivity; the relationship, however, between uranium-thorium and hafnium is not clearly understood.

Properties.—The specific gravity of hafnium (13.3) and atomic weight (178.6) are approximately twice those of zirconium. Hafnium resembles zirconium closely but has a higher melting point (3,590° F.), less ductility, higher electron emission, and a very strong tendency to absorb slow neutrons. This latter property makes hafnium an objectionable impurity in zirconium metal used in nuclear-reactor plant design. The probability that a hafnium nucleus will capture a thermal neutron is approximately 550 times over that of a zirconium nucleus.

Pure hafnium, produced under controlled conditions, is a bright, ductile metal. Although somewhat more difficult to work than duc-

---

17 Metal Industry, Rare-Metal Fabrication: Vol. 80, No. 4, Jan. 25, 1952, p. 66.
18 Metal Bulletin (London), No. 3703, June 24, 1952, p. 24.

tile zirconium because of its greater tendency to absorb gases, hafnium can be bent, deep-drawn, formed, and cold-worked to a maximum reduction of 30 percent between anneals. It can be hammered cold, drawn into wire, and rolled into sheet. Hafnium has excellent resistance to oxidation in still air and has corrosion resistance to certain acids and bases comparable to zirconium.

Production.—Several tons of hafnium metal containing less than 2 percent zirconium have been produced by the Bureau of Mines at Albany, Oreg. De Rewal International Rare Metals Co., Philadelphia, Pa., is a pioneer in the production of hafnium metal and compounds. Fairmount Chemical Co., Newark, N. J., reportedly produces hafnium oxide; Metal Hydrides, Inc., Beverly, Mass., has experimented with a hafnium-nickel alloy; Zirconium Co., Flemington, N. J., produces hafnium oxychloride; F. W. Berk & Co., Woodridge, N. J., produces the oxide; and Foote Mineral Co., Philadelphia, Pa., produces iodide crystal bar hafnium from hafnium sponge produced by the Bureau of Mines, Albany, Oreg.

Uses.—Most of the hafnium produced to date has been consigned to the Atomic Energy Commission; specific applications have not been revealed. The small quantities of metal and compounds available for experimental industrial applications have been used in chemical and physical research to determine their properties. The oxide and carbide of hafnium are among the most refractory compounds, with melting points of 2,664° and 3,787° C., respectively. Hafnium boride is an extremely hard material. The oxide and salts of hafnium exhibit catalytic properties similar to their zirconium homologues. The high melting point of hafnium and its high degree of electron emission suggest uses in radio tubes, incandescent lamps, and rectifiers and cathodes for X-ray tubes. The high thermal neutron absorption cross-section suggests use for shielding against radioactivity. As a metal for jewelry, hafnium is heavy, probably as tarnish resisting as gold, and can be formed and polished beautifully.

Prices.—In 1952, De Rewal International Rare Metals Co. quoted hafnium metal (99.5 percent Hf) and hafnium oxide (99 percent HfO_2) at $22 per gram (100-gram lots). This company announced plans to expand production with expectations of offering hafnium metal at $150 per pound.

Technology.—Hafnium can be separated from zirconium by fractional crystallization, fractional precipitation, by the use of ion exchange resins, or by liquid-liquid separation. In the processing of zirconium, commercial zirconium tetrachloride containing hafnium is processed to effect the hafnium separation. Details of this process are not available for publication. The resultant hafnium hydroxide is calcined to hafnium oxide, which is then processed in the same manner as zirconium oxide, with only slight operational changes, to produce hafnium sponge metal. Ductile hafnium metal produced from hafnium sponge by the iodide process (Foote Mineral Co.) contains less than 1 percent zirconium. The high reactivity and sensitivity of hafnium (and zirconium) to the effects of oxygen, nitrogen, and other contaminating elements poses special problems in the production of usefully ductile metal.

Hafnium analyses are usually performed by making a chemical separation and extracting hafnium and zirconium in the form of combined oxide. The oxide is weighed and the percentage determined. The ratio of hafnium to zirconium plus hafnium is determined by X-ray spectroscopy. Results are usually reported in terms of this ratio because, regardless of the purity of the ore sample or the purity of the chloride, oxide, or metal, from that ore, the ratio of hafnium to hafnium plus zirconium is numerically the same. If desired, however, the hafnium content of the original sample can be calculated.

Outlook.—The availability of enough hafnium metal and compounds for industrial purposes may depend upon expanded production of hafnium-free zirconium. If hafnium is not an objectionable impurity in zirconium used for nonreactor applications or unless a strong demand develops for hafnium and its compounds, the large-scale separation of the two metals probably will be undertaken only if a low-cost process is developed.

SELECTED BIBLIOGRAPHY

VON HERESY, G. The Discovery and Properties of Hafnium. Chem. Revs., vol. 2, No. 1, April 1925.

LEE, IVAN O. The Mineralogy of Hafnium. Chem. Revs., vol. 5, No. 1, February 1928.

TYLER, Paul M. Hafnium. Bureau of Mines Inf. Circ. 6457, 1931, 11 pp.

KROLL, W. J. Production and Uses of Rare Metals. Min. and Met., vol. 27, No. 473, May 1946, p. 262.

MARTIN, D. R. Hafnium. Foote Mineral Co., Phila., Pa., Foote Prints, vol. 21, No. 1, 1949, p. 8.

DUWEZ, P. The Allotropic Transformation of Hafnium. Jour. Appl. Phys., vol. 22, No. 9, September 1951, p. 1174.

LITTON, FELIX B. Preparation and Some Properties of Hafnium Metal. Jour. Electrochem. Soc., vol. 98, No. 12, December 1951, pp. 488–494.

ADENSTADT, H. K. Physical, Thermal, and Electrical Properties of Hafnium and High Purity Zirconium. Paper presented at midwinter meeting of Am. Soc. Metals, Pittsburgh, Jan. 31–Feb. 1, 1952.

EVERHART, JOHN L. Hafnium Metal—Its Properties and Future. Materials and Methods, vol. 36, No. 5, November 1952, pp. 1195–1197.

Minor Metals

By E. J. Carlson,[1] H. D. Keiser,[1] and J. D. Sargent[1] [2]

CESIUM AND RUBIDIUM [3]

CESIUM and rubidium are two soft, silvery-white, alkali metals that are usually associated in nature. They tarnish rapidly and, if placed in dry oxygen at room temperature, will ignite spontaneously. The metals are stored in a vacuum or kept immersed in an inert liquid. Pollucite, a cesium-aluminum silicate containing about 34 percent Cs_2O, is the principal ore mineral of cesium and often contains from a fraction to 1.5 percent Rb_2O. Commercial quantities of pollucite have been found in the pegmatites of Maine, South Dakota, Sweden, and South-West Africa. Lepidolite, a lithium mica containing 1 to 3 percent Rb_2O and smaller amounts of Cs_2O, is the richest source mineral of rubidium. Over 80 percent of the lepidolite consumed domestically in 1952 was imported from the pegmatite mines of South-West Africa. Other sources of lepidolite were South Dakota, Colorado, California, and Norway.

