Minerals yearbook: Metals and minerals (except fuels) 1955. Year 1955, Volume I 1958

Bureau of Mines
Washington, D. C.: Bureau of Mines : United States Government Printing Office, 1958

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

MINERALS YEARBOOK

1955

Volume I of Three Volumes

METALS AND MINERALS
(EXCEPT FUELS)

Prepared by the staff of the

BUREAU OF MINES

DIVISION OF MINERALS

Charles W. Merrill, Chief

Frank D. Lamb, Assistant Chief

Paul Yopes, Assistant to the Chief

UNITED STATES DEPARTMENT OF THE INTERIOR

FRED A. SEATON, *Secretary*

BUREAU OF MINES

MARLING J. ANKENY, *Director*

OFFICE OF THE DIRECTOR:

THOMAS H. MILLER, *Deputy Director*
PAUL ZINNER, *Assistant Director for Programs*
JAMES WESTFIELD, *Assistant Director for Health and Safety*
C. W. SEIBEL, *Assistant Director for Helium Activities*
PAUL T. ALLSMAN, *Chief Mining Engineer*
EARL T. HAYES, *Acting Chief Metallurgist*
CARL C. ANDERSON, *Chief Petroleum Engineer*
LOUIS L. NEWMAN, *Acting Chief Coal Technologist*
PAUL W. McGANN, *Chief Economist*
REXFORD C. PARMELEE, *Chief Statistician*
ALLAN SHERMAN, *Chief, Office of Mineral Reports*

DIVISIONS:

CHARLES W. MERRILL, *Chief, Division of Minerals*
T. REED SCOLLON, *Chief, Division of Bituminous Coal*
JOSEPH A. CORGAN, *Chief, Division of Anthracite*
R. A. CATTELL, *Chief, Division of Petroleum*
ELMER W. PEHRSON, *Chief, Division of Foreign Activities*
W. E. RICE, *Chief, Division of Administration*

REGIONAL OFFICES:

MARK L. WRIGHT, *Acting Regional Director, Region I, Albany, Oreg.*
R. B. MAURER, *Acting Regional Director, Region II, San Francisco, Calif.*
JOHN H. EAST, JR., *Regional Director, Region III, Denver, Colo.*
HAROLD M. SMITH, *Regional Director, Region IV, Bartlesville, Okla.*
EARLE P. SHOUB, *Acting Regional Director, Region V, Pittsburgh, Pa.*

UNITED STATES
GOVERNMENT PRINTING OFFICE
WASHINGTON : 1958

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington, D. C. - Price, $4.25 (Buckram)

FOREWORD

Minerals Yearbook, 1955, published in three volumes, provides a record of performance of the Nation's mineral industries during the year, with enough background information to interpret the year's developments.

Volume I includes chapters on metal and nonmetal mineral commodities, with the exception of the mineral fuels. Included also are a chapter reviewing these mineral industries, a statistical summary, and chapters on mining technology, metallurgical technology, and employment and injuries.

Volume II includes chapters on each mineral fuel, an employment and injuries presentation, and a mineral-fuels review chapter that summarizes developments in the fuel industries and incorporates all data previously published in the Statistical Summary chapter. Also now included in this review chapter are data on energy production and uses that have previously been included in the Bituminous Coal chapter.

Volume III is comprised of chapters covering each of the 48 States, plus chapters on the Territory of Alaska, the Territory of Hawaii and island possessions in the Pacific Ocean, and the Commonwealth of Puerto Rico and island possessions in the Caribbean Sea, including the Canal Zone. Volume III also has a Statistical Summary chapter, identical with that in volume I, and another presenting employment and injury data.

The data in the Minerals Yearbook are based largely upon information supplied by mineral producers, processors, and users, and acknowledgment is made of this indispensable cooperation given by industry. Information obtained from individuals by means of confidential surveys has been grouped to provide statistical aggregates. Data on individual producers are presented only if available from published or other nonconfidential sources, or when permission of the individuals concerned has been granted.

Marling J. Ankeny, *Director*.