Domestic Production.—Small quantities of cesium and rubidium metals and compounds were produced in 1952 by Fairmount Chemical Co., Newark, N. J.; DeRewal International Rare Metals Co., Philadelphia, Pa.; Maywood Chemical Works, Maywood, N. J.; and A. D. Mackay, Inc., New York, N. Y. Harshaw Chemical Co., Cleveland, Ohio, and Foote Mineral Co., Philadelphia, Pa., produced some compounds of cesium and rubidium.

Uses.—Cesium was used in scintillator counters and various optical and detecting devices, such as the sniperscope. This military instrument is used to detect enemy objects in the dark and is similar to radar in operation. Other uses for cesium were as the active agent in the emission of electrons in photoelectric cells; in vapor lamps for infrared signaling by the military; and in cesium-vapor rectifiers. The National Bureau of Standards explored the value of cesium as a microwave frequency standard in electronics and spectroscopy. The work resulted in the making of an atomic clock, based upon the frequency of the vibrations of cesium atoms. This clock, which never needs winding, would show an error of not greater than 1 second in 300 years.[4]

---

[1] Commodity-indu try analyst.
[2] Unless otherwise noted, figures on imports compiled by Mae B. Price and Elsie D. Page, of the Bureau of Mines, from records of the U. S. Department of Commerce.
[3] Prepared by E. J. Carlson.
[4] Lyons, Harold, Spectral Lines as Frequency Standards: Nat. Bur. of Standards Rept. 1948, Aug. 8, 1952, 76 pp.

Rubidium was generally used in 1952 for the same applications as cesium and often in combination with that metal; its principal use was in the manufacture of vacuum tubes and photoelectric cells. Rubidium compounds have been used in medicine for treating goiter and syphilis, and rubidium-mercury amalgams have been used as catalytic agents in the hydrogenation of certain compounds.

Prices.—Cesium metal, C. P. and double-distilled, in sealed-glass tubes, was quoted at $4 per gram; cesium chloride and cesium bromide, 5-gram lots, $2 per gram; and cesium sulfate, 5-gram lots, $3.50 per gram. Pollucite ore, chiefly foreign, was sold at $400–$500 per ton, depending on Cs_2O content.

Rubidium metal, C. P. and double-distilled, in sealed-glass tubes, was quoted at $4.50 per gram; rubidium chloride, 5-gram lots, $3.50 per gram; and rubidium iodide, 5-gram lots, $3 per gram.

GALLIUM [5]

Gallium at normal room temperatures is a solid, gray metal, but at 86° F. the metal becomes liquid and changes to a silver color. The element remains in a liquid state up to 3,601° F., its boiling point, and thus has one of the longest liquid phases among elements or compounds. Like water, it expands upon solidification and therefore must be stored in flexible containers. Gallium is extremely corrosive in its attack on other metals, particularly at elevated temperatures. The element is widely distributed in the crust of the earth, but no minerals are known to contain gallium as a major constituent. Germanite, a complex copper-zinc-germanium-arsenic sulfide, normally contains 0.1 to 0.8 percent gallium. Some zinc, tin, and aluminum ores contain 0.002 to 0.05 percent gallium.

Domestic Production.—Gallium is produced in the United States from zinc flue dusts, electrolytic-zinc-plant residues, and circulating liquors of the Bayer aluminum process. The normal domestic production of the metal is a few hundred pounds annually, a quantity adequate to satisfy demand. No output, however, was reported for 1952, inasmuch as 1951 end stocks were adequate to supply market needs. The potential production, if new uses for gallium were developed, might be measured in tons. In past years gallium has been produced by the Aluminum Ore Co., East St. Louis, Ill.; the Anaconda Copper Mining Co., Great Falls, Mont.; and the Eagle-Picher Co., Joplin, Mo.

Uses.—Gallium has promise as a heat-transfer liquid owing to its unique properties. A research study was made by the Battelle Memorial Institute [6] to determine the effect of alloying on the melting point of gallium and to study the corrosion resistance of possible container materials. Sn–Zn and Pb–Sn were found to be suitable diluents. Zinc and tin were found to form a ternary eutectic with gallium, located at 82 percent Ga—12 percent Sn—6 percent Zn, melting at 17° C. It was found that As, Ca, Ce, Mg, Sb, Si, and Ti do not lower the melting point of gallium. The only metals found capable of containing gallium at elevated temperatures were tungsten and tantalum.

---

[5] Prepared by E. J. Carlson.

[6] Evans, R. M., and Jaffee, R. I., Low-Melting Gallium Alloys: Jour. Metals, February 1952, pp. 154–158.

Small quantities of gallium were used in direct-reading fused-quartz thermometers, in dental alloys, in selenium rectifiers, and as optical mirror backings. Radioactive gallium has been used in diagnosing and treating bone cancer. A minor application of the metal was as a liquid seal on the inlet system of mass spectrometers, for analyzing hydrocarbons with high boiling points.

Prices.—Gallium metal, 99.9 percent pure, was quoted in 1952 at $4.50 per gram in lots less than 100 grams; $3.50, 100 to 999 grams; and $3, 1,000 to 2,499 grams.

GERMANIUM [7]

Both production and consumption of germanium increased markedly in 1952. Toward the close of the year another producer with an annual capacity of 5,000 pounds entered the industry. Manufacture of germanium semiconductor devices expanded substantially, and a number of new products with such devices as components appeared on the market.

Much discussion prevailed during 1952 relative to the transistor, particularly the junction transistor—the most recent type of germanium semiconductor device which seemed destined to revolutionize electronics. That the junction transistor, however, had not as yet been perfected and would not completely supersede the point-contact transistor was recognized.[8] The point-contact transistor still retained the advantages of producing current gain directly, operating at higher frequencies, and being less difficult and cheaper to manufacture than the junction transistor.

Refined germanium metal of extremely high purity was made with scientific precision in 1952. Impurities in the metal were measured in parts per trillion rather than in parts per million. Necessity for such exactitude was indicated by the statement that 1 part of antimony per 100 million parts of germanium doubled the conductivity of the metal.[9]

The prediction was made that a new industry will grow from germanium which will rival the chemical industry in size.[10] Several comprehensive reviews of germanium were published.[11] [12-16]

Domestic Production.—Germanium production in the United States in 1952 was almost two and a half times as much as in 1951. The major part of the output was derived from zinc concentrate produced in the tri-State district of Kansas, Missouri, and Oklahoma. The Eagle-Picher Co. was again, by a wide margin, the principal producer. Significant quantities were also recovered in 1952 by the American Steel & Wire Co., Donora, Pa.; American Zinc Co. of Illinois, Fair-

[7] Prepared by H. D. Keiser and J. D. Sargent.
[8] Sparks, Morgan, The Junction Transistor: Sci. Am., vol. 187, No. 1, July 1952, pp. 29–32.
[9] Rugare, Anthony S., The Metal Germanium and Its Use in the Electronics Industry: Metal Progress, August 1952, vol. 62, No. 2, pp. 97–103.
[10] Electronics, Germanium—Threat or Promise to the Electronics Industry: Vol. 25, No. 2, February 1952, pp. 18, 20.
[11] Works cited in footnotes 8, 9, and 10.
[12] O'Connor, Joseph A., Germanium's Electronic Upsurge: Chem. Eng., vol. 59, No. 4, April 1952, pp. 158–160, 290.
[13] Thompson, A. P., and Musgrave, J. R., Germanium, Produced as a Byproduct, Has Become of Primary Importance: Jour. Metals, vol. 4, No. 11, November 1952, pp. 1132–1137.
[14] Canadian Metals, Germanium, the Unknown Element: Vol. 15, No. 12, November 1952, p. 28.
[15] Engineering and Mining Journal, Germanium Promises an Early Revolution in Electronics: Vol. 153, No. 2, February 1952, pp. 154, 156, 159.
[16] Iron Age, Germanium: Vol. 170, No. 14, Oct. 9, 1952, p. 289.

mont City, Ill.; and Saratoga Laboratories, Saratoga Springs, N. Y. The new germanium-recovery unit at the Fairmont City, Ill., plant of American Zinc Co. of Illinois, with a designed annual capacity of 5,000 pounds of germanium dioxide, was placed in operation on December 18.

A tax-amortization application filed by the Eagle-Picher Co. in 1951 was approved in May 1952, in connection with the company's contemplated enlargement of germanium research and production facilities at Joplin, Mo. Construction during 1953 of a new plant at Miami, Okla., for production of germanium was announced by the Eagle-Picher Co.

Consumption and Uses.—Apparent consumption of germanium and its compounds in 1952 more than doubled that in 1951. Germanium dioxide continued to be the major form shipped by producers, and smaller quantities of germanium metal and germanium tetrachloride were required by industry. Manufacturers of semiconductor devices consumed virtually all the germanium shipped, converting it to extremely high purity metal for use in the production of diodes, transistors, and rectifiers. Over 10,000,000 diodes were produced in 1952 compared with about 6,000,000 in 1951.

Although many manufacturers of electronic equipment were using germanium diodes and transistors in their products, only a few such firms were making those component semiconductor devices. In 1952 diodes were produced by the Hughes Aircraft Co., Culver City, Calif.; Kemtron Electron Products, Inc., Salem, Mass.; Philco Corp., Philadelphia, Pa.; Radio Receptor Co., New York, N. Y.; and Sylvania Electric Products, Inc., Woburn, Mass. Transistors were produced by Federated Semi-Conductor Co., New York, N. Y., and Raytheon Manufacturing Co., Newton, Mass. Both diodes and transistors were produced by Hytron Radio Electronics Co., Danvers, Mass.; General Electric Co., Syracuse, N. Y.; National Union Radio Corp., Hatboro, Pa.; Radio Corp. of America, Harrison, N. J.; Transistor Products, Inc., Boston, Mass.; and Western Electric Co., Allentown, Pa.[17]

In 1952 the Bell System began using transistors instead of vacuum tubes in its long-distance dialing facilities at Englewood, N. J., enabling telephone subscribers in that locality to reach about 11,000,000 telephones in a dozen areas, from coast to coast, without the assistance of an operator.[18] Construction of a pilot plant by Western Electric Co. in the near future to produce about 240,000 transistors a year for long-distance dial-telephone networks was reported.[19]

Some magnesium germanate was utilized as a phosphor in fluorescent lamps.[20] Other applications of germanium that appeared promising were in the infrared spectroscope and other infrared optical instruments, inasmuch as germanium is transparent to infrared radiation; in the production of germanium glass, which has a high index of refraction; and for various photoelectric and thermoelectric purposes.[21]

Stocks.—Stocks of germanium held by producers at the close of 1952 were about four times as large as those held at the close of 1951.

---

17 Electronics Production Resources Agency, Department of Defense.

18 American Telephone & Telegraph Co., New York, N. Y.: Annual Rept. for 1952, p. 9. Journal of Metals, vol. 4, No. 12, December 1952, p. 1261.

19 American Metal Market, Germanium, the Strange Metal: Vol. 59, No. 93, May 14, 1952, p. 2.

20 Work cited in footnote 13.

21 Work cited in footnote 16.

Prices.—Prices quoted for germanium in 1952 reflected an unstabilized market, particularly in the first half of the year. E&MJ Metal and Mineral Markets quoted germanium metal at $180 per pound from the beginning of the year until September 11; beginning September 11 and until October 2 the quotation was published as nominal; on October 2 the quotation advanced to $340 per pound and continued at that level for the remainder of the year. On October 9 E&MJ Metal and Mineral Markets began quoting germanium dioxide, publishing a quotation of $142 per pound, which continued unchanged up to the close of the year.

The American Metal Market quoted germanium metal, 99.9 percent, at $180 per pound from the beginning of the year through May 14; no quotation was published over the period of May 15–19. On May 20 germanium metal, 99.9 percent, was quoted at $340 per pound and dioxide, high purity, at $140 per pound. These quotations continued until October 2, when germanium metal, 99.9 percent, was quoted nominally at $350 per pound, with the quotation for dioxide, high purity, continuing at $140 per pound. For the remainder of the year the quotations were unchanged.

Foreign Trade.—In 1952 a total of 203 pounds of germanium dioxide, valued at $48,475, was imported from West Germany, United Kingdom, and Belgium.[22] Data on exports of germanium were not available.

Technology.—Inasmuch as the demand for germanium appeared destined to increase materially over the next few years, the Bureau of Mines search for new sources of germanium was intensified in 1952. Germanium was found in zinc sulfide concentrates other than those produced in the tri-State district (Kansas, Missouri, and Oklahoma) and in certain final and intermediate products of processing at various coal- and coke-burning, chemical, and electrolytic plants. Coal byproducts, although not high in germanium content, appeared to be the most promising source for quantity production of the metal.

The Bureau of Mines, in cooperation with the Signal Corps, United States Army, initiated a research and development program to study coal and major coal-consuming plants to determine the germanium content of various products at all stages of coal-burning operations. Improvement and standardization of analytical methods for germanium were included in the program. No quick, simple test for germanium had been found by the close of 1952.