ACKNOWLEDGMENTS

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

Alabama: Geological Survey of Alabama.
Alaska: Alaska Department of Mines.
Arkansas: Division of Geology.
California: Division of Mines.
Delaware: Delaware Geological Survey.
Florida: Florida Geological Survey.
Georgia: Department of Mines, Mining, and Geology.
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: Department of Development of Industry and Commerce.
Maryland: Department of Geology, Mines, and Water Resources.
Michigan: Michigan Department of Conservation.
Mississippi: Mississippi Geological Survey.
Missouri: Division of Geological Survey and Water Resources.
Montana: Montana Bureau of Mines and Geology.
Nevada: Nevada Bureau of Mines.
New Hampshire: New Hampshire State Planning and Development Commission.
New Jersey: Bureau of Geology and Topography.
New York: State Geological and Natural History Surveys.
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 Geological Survey.
Puerto Rico, Panama Canal Zone, and the Virgin Islands:
Mineralogy and Geology Section, Economic Development Administration, Puerto Rico.
South Carolina: Department of Geology, Mineralogy and Geography.
South Dakota: State Geological Survey.
Tennessee: Tennessee Department of Conservation.
Texas: Bureau of Economic Geology, The University of Texas.
Utah: Utah Geological and Mineralogical Survey.
Virginia: Virginia Geological Survey.
Washington: Department of Conservation and Development.
West Virginia: West Virginia Geological and Economic Survey.
Wisconsin: Wisconsin Geological Survey.
Wyoming: Geological Survey of Wyoming.

Except for the four review chapters, this volume was prepared by the staff of the Division of Minerals. The following persons supervised preparation of the various chapters: Richard H. Mote, chief, Branch of Base Metals; Henry G. Iverson, chief, Branch of Ferrous Metals and Ferroalloys; Frank J. Cservenyak, chief, Branch of Light Metals; Charles T. Baroch, acting chief, Branch of Rare and Precious

▼

Metals; G. W. Josephson, chief, Branch of Construction and Chemical Materials; and W. F. Dietrich, chief, Branch of Ceramic and Fertilizer Materials. Preparation of this volume was supervised and the chapters were coordinated with those in volume III by Paul Yopes, assistant to the chief, Division of Minerals.

The manuscripts upon which this volume is based have been reviewed to insure statistical consistency between the tables, figures, and text, between this volume and volume III and between this volume and those for former years, by a staff directly supervised by Kathleen J. D'Amico, who was assisted by Julia Muscal, Hope R. Anderson, Helen L. Gealy, Ruby J. Phillips, Helen E. Tice, Anita C. Going, Fairy L. McClendon, and Anne C. Rogers.

Minerals Yearbook compilations are based largely on data provided by the mineral industries. Acknowledgment is made of the willing contribution both by companies and individuals of these essential data.

CHARLES W. MERRILL,
Chief, Division of Minerals.

CONTENTS

Review of the Mineral Industries[1]

(Metals and Nonmetals Except Fuels)

By Gabriel F. Cazell[2]

THE NONFUEL MINING industry recovered dramatically from its 1953–54 slump, with gains over 1954 well above those recorded for the total economy. Income generated in the production of nonfuel minerals and mineral products[3] increased 27 percent over 1954, compared with 9 percent for total national income. Only 1 sector (automobiles and automobile equipment) of the economy exceeded the 37-percent increase over 1954 recorded in metal mining. This 1954–55 recovery is similar to the recovery in the mining and mineral-refining industries relative to that of other sectors that occurred in 1949–50.

Reacting to an increased demand, the net new supply of the metals and nonfuel minerals rose sharply, and consumption increased almost without exception throughout the nonfuel-minerals complex. The domestic mining industry, after having increased its share of total supply during the mild recession of 1954, consolidated this improved position in 1955. The surprising increase in exports of nonfuel minerals and metals during 1954 continued in 1955, reaching $0.6 billion for the year, representing over 30 percent of the import value of these same minerals—a striking increase over the 14-percent export-import ratio for the year 1953.