Others engaged in extensive research on the germanium content of coal included the Federal Geological Survey, West Virginia Geological Survey, Pennsylvania State College, Illinois Geological Survey, Pennsylvania Coal & Coke Corp., and Eagle-Picher Co.

The Federal Geological Survey, in a comprehensive, long-range study of the minor elements in coal ash, found that concentrations appear to be limited in vertical as well as lateral extent of coal beds. During 1952, according to Taisia Stadnichenko of that agency, the Survey sampled and studied coal beds in Colorado, Indiana, Kentucky, Montana, New Mexico, Utah, and Wyoming. Pennsylvania State College investigated the germanium content of the Pennsylvania anthracite fields. A letter from C. C. Wright, of the college faculty,

[22] U. S. Tariff Commission.

states that the bottom part of the Ross bed was found to be especially promising.

Investigations of germanium in coal indicated that, in some instances, the value of the germanium content exceeded the selling price of the coal. The germanium content of British, German, and Russian coals, as recorded in the literature of the last 20 years, was reviewed.[23]

In the course of a Bureau of Mines metallurgical investigation of zinc concentrate produced in the tri-State district of Kansas, Missouri, and Oklahoma, over 90 percent of the germanium in the concentrate was removed by utilizing inert atmospheres, reducing atmospheres, or partial vacuum and temperatures ranging from 900° to 1,050° C.[24]

World Review.—Union Minière du Haut Katanga, in the Belgian Congo, and Tsumeb Corp., Ltd., in South-West Africa, appeared to be the most promising foreign potential producers of germanium. Flue dusts at the former's Lubumbashi smelter were said to contain economically attractive percentages of germanium. The germanium potential of Tsumeb Corp. was indicated in the following excerpt from a letter to the Bureau of Mines from H. DeWitt Smith, managing director:

> During 1952 Tsumeb Corporation made sales of approximately 15 tons of germanium ore, of approximately 4 to 5 percent germanium content, to France and Western Germany. This represented the balance of approximately 30 tons of this type of ore which had been mined by former German owners at Tsumeb many years ago.
>
> Tsumeb Corporation is carrying out intensive research on germanium recovery at its own research laboratory at Tsumeb, South-West Africa, through the Battelle Memorial Institute, the American Cyanamid Company at Stamford, and through the Newmont research laboratory which is in the process of being set up at Grass Valley, California.
>
> On an ore production of 600,000 tons per annum at Tsumeb, which rate we expect to achieve before the end of 1954, we anticipate a germanium content of approximately 0.0175 percent, equivalent to 220,000 pounds of germanium. In our normal selective flotation operations at Tsumeb we would expect to produce 150,000 tons of copper-lead concentrates carrying 0.04 percent germanium, equivalent to 120,000 pounds of germanium. During the calendar year 1952, our production of copper-lead concentrates amounted to approximately 115,000 tons, of which half was sent to El Paso [Texas] and the balance to Hoboken [Belgium] for smelting.

The European firm S. A. de la Vieille Montagne began recovering germanium in 1952.[25]

INDIUM[26]

Indium is the softest metal stable in air; it is readily scratched with the fingernail. This silver-white metal is highly plastic and deforms under compression almost indefinitely. Indium does not work-harden and actually softens during rolling because the recrystallization point is below room temperature. The metal and most of its alloys resist alkali corrosion and will adhere to smooth surfaces, including glass. No minerals rich in indium have been found. Some zinc blendes and complex ores of lead-tin-antimony sulfides have been found to contain up to 1 percent of the metal.

[23] McCabe, Louis C., Atmospheric Pollution: Ind. Eng. Chem., vol. 44, No. 3, March 1952, pp. 113A, 114A, 116A.

[24] Kenworthy, H., and Absalom, J. S., Separation of Lead, Cadmium, and Germanium Sulfides from Zinc Sulfide Concentrates: Bureau of Mines Rept. of Investigations 4876, 1952, 7 pp.

[25] American Metal Market, vol. 60, No. 89, May 1, 1953, p. 1.

[26] Prepared by E. J. Carlson.

Domestic Production.—Commercial production of indium is obtained by treating residues, dusts, and dross accumulated in refining zinc and lead ores. Domestic output of indium in 1952 decreased about 25 percent compared to 1951, and producers' year-end stocks were reduced over 50 percent. Principal producers of indium were the Anaconda Copper Mining Co., Great Falls, Mont.; Cerro de Pasco Copper Corp., Brooklyn, N. Y.; Belmont Smelting & Refining Co., Brooklyn, N. Y.; and American Smelting & Refining Co., Denver, Colo., and Perth Amboy, N. J.

Uses.—The principal uses for indium in 1952 were, as in prior years, as a diffused plating for engine bearings; as a constituent in solders and brazing alloys; as plating for jewelry and other metals used for decorative purposes; and as a bond to join glass to glass or glass to metal. New uses suggested for the metal were: As a lubricant with graphite in internal-combustion engines, dies and molds, metal-disk clutches, and brakes; as an additive to the bath for chrome plating, to reduce brittleness of the plated chrome; and, with germanium, in the electronics industry for making junction-type transistors to replace vacuum tubes.

Prices.—Quotations on indium metal, electrolytic grade, 99.9 percent, have remained constant from 1946 through 1952 at $2.25 per troy ounce.

World Review.—Consolidated Mining & Smelting Co. of Canada, Ltd., revealed in 1952 that it had developed a new process for making pure indium metal and could go into production at the rate of 35 tons a year.[27]

RARE-EARTH MINERALS AND METALS[28]

Recent discoveries of monazite and bastnaesite deposits in the United States indicate that the Nation may soon become independent of foreign sources for rare-earth metals, which are highly important in connection with defense. Monazite, a rare-earth phosphate containing thorium, was produced in 1952 from beach sands in Florida and placer alluvium in Idaho. Bureau of Mines investigations, partly on a cooperative basis with the Federal Geological Survey, indicated minable deposits of monazite sands in North Carolina, South Carolina, Georgia, and Florida. Other Bureau investigations proved the existence of rich monazite alluvials in Idaho, Montana, and Wyoming. The Bureau, in cooperation with the Atomic Energy Commission, continued field investigations of potentially important monazite deposits in the Southeastern States, Western States, and Alaska. Dredge and plant sampling, with related ore-dressing studies, at Bureau stations developed techniques and equipment that helped producers to increase monazite recoveries considerably.

In the late summer of 1952 several lode deposits of monazite were discovered in Lemhi County, Idaho, on the western slope of the Continental Divide. The veinlike ore bodies have a banded appearance and consist mainly of calcite in some deposits and quartz in others. The monazite appears to be disseminated in the light-color gangue materials, although some irregular lenses in the ore bodies contain 10

[27] Chemical Week, vol. 71, No. 20, Nov. 15, 1952, p. 52.
[28] Prepared by E. J. Carlson.

to 50 percent monazite. Ilmenite and magnetite are sometimes prominent accessory minerals, and small quantities of radioactive opaque minerals are noticeable. A systematic evaluation of these deposits could not be completed by the Bureau of Mines in 1952 because of heavy and early snows in the high, mountainous area.

Domestic Production.—Monazite production statistics are classified because the mineral contains thorium and comes under the regulations of the Atomic Energy Act of 1946. A small increase in production compared with that in 1951 was noted in 1952. The principal producers were Baumhoff-Marshall, Inc., Warren Dredging Corp., and Idaho-Canadian Dredging Co., all of Boise, Idaho. Another substantial producer was the Humphreys Gold Corp., Jacksonville, Fla. Bastnaesite concentrates were produced by the Molybdenum Corp. of America at its property in San Bernardino County, Calif.

The principal processors of monazite ores were Lindsay Chemical Co., West Chicago, Ill.; Rare Earths, Inc., Paterson, N. J.; and Maywood Chemical Works, Maywood, N. J. Bastnaesite concentrates were processed by the Lindsay Chemical Co.

The following firms produced misch metal and ferrocerium: Cerium Metals Corp., New York, N. Y.; New Process Metals Corp., Newark, N. J.; General Cerium Corp., Edgewater, N. J.; American Light Alloys, Little Falls, N. J.; Matchless Metals Co., Flushing, N. Y.; and American Metallurgical Products Co., Pittsburgh, Pa.

Uses.—Rare-earth oxides and fluorides are superior to any known salts of other metals for use in carbon arc electrode cores to produce high luminosity. Misch metal, the mixture of all the rare-earth elements in metallic form, has been alloyed with aluminum, copper, magnesium, nickel, and zinc. The resulting alloys, with improved properties, are important in the construction of aircraft, jet engines, and gas turbines. Small quantities of misch metal added to iron and steel melts act as scavengers to remove many undesirable impurities, while larger quantities of misch metal will make cast iron malleable and stainless steel formable. The uses of rare-earth metals as alloying materials can be expected to expand greatly as research is continued by both Government agencies and private industry.

An important use in 1952 for the rare earths was in making ferrocerium for lighter flints, tracer bullets, and luminescent shells. The rare earths were also used in the manufacture of special glass for packaging food to prevent photochemical reactions that result in food deterioration, in waterproofing and mildewproofing, weighting and dyeing of fabrics, and compounding of printers inks and fabrics. Small quantities of rare earths were used as a scavenger in the production of explosives, as a constituent in the fabrication of high-temperature crucibles, and as an ingredient in the production of aerial photographic lenses, radio condensers, beauty preparations, and medicines.

Prices.—Monazite was quoted from March 27, 1952, through December 18, 1952, in the E & M J Metal and Mineral Markets as follows: Total rare-earth oxides plus thoria, f. o. b. domestic mill, 16½ cents per pound, 55 percent; 18¾ cents per pound, 64 percent; and 19 cents per pound, 65 percent. No prices were quoted for bastnaesite ores or concentrates, as the single producer made individual contracts with buyers.

Misch metal and ferrocerium were quoted at $4.50 and $8, respectively. High-purity cerium metal was offered at $18 per pound. Rare-earth chlorides were priced at 45 cents–50 cents per pound.

World Review.—India and Brazil, the principal producers of monazite sands during the last 40 years, maintained restrictions on the export of monazite in 1952, and no domestic processors reported any imports from those countries or from other foreign sources. Indian Rare Earths, Ltd., began processing monazite sands the latter part of 1952 at its plant at Alwaye, Travancore, India. The plant has a reported capacity of 1,500 tons a year and will produce both thorium and rare-earth materials.[29]

No data were available in 1952 relative to monazite production in Malaya, or where such production, which amounted in past years to several hundred tons annually, was marketed. In Ceylon, a pilot plant produced a few tons of monazite from beach sands, and that Government appeared interested in having either United States or other foreign organizations exploit both monazite and ilmenite deposits in Ceylon.

A lode deposit of monazite was reported to have been found in the van Rhynsdorp district of Cape Province, Union of South Africa. Anglo American Corp. of South Africa, Ltd., was said to have been given the right to mine and concentrate the ore. The major part of the estimated 8,000 tons of concentrate, containing 55 percent rare-earth oxides, was to be sold to the United States.[30] An interesting lode deposit of monazite was found in volcanic rocks at Sukulu, Uganda, Africa.[31] Beach sands on the east coast of Madagascar, from Manakara north to Vatomandry, were estimated to contain 2 percent monazite.[32] The Geographic and Geological Institute announced the occurrence of monazite sands in the Paraiba Valley and at Itapecerica, Sao Paulo, Brazil, with monazite from the latter deposit having a high thoria content.[33] In Argentina, monazite was reported to have been discovered in the sands of the Riecito Stream, in San Luis Province.[34]

SELENIUM AND TELLURIUM [35]

Selenium was in short supply throughout 1952 and the subject of much study by industry, various Government agencies, including the National Production Authority, Munitions Board, Defense Materials Procurement Agency, and the Bureau of Mines, and others.[36] An expansion goal aimed at a total United States supply of 1,100,000 pounds of selenium in 1955—about 225,000 pounds above the total available supply in 1952—was announced by the Defense Production Administration.[37] Supplies of tellurium were more than ample in 1952 to satisfy all requirements for the metal.

[29] Atomic Energy Newsletter, vol. 8, No. 10, Dec. 30, 1952, p. 4.
[30] Bureau of Mines, Mineral Trade Notes: Vol. 35, No. 3, September 1952, p. 48.
[31] Mining Journal (London), vol. 238, No. 6090, May 9, 1952, p. 472.
[32] Work cited in footnote 30.
[33] Mining Journal (London), vol. 238, No. 6089, May 2, 1952, p. 446.
[34] Mining World, vol. 14, No. 9, August 1952, p. 78.
[35] Prepared by H. D. Keiser and J. D. Sargent.
[36] Tyler, Paul M., Selenium: Rept. MMAB-15-M, Minerals and Metals Advisory Board, Nat. Research Council, April 15, 1952, 62 pp.
Iron Age, Selenium: Vol. 170, No. 14, Oct. 9, 1952, pp. 283-284.
[37] Defense Production Administration: Press release, Oct. 22, 1952, 1 p.
Wall Street Journal, DPA Sets Selenium Expansion Goal of 1.1 Million Pounds by '55: Vol. 140, No. 97, Oct. 23, 1952 p. 3.