Prices of minerals rose substantially over 1954 while major cost items changed very little from their 1954 level. The improved earnings position in the minerals segment of the economy was reflected in a 15-percent increase in the annual average price of common stocks of mining firms. Investments in mining and smelting industries in foreign countries were only moderately higher than in 1954, but earnings on these investments showed a sharp increase of almost 60 percent above 1954.

To carry out the minerals mobilization responsibilities delegated by the Office of Defense Mobilization, the Secretary of the Interior established the Office of Minerals Mobilization. This office, with the technical assistance of the Bureau of Mines and the Geological Survey, undertook, during the year, to determine and make recommendations for maintaining an adequate supply position for the strategic minerals.

[1] Fuels are covered in a number of instances in this chapter but only where specifically indicated. In general, this occurs where mining-industry data were not available for both nonfuels and fuels components.
[2] Assistant chief economist; assisted by Robert E. Herman, analytical statistician.
[3] Includes the following national income categories: metal mining, nonmetallic mining and quarrying, primary metal industries, and stone, clay and glass products.

On the world scene, virtually all of the principal metals and minerals registered increases in world production, in contrast with the mixed movements in 1954. World mineral prices were also somewhat higher in 1955, the first upward movement since 1952.

DOMESTIC PRODUCTION

Value of Mineral Production.—The value of nonfuel-mineral production in the United States increased approximately $1 billion over 1954, an extremely large increase for a 1-year period. Of the $5 billion nonfuel-mineral total, nonmetals accounted for 60 percent, metals 40 percent. The metals category, however, increased 36 percent in 1954–55 compared with 13 percent for the nonmetallics. The large increase in iron-ore production was the most significant factor in the metals category. The mineral fuels in 1955 exceeded the 1954 value by 9 percent, resulting in an overall mineral-value increase of 12 percent.

TABLE 1.—Value of mineral production in continental United States, 1950–55, by mineral groups

(Million dollars)

Mineral group	1950	1951	1952[1]	1953[1]	1954[1]	1955	Change in 1955 from 1954 (percent)
Metals and nonmetals except fuels:							
Nonmetallic minerals except fuels	1,822	2,079	2,163	2,342	2,619	2,956	+13
Metals	1,351	1,671	1,617	1,800	1,507	2,044	+36
Total	3,173	3,750	3,780	4,142	4,126	5,000	+21
Mineral fuels	8,689	9,779	9,616	10,249	9,912	10,774	+9
Grand total	11,862	13,529	13,396	14,391	14,038	15,774	+12

[1] Revised figures.

Volume of Production.—The Federal Reserve Board index of physical volume of mined and concentrated metal, stone, and earth minerals increased 13 percent over 1954 to 120 percent of the 1947–49 base—only 1 point lower than the 1951 high for this index. Each component of the index—iron ore, copper mining, lead mining, zinc mining, and stone and earth minerals—increased over 1954. As indicated above, the recouping of 1953–54 losses in iron-ore mining was the most significant factor in the 1954–55 increase in the mining index.

The index of production of pig iron and steel rose from 108 in 1954 to 144 in 1955, the highest level for the years shown in table 2. Primary nonferrous-metal production was 22 percent above 1954; secondary production increased 17 percent. The output of stone, clay products (including cement), and fertilizer, fairly representative of nonmetallic-mineral manufactures was 13 percent above 1954. The weighted average of the 4 metal and mineral indexes shown in table 2 rose from 117 to 137, an increase of 17 percent.

Within the year unadjusted steel production rose steadily through May, fell heavily in June and July, then rose steadily the remainder of the year, except for a slight downturn in December. Pig-iron production followed a similar pattern except for the downturn in December. Primary nonferrous-metal production dropped sharply in July and August because of the copper strike but moved up steadily in the last 4 months. Zinc production drifted generally downward through August but rose rapidly in the last 4 months. Both primary lead and secondary nonferrous production showed the effects of the copper strike in July and August, but were high in the other months, showing a generally rising trend for the 12-month period. Aluminum production rose in every month except October.