Domestic Production.—Producers of primary selenium and tellurium in 1952 were the American Smelting & Refining Co., Baltimore, Md.; United States Metals Refining Co., Carteret, N. J.; International Smelting & Refining Co., Perth Amboy, N. J.; Kennecott Copper Corp. Garfield, Utah; and United States Smelting Refining & Mining Co. (tellurium only), East Chicago, Ind. The new selenium-recovery plant at the Garfield (Utah) refinery of the Kennecott Copper Corp. was placed in operation during October 1952.

Production of primary selenium and tellurium in 1952 totaled 687,384 and 189,076 pounds, respectively, compared with 494,912 and 187,148 pounds in 1951—an increase of 39 percent in selenium output and of 1 percent in tellurium output. The increased selenium production in 1952 was principally attributable to the treatment of anode slimes accumulated by one producer during 1950 and 1951.

A total of 66,781 pounds of secondary selenium was recovered in 1952 from scrap of rectifier manufacturers and spent catalysts by American Smelting & Refining Co.; United States Metals Refining Co.; Kawecki Chemical Co., Boyertown, Pa.; and Vickers Electric Division, Vickers, Inc., St. Louis, Mo.; the above figure is based on data collected by the National Production Authority.

Consumption and Uses.—Apparent domestic consumption[38] of elemental selenium and tellurium in 1952 was 802,033 and 94,615 pounds, respectively, representing an increase of 1 percent for selenium and a decrease of 14 percent for tellurium compared with apparent domestic consumption of the 2 metals in 1951. The increased apparent consumption of selenium in 1952 reflected principally the substantial increase in production which more than offset a marked decline in imports.

Selenium was allocated to consumers beginning with February 1952, when Order M–91, issued by the National Production Authority in December 1951, became effective as to allocations. For the 11 months February to December 1952, inclusive, the total quantity of selenium allocated each month ranged from 71 to 100 percent of that requested by consumers. The total quantity allocated in the 11 months represented 85 percent of that requested. Of the total quantity allocated, about 36 percent went to manufacturers of rectifiers; 34 percent to the chemical, pigment, and rubber industries; 14 percent to the glass-container industry; 9 percent to the steel industry; and 7 percent to miscellaneous manufacturers, including those making glass products other than containers.

The principal uses of selenium in 1952 were (1) in the manufacture of dry-plate rectifiers, employed in electronic equipment, including television and radio sets, to convert alternating current to direct current, and to perform the same function as power tubes; (2) in the production of special grades of stainless steel to improve machinability and in the casting of stainless steel to provide gas control and thereby assure soundness of castings; (3) as a decolorizer in the glass industry; and (4) for diversified chemical purposes, including its use (*a*) in the production of pigments and enamels, (*b*) as a vulcanizing agent and an

[38] Primary producers' domestic shipments plus imports less producers' imports and imports under toll arrangements.

accelerator in the production of rubber, and (*c*) as a catalyst in the synthesis of organic chemical and drug products.

Tellurium was used principally (1) in the manufacture of alloys, such as tellurium lead, tellurium copper, and various tellurium bronzes and (2) in the rubber industry as a secondary vulcanizing agent. Minor uses were as an additive and core wash to induce chill in the manufacture of iron castings and as a coloring agent in the production of art glass and ceramics.

Stocks.—Although stocks of elemental selenium held by primary producers at the close of 1952 were 44 percent greater than at the close of 1951, they were nevertheless at a low level and represented less than a 2-month supply on the basis of apparent consumption in 1952. Year-end stocks of tellurium, on the contrary, were at a new high level and about equal to a 2-year supply.

Prices.—Selenium, 99.5 percent pure, black powdered, was quoted throughout 1952 by E. & M. J. Metal and Mineral Markets at $3 to $3.50 a pound, a price level that prevailed throughout 1951. Tellurium was quoted at $1.75 a pound, continuing in 1952 for another year the quotation of the preceding 13 years.

Prices of both selenium and tellurium in 1952 accorded with the provisions of the general ceiling price regulation issued by the Office of Price Stabilization on January 26, 1951, which established selling prices for each individual seller at the highest level his selling prices reached between December 19, 1950, and January 25, 1951.

Generally prevailing prices for the various grades of selenium and selenium compounds in 1952 were, a pound, as follows: High-purity grade selenium, 99.99 percent or more pure, $6; DDQ (double distilled in quartz) grade, 99.95 percent or more but less than 99.99 percent pure, $5.50; commercial grade, 99.5 percent or more but less than 99.95 percent pure, $3.50; ferroselenium, $4; and selenium dioxide, 71 percent selenium content, $4.25.

High-purity and DDQ grades of selenium were used in manufacturing rectifiers; the commercial grade in the chemical, glass, pigment, and rubber industries; selenium dioxide as a catalyst in the preparation of chemicals and drugs; and ferroselenium in the steel industry.

Foreign Trade.—Imports of selenium in metal and salts in 1952 totaled 123,135 pounds, valued at $564,326, a decrease of 50 percent in quantity and 45 percent in value compared with 1951. Canada was the source of 111,255 pounds, or 90 percent of 1952 imports, valued at $443,627. Sweden furnished 8,194 pounds valued at $85,006 and Japan 2,532 pounds valued at $29,318. Most of the remainder was received from West Germany and Belgium-Luxembourg. No imports of tellurium were reported in 1952. Data on exports of selenium and tellurium are not available.

Technology.—Improvements in the metallurgical treatment of anode slimes developed in 1952 by primary producers, to be placed in operation in 1953, were expected to increase the recovery of selenium by over 25 percent. The Bureau of Mines continued investigations in 1952 looking toward increased supplies of selenium through improved metallurgy and the discovery of new sources of raw materials; the vanadiferous shales of Idaho and Wyoming appeared to be potentially important as a future source.

A titanium dioxide rectifier, as a substitute for the selenium rectifier, was reported under development by the National Bureau of Standards. A cost favorably comparable with that for the selenium rectifier and satisfactory operation at temperatures as high as 300° F. were claimed for the titanium dioxide rectifier.[39] Research investigations were conducted on the electrical properties of semi-conducting selenium.[40] Further economies were suggested in the use of selenium by the glass-container industry.[41] A process for the preparation of selenium dioxide without the formation of selenic acid was patented.[42]

World Review.—Production of selenium in Canada decreased 31 percent in 1952, principally as a result of an 18-week strike at the Montreal East, Quebec, refinery of Canadian Copper Refiners, Ltd. Total selenium output in 1952 was 265,600 pounds, valued at C$841,100, compared with 382,603 pounds, valued at C$1,239,633, in 1951. Tellurium production increased from 8,913 pounds, valued at C$16,400, in 1951 to 13,700 pounds, valued at C$30,200, in 1952.[43]

Canadian Copper Refiners, Ltd., accounted for about 60 percent of the Canadian production of selenium in 1952 compared with about 75 percent in 1951; the output was recovered in electrolytic refining of blister copper produced from the copper-gold ores of Noranda Mines, Ltd., Noranda, Quebec, and from the copper-zinc ores of Hudson Bay Mining & Smelting Co., Ltd., Flin Flon, Manitoba. About 40 percent of the total selenium output was recovered at the Copper Cliff, Ontario, refinery of the International Nickel Co. of Canada, Ltd., from the Sudbury copper-nickel ores. Selenium and its compounds were also produced by the International Nickel Co. of Canada, Ltd., at its Clydach refinery, near Swansea, Wales, United Kingdom.

Boliden Gruv AB, operating various mining properties in the Skelleftea region and a smelter and electrolytic refinery at Skellefthavn, was the sole producer of selenium in Sweden in 1952.

Production of selenium in Japan in 1952 was estimated at 49,800 pounds compared with 44,000 pounds in 1951. Six copper refineries and two sulfuric acid plants contributed the 1952 selenium output.

In West Germany production of selenium in the first half of 1952 totaled 5,483 pounds compared with an output of 18,503 pounds for the 12 months of 1951.

Metallurgie de Hoboken was the only producer of selenium in Belgium in 1952.

[39] Science News Letter, vol. 62, No. 17, Oct. 25, 1952, p. 261.
[40] Henkels, H. W., Research Investigations on the Electrical Properties of Semiconducting Selenium: Moore School Electrical Eng., Univ. of Pennsylvania, Philadelphia, Pa., Quarterly Prog. Rept. 5, Dec. 15, 1951–Mar. 15, 1952, Mar. 31, 1952, 14 pp.; Henkels, H. W., and Roberts, F. R., Quarterly Prog. Rept. 6, Mar. 15, 1952–June 14, 1952, June 30, 1952, 26 pp.
[41] Manring, W. H., Are You Saving Enough Selenium: Ceram. Ind., vol. 59, No. 6, December 1952, pp. 84–85.
[42] Roseman, R., Neptune, R. W., and Allan, B. W. (assigned to Glidden Co.), Process for Preparing Selenium Dioxide: U. S. Patent 2,616,791, Nov. 4, 1952.
[43] Dominion Bureau of Statistics, Ottawa, Canada, Press Release: Jan. 2, 1953, 4 pp.

TABLE 1.—Salient statistics of elemental selenium and tellurium in the United States, 1940–52, in pounds [1]

Year	Selenium					Tellurium		
	Production [2]	Primary producers' domestic shipments	Primary producers' stocks at end of year	Imports [3]		Production [4]	Primary producers' domestic shipments	Primary producers' stocks at end of year
				Pounds	Value			
1940	328,731	330,207	178,873	134,429	$198,163	85,622	88,996	33,419
1941	620,493	661,171	105,026	197,873	288,161	224,639	237,729	29,333
1942	502,396	442,482	174,803	83,666	127,004	224,973	123,076	134,542
1943	643,660	613,434	225,828	81,720	142,032	54,288	48,662	140,944
1944	525,331	394,818	379,137	97,800	170,582	61,869	29,657	172,868
1945	486,815	554,944	324,967	216,793	395,934	33,462	29,079	176,984
1946	298,233	378,254	232,615	475,881	806,205	11,600	48,538	142,057
1947	511,612	492,716	259,532	529,175	893,175	60,486	68,260	132,616
1948	557,402	527,137	231,294	267,118	489,762	56,915	74,698	114,415
1949	441,898	398,456	265,837	172,636	318,046	120,725	68,415	166,595
1950	558,931	715,185	106,458	363,597	768,544	107,364	129,877	134,402
1951	494,912	547,582	85,123	246,652	1,018,263	187,148	110,162	147,271
1952	687,384	690,978	122,550	[5] 123,135	564,326	189,076	94,615	181,096

[1] Revised
[2] Primary selenium and selenium content of compounds, as reported by primary producers.
[3] Includes selenium dioxide and salts.
[4] Primary tellurium and tellurium content of compounds, as reported by primary producers.
[5] Includes DDQ-grade selenium from Canada under toll arrangement.

THALLIUM [44]

Thallium, a soft bluish-white metal resembling lead, has never been found in free or uncombined state. It has been detected in numerous types of rocks and ores; however, the quantity present is usually so small that direct extraction is economically impracticable. Four minerals—crookesite, hutchinsonite, urbanite, and lorandite—contain 16 to 60 percent of thallium, but these minerals are so rare that they cannot be considered a commercial source of the metal. Thallium is produced at present as a byproduct of treatment of cadmium-rich flue dusts and residues obtained from the smelting of zinc-lead ores.

Domestic Production.—Consumer demands for thallium and thallium sulfate totaled a few thousand pounds in 1952. The Globe cadmium refinery of the American Smelting & Refining Co., at Denver, Colo., was again the sole producer of the metal.

Uses.—In past years thallium sulfate was used extensively to exterminate rodents, insects, and other pests. The sale of thallium compounds to the public is now generally forbidden because of their extreme toxicity to man and animals; no effective antidote exists.

One of the principal uses of thallium in 1952 was in connection with the ability of thallium bromoiodide crystals to transmit infrared radiation of very long wave length. Such crystals find important applications in military equipment designed for detection and signaling, where visible radiation must be absent. Thallium oxysulfide is more sensitive than selenium to light of long wave length and low

[44] Prepared by E. J. Carlson.

intensity and finds application in photoelectric cells. Mercury, with 8.5 percent thallium, becomes an amalgam with a much lower freezing point than mercury alone, permitting temperature measurements with glass-type thermometers in the range of plus 20° to minus 60° C. Other uses of thallium were in high-density liquids, special glasses, corrosion-resistant and fusible lead alloys, mold- and insect-proofing, and (in minor quantities) in selenium rectifiers, scintillating counters, and activated phosphors for cathode-ray tubes.

Prices.—Thallium metal and thallium sulfate were quoted in 1952 at $12.50 and $10.50 per pound, respectively.

Minor Nonmetals

By Joseph C. Arundale [1] and Oliver S. North [2]

GREENSAND

A TOTAL of 4,381 short tons of greensand was produced in the United States in 1952 by the following firms: The Permutit Co., 330 West 42d St., New York, N. Y.; Zeolite Chemical Co., Medford, N. J.; and Inversand Co., 226 Atlantic Ave., Clayton, N. J. All production was from open-pit operations in Burlington and Gloucester Counties, N. J. The bulk of the product was sold for water softening and purification.

The price of refined greensand, f. o. b. shipping point, ranged from about $60 to about $128 per short ton.