Mining of metal, stone, and earth minerals followed a different pattern from that of metal production. The index rose rapidly in the first 5 months, dropped in July, reached a peak for the year in September, then fell in the last 3 months. The metal mining component of the index was the basic factor in this M-shaped pattern; and the pattern of the metal-mining component, in turn, was determined largely by the monthly production of iron ore. Both lead mining and zinc mining drifted downward during the 12-month period.

TABLE 2.—Indexes of physical volume of metal and mineral mining, production of metals, production of nonmetallic products, and industrial production, 1949–55 [1]

(1947–49=100)

Year	Mining: Metal, stone, and earth minerals	Pig iron and steel	Primary and secondary nonferrous metals [2]	Stone and clay products and fertilizer [2]	Total industrial production
1949	97	92	93	99	97
1950	111	117	111	118	112
1951	121	131	116	134	120
1952	115	115	121	131	124
1953	119	138	136	138	134
1954	106	108	136	137	125
1955	120	144	153	155	139

[1] Source: Federal Reserve Bulletin, December 1955, pp. 1370–1373, and April 1956, pp. 384–387. Indexes for years before 1947 are not available on the 1947–49 base, and recent years are not available on the 1935–39 base.

[2] Weighted average, computed by authors of this chapter, employing Federal Reserve indexes and weights

Mining Firms.—The latest published figures on the number of firms engaged in mining (including fuels) and quarrying are those for 1953.[4] Tentative estimates by the U. S. Department of Commerce indicate the number of firms in this category in 1954 was only slightly higher than the 38,300 listed for 1953, but that the number in 1955 had risen by about 8 percent over the 1953 total. The number of new firms established in mining and quarrying in 1954 was estimated to be slightly higher than the 3,800 listed for 1953, but about one-third higher in 1955.

NET NEW SUPPLY

The net new supply [5] of minerals and metals rose sharply in 1955. Whereas in 1953–54 22 of the 31 minerals in table 3 showed decreases in net new supply, in 1955 all but 8 showed increases over 1954. The increases were generally large, ranging from 3 percent for lead to

[4] Office of Business Economics, U. S. Department of Commerce, Survey of Current Business: Vol. 34, No. 5, May 1954, pp. 15–24, No. 11, November 1954, pp. 14–23; vol. 35, No. 4, April 1955, pp. 14–20.

[5] The sum of primary shipments, secondary production, and imports, minus exports.

TABLE 3.—Net new supply of principal minerals in the United States and components of gross new supply,[1] 1954–55

(Net new supply in thousand short tons unless otherwise stated)

Commodity	Net new supply			Components as a percent of gross new supply (Gross new supply=100)						Exports as a percent of gross new supply	
	1954	1955	Change from 1954 (percent)	Primary shipments[2] 1954	Primary shipments[2] 1955	Secondary production[3] 1954	Secondary production[3] 1955	Imports[4] 1954	Imports[4] 1955	1954	1955
Ferrous ores, scrap, and metals:											
Iron (equivalent)[5]	[6] 84,900	117,800	+39	53	54	[7] 33	[7] 32	14	14	2	2
Manganese (content)	[6] 1,231	1,338	+9	[6] 14	18	-----	-----	[6, 8] 86	[8] 82	(9)	(9)
Chromite (Cr_2O_3 content)	671	825	+23	9	7	-----	-----	91	93	(9)	(9)
Cobalt (content) ... thousand pounds	19,870	21,690	+9	11	11	[10] 4	[10] 2	85	87	-----	-----
Molybdenum (content) ... do	[6] 50,450	49,790	−1	100	100	-----	-----	(9)	(9)	21	23
Nickel (content)	139	155	+12	2	3	3	5	95	92	-----	-----
Tungsten ore and concentrate (W content) ... short tons	18,590	18,140	−2	35	43	-----	-----	65	57	(9)	(9)
Other metallic ores, scrap, and metals:											
Copper (content)	[6] 1,623	1,880	+16	[6] 45	48	22	25	[6] 33	27	12	10
Lead (content)	1,187	1,228	+3	27	27	36	37	[8] 37	[8] 36	(9)	(9)
Zinc (recoverable content)	[6] 1,065	1,182	+11	43	43	7	7	[8] 50	[8] 50	2	2
Aluminum (equivalent)[11]	[6] 1,893	1,828	−3	[12] 24	[12] 22	3	4	[13] 73	[13] 74	2	1
Tin (content) ... thousand long tons	105	104	−1	(9)	(9)	16	19	84	81	(9)	(9)
Antimony (recoverable content)	30	35	+17	7	5	63	58	[14] 30	[14] 37	(9)	1
Cadmium (content)[15] ... short tons	4,479	4,787	+7	38	35	1	3	61	62	10	13
Magnesium (content)	71	60	−15	[16] 95	[16] 90	4	7	1	3	4	11
Mercury[17] ... 76-pound flasks	88,710	48,890	−45	[16] 21	[16] 39	7	20	72	41	1	1
Platinum-group metals ... thousand troy ounces	[6] 668	1,068	+60	4	2	[18] 9	[18] 6	87	92	4	3
Titanium concentrate: Ilmenite and slag (TiO_2 content)	446	526	+18	61	57	-----	-----	39	43	-----	-----
Nonmetallic minerals:											
Asbestos	724	782	+8	7	6	-----	-----	93	94	(9, 19)	(9, 19)
Barite, crude	1,200	1,472	+23	74	76	-----	-----	26	24	-----	-----
Boron minerals and compounds ... gross weight	[6] 585	702	+20	100	100	-----	-----	(9)	(9)	26	24
Bromine and bromine in compounds ... million pounds	182	181	−1	100	100	-----	-----	(6, 9)	(9)	3	2
Clays	[6] 42,340	48,030	+13	100	100	-----	-----	(9)	(9)	1	1
Fluorspar, finished	538	642	+19	46	43	-----	-----	54	57	(9)	(9)
Gypsum, crude	[6] 12,230	14,420	+18	[6, 20] 72	[20] 72	-----	-----	[6] 28	28	-----	-----
Mica (except scrap) ... thousand pounds	8,600	14,120	+64	7	4	-----	-----	93	96	4	3
Phosphate rock (P_2O_5 content) ... thousand long tons	[6] 3,882	3,478	−10	99	99	-----	-----	1	1	19	18
Potash (K_2O equivalent)	1,971	2,050	+4	94	92	-----	-----	6	8	3	6
Salt, common	[6] 20,440	22,480	+10	99	99	-----	-----	1	1	2	2
Sulfur (all forms, content) ... thousand long tons	[6] 4,800	5,480	+14	[21] 100	[21] 99	-----	-----	(9)	1	26	23
Talc and allied minerals	[6] 599	713	+19	96	96	-----	-----	4	4	4	5

[1] Net new supply is the sum of primary shipments, secondary production, and imports, minus exports. Gross new supply is the total before subtraction of exports.
[2] Primary shipments are mine shipments or mine sales (including consumption by producers) plus byproduct production. Shipments more nearly represent quantities marketed by the domestic industry and as such are more comparable to imports. Use of shipments data rather than production data also permits uniformity of treatment of more commodities.
[3] From old scrap only.
[4] Imports for consumption, except where otherwise indicated; scrap is excluded where possible both in imports and exports, but included are all other sources of minerals through the refined or roughly comparable stage, except where the commodity description indicates an earlier stage.
[5] Iron ore reduced to an estimated pig-iron equivalent; reported weights used for all other items of supply.
[6] Revised figure.
[7] Receipts of purchased scrap.
[8] General imports; corresponding exports are of both domestic and foreign merchandise.
[9] Less than 0.5 percent.
[10] Consumption of purchased scrap.
[11] Includes 85 percent of bauxite mine production (rather than shipments) and imports and 91 percent of alumina imports, both converted to estimated aluminum equivalent, in 1954; 86 and 92 percent in 1955 These percentages are based on estimated proportions used in the production of metal. To avoid a duplicate adjustment for nonmetallic use, exports of bauxite to Canada were excluded from exports.
[12] Mine production of bauxite.
[13] Includes ingot equivalent (weight times 0.9) of imports of scrap, largely scrap pig. Some duplication occurs because of small amount of loose scrap imported, which is also reflected in secondary production. See also footnote 11.
[14] Includes recovery in antimonial lead from foreign silver and lead ores.
[15] Primary shipments are estimated as 40 percent of total primary production of metal, while imports are represented by the sum of the remaining 60 percent of such production plus imports of metal. Primary compounds not made from metal, 1955 data for which cannot be disclosed, are excluded for both years. Secondary includes recovery from both old and new scrap.
[16] Primary production of metal.
[17] Includes secondary production, which was omitted in tables published in earlier years.
[18] Recovery from both old and new scrap.
[19] Exports of foreign merchandise (that is, reexports) have also been deducted.
[20] Estimated by adjusting production, excluding byproduct, for changes in producers' stocks.
[21] For pyrites, includes sulfur content of production.