The University of Massachusetts studied the New Jersey greensands to determine their genesis. The study indicated that these greensands were derived from the illitic clays in the area.[3]

TABLE 1.—Greensand marl sold or used by producers in the United States, 1943–47 (average) and 1948–52

Year	Short tons	Value	Year	Short tons	Value
1943–47 (average)	6, 685	$472, 715	1950	3, 935	$304, 321
1948	7, 269	392, 959	1951	5, 067	263, 944
1949	6, 128	276, 564	1952	4, 600	177, 847

[1] Assistant chief, Construction and Chemical Materials Branch.
[2] Commodity-industry analyst.
[3] Light, Mitchell A., Evidence of Anthigenic and Detrital Glauconite: Science, vol. 115, No. 2977, Jan. 18, 1952, pp. 73–75.

MEERSCHAUM

No production of meerschaum (sepiolite) was reported in the United States during 1952. The few known domestic deposits have yielded only small tonnages. The world's principal source is Turkey, where this material has been mined since antiquity. The use of meerschaum is confined largely to smokers' articles, such as pipes and cigarholders.

TABLE 2.—Meerschaum imported for consumption in the United States, 1948–52 [1]

[U. S. Department of Commerce]

Year	Pounds	Value	Year	Pounds	Value
1948	3,000	$10,070	1951	11,289	$13,384
1949	5,844	13,897	1952	10,479	12,344
1950	9,621	18,549			

[1] 1948–49: all from Turkey; 1950: Italy: 20 pounds, $120; Turkey: 9,601 pounds, $18,429; 1951: all from Turkey; 1952: Austria: 18 pounds, $40; Turkey: 10,461 pounds, $12,304.

MINERAL WOOL

According to the Bureau of the Census, the total value of mineral wool produced from rock, slag, and glass and shipped from plants in the United States in 1952 was $138,305,000, compared to $134,128,000 in 1951 and $115,664,000 in 1950. Use statistics are not available for 1952, but detailed data for 1947 were published on page 1362 of Minerals Yearbook 1948. The Bureau of the Census 1947 report on mineral wool gave the following percentages for broad classifications of its use: Structural insulation, 56; equipment insulation, 23; industrial insulation, 17; and unspecified, 4. The Industrial Mineral Wool Institute was reported to have issued a series of pamphlets on the various uses of mineral wool.[4]

The average number of persons employed in the mineral-wool industry in 1951 was 10,374 compared with 9,244 in 1950. Of the number reported in 1951, 8,583 were production workers.

Exports of mineral-wool products from the United States during 1952 were valued at $1,723,000 compared to $1,511,000 in 1951 and $1,132,000 in 1950.

Articles in trade magazines discussed the utilization of mineral wool and mineral-wool products for insulation purposes in petroleum refineries [5] and in steam power plants.[6]

A report summarized the properties and value of various lightweight materials, including mineral wool, in the fireproofing of structural-steel members.[7]

A trade journal described the method of producing mineral-wool insulating materials at a British plant.[8]

[4] Rock Products, Mineral Wool: Vol. 55, No. 10, October 1952, p. 99.
[5] Petroleum Engineer, Insulating Cement Versatile Heat Saver: Vol. 24, No. 4, April 1952, pp. C75–76, C78; Self-Retaining Mineral Wool Boards: Vol. 24, No. 11, October 1952, pp. C35–36.
Swenson, S. W., Insulation Methods for Air-Lift TCC Unit: Petrol. Eng., vol. 24, No. 4, April 1952, pp. C22, C24, C26.
Bonner, M. K., Expansion Joint Insulating Technique: Petrol. Eng., vol. 24, No. 1, January 1952, p. C41.
[6] Davis, R. L., Spaced Duct Insulation: Ind. and Power, vol. 62, No. 5, May 1952, pp. 92–94.
[7] Engineering News-Record, Lightweight Fireproofing for Steel Framing: Vol. 149, No. 19, Nov. 6, 1952, pp. 34–36.
[8] Mass Production (London), Producing Mineral-Wool Insulating Material: Vol. 27, No. 12, December 1951, pp. 78–81.

Methods of using mineral-wool materials for low-temperature insulating purposes have been described and diagramed.[9]

An article in a trade magazine described methods of applying mineral-wool insulation to pipes.[10]

The use of blanket-type mineral-wool insulation was reported to solve such troublesome problems as the insulation of asphalt piping heated by spirally wrapped steam tracers.[11]

Patents relating to mineral wool issued during the year covered the use of polyhydric alcohol esters of tall oil to replace part of the drying-oil binder in the manufacture of mineral-wool batts [12] and the addition of small quantities of slag-wool pellets to fiber-glass fibers in the manufacture of thermal insulating mats.[13]

WOLLASTONITE

Research and market development have added wollastonite to the lengthening list of mineral raw materials with important industrial applications. In 1952 the Cabot Carbon Co., 77 Franklin St., Boston, Mass., began construction of a plant near Willsboro, N. Y., for producing wollastonite on a commercial scale. This deposit had been mined on a small scale by Willsboro Mining Co. It was reported that diamond drilling had proved the ore body to an average depth of 200 feet over an outcrop of about 2,000 feet. It will be mined by open-pit methods. The basic steps in the pilot-plant operation are preliminary crushing in jaw crushers and rolls, magnetic separation, air tabling, and fine grinding in conical and tube mills. The full-scale mill under construction by the company will employ a variation of this basic flowsheet. Capacity of the plant will be about 180 tons a day of the bagged product. The firm anticipates that the products will be used in the manufacture of ceramic insulators, tile and glazes, paint, paper coating, and various fillers.[14]

A new firm, Colorado Development Co., 406 Kress Bldg., Long Beach 12, Calif., reported a small tonnage of wollastonite produced during development of a deposit near Midland, Riverside County, Calif.

---

[9] Swain, P., Save Cold-Job $$$ With Versatile Mineral Wool: Power, vol. 96, No. 1, January 1952, pp. 76–79.

[10] Lewis, H. E., and Young, C. E., Application Methods for Mineral-Wool Pipe Insulation: Heat., Pip., and Air Cond., vol. 24, No. 7, July 1952, pp. 106–108.

[11] Petroleum Processing, Insulating Traced Asphalt Piping: Vol. 7, No. 4, April 1952, pp. 521–522.

[12] Simmers, C. D. (assigned to Johns-Manville Corp.), Liquid Binder: U. S. Patent 2,584,300, Feb. 5, 1952.

[13] Baxter, M. (assigned to James D. Akins), Heat-Insulating Material: U. S. Patent 2,598,102, May 27, 1952.

[14] Hall, A. L., Ladoo, R. B., Secord, R. N., Stokes, C. A., Wollastonite—A New Venture in Nonmetallic Minerals: Pres. at ann. meeting, American Institute of Mining and Metallurgical Engineers, New York, Feb. 21, 1952.

Index

By Mabel E. Winslow

J

M

O

U

O