TABLE 4.—Percentage distribution of imports of principal minerals consumed in the United States, 1954–55, by country group of origin [1]

Commodity	Total (thousand short tons unless otherwise stated)		Canada and Mexico		East and South Pacific [2]		Other Western Hemisphere		Other free world		U. S. S. R. bloc	
	1954	1955	1954	1955	1954	1955	1954	1955	1954	1955	1954	1955
Ferrous ores, scrap and metals:												
Iron (equivalent) [3]	[4] 11,890	17,080	[4] 22	41	[4] 23	12	[4] 38	37	[4] 17	10	--	--
Manganese (content) [5]	[4] 1,068	1,104	4	4	[4] 1	1	15	17	[4] 80	78	--	--
Chromite (Cr_2O_3 content)	609	763	--	(6)	3	2	2	3	95	95	--	--
Cobalt (content) ... thousand pounds	16,870	18,730	7	7	--	--	--	--	93	93	--	--
Molybdenum (content) ... do	154	134	100	100	--	--	--	--	--	--	--	--
Nickel (content)	132	143	[4] 80	81	--	--	[4] 11	10	9	9	--	--
Tungsten ore and concentrate (W content) ... short tons	12,090	10,350	9	13	30	35	6	11	55	41	--	--
Other metallic ores, scrap, and metals:												
Copper (content)	[4] 598	574	23	25	52	47	3	4	22	24	--	--
Lead (content) [5]	438	442	39	37	35	38	1	2	25	23	--	--
Zinc (recoverable content) [5]	[4] 544	602	73	73	19	16	1	2	7	9	--	--
Aluminum (equivalent) [7]	1,418	1,372	15	15	--	--	84	84	1	1	--	--
Tin (content) ... thousand long tons	88	85	(6)	(6)	14	12	--	--	86	88	--	--
Antimony (recoverable content) [8]	8	12	(9)	(9)	(9)	(9)	--	--	(9)	(9)	--	(9)
Cadmium (content) [10] ... short tons	[4] 942	1,380	87	87	[4] 4	1	--	--	[4] 9	12	--	--
Magnesium (content)	1	2	(9)	(9)	--	--	--	--	(9)	(9)	--	--
Mercury ... 76-pound flasks	64,960	20,350	14	51	--	(6)	--	--	86	49	--	--
Platinum-group metals ... thousand troy ounces	[4] 606	1,010	38	35	(6)	(6)	7	4	54	59	1	2
Titanium concentrates: Ilmenite and slag (TiO_2 content)	176	229	43	51	--	--	--	--	57	49	--	--
Nonmetallic minerals:												
Asbestos	678	740	95	95	(6)	(6)	(6)	(6)	5	5	(6)	--
Barite, crude	317	360	66	82	--	--	2	1	32	17	--	--
Boron minerals and compounds ... gross weight	(11)	(11)	(9)	(9)	--	--	--	--	(9)	(9)	--	--
Bromine and bromine in compounds ... million pounds	([4] 11)	(11)	--	(9)	(9)	(9)	--	--	(9)	(9)	--	--
Clays	165	192	3	3	--	--	--	--	97	97	--	--
Flourspar, finished	293	363	58	65	--	--	--	--	42	35	--	--
Gypsum, crude	3,368	3,966	94	97	--	--	6	3	--	--	--	--
Mica (except scrap) ... thousand pounds	8,250	13,920	2	(6)	([4] 6)	--	21	15	77	85	--	--
Phosphate rock (P_2O_5 content) ... thousand long tons	40	39	(9)	(9)	--	--	(9)	(9)	(9)	(9)	--	--
Potash (K_2O equivalent)	119	177	--	(6)	2	2	--	--	75	71	23	27
Salt, common	161	186	1	77	--	--	99	23	--	--	--	--
Sulfur (content) ... thousand long tons	23	63	(9)	100	--	--	--	--	(9)	(6)	--	--
Talc and allied minerals	22	29	(9)	(9)	--	--	--	--	(9)	(9)	--	--

[1] Unless otherwise indicated, data are for imports for consumption and represent those used in calculating net new supply shown in table 3.
[2] West coast of South America (Salvador, Chile, Bolivia, Peru, and Ecuador), New Zealand, New Caledonia, and Australia.
[3] Include iron ore, pig iron, and scrap.
[4] Revised figure.
[5] General imports.
[6] Less than 0.5 percent.
[7] See footnotes 11 and 13, table 4.
[8] Excludes antimony from foreign silver and lead ores.
[9] Source of supply. Percentage not shown where figure in total column is less than 50.
[10] Metal and flue dust only.
[11] Negligible.

64 percent for mica, with 13 of the 22 exceeding 15 percent. Only 1 mineral decreased more than 10 percent. Of the several measures of activity, net new supply is the best indicator of the excellent year experienced by the minerals and metals in 1955.

Sources of New Supply.—There was little change, in general, in the relative contributions to gross new supply by domestic primary production, domestic secondary, and imports. If domestic primary and secondary are added to compare with imports, the total domestic share either held its own or increased in 17 of the 31 commodities while decreasing in 14. The gain, however slight, favored the domestic component and is more significant following the sizable gain in the 1953–54 period by the domestic component of the reduced total supply of 1954. In other words, the gains made in a contracted demand for the metals and minerals in 1954 were maintained in the large expansion of demand in 1955. In addition, the domestic industry, through increased exports (see table 5), increased its share of the world markets for metals and minerals.

Sources of Imports.—In contrast to the few area changes of the 1953–54 period, there were more and larger changes in the source of supply of the varied minerals in 1954–55. Changes of 5 percent or more in imports from Canada and Mexico were: Iron equivalent (up 19 percent), mercury (up 37 percent), titanium concentrates (up 8 percent), barite (up 16 percent), gypsum (up 7 percent), and salt, which moved from 1 percent of total imports in 1954 to 77 percent in 1955. Similar changes in the East and South Pacific area were in iron equivalent (down 11 percent), tungsten ore and concentrate (up 5 percent), and copper (down 5 percent). The larger changes in the Other Western Hemisphere area were in mica (down 6 percent) and salt (down 76 percent). Large changes were more numerous in the Other Free World area: Iron equivalent (down 7 percent), tungsten ore and concentrate (down 6 percent), mercury (down 37 percent), titanium concentrates (down 8 percent), barite (down 15 percent), fluorspar (down 7 percent), and mica (up 8 percent)

FOREIGN TRADE

Value.—Exports of nonfuel minerals and metals continued their rapid rise in 1955, while imports, though higher than in 1954, were actually lower than in 1953. The ratios of the value of exports to the value of imports of the minerals and metals shown in table 5 for the years 1953, 1954, and 1955 were 14, 26, and 31 percent, respectively. Imports in 1955 were $1.9 billion; exports reached $0.6 billion during the year, more than double the 1953 level. Although each of the three components of exports shown in table 5 increased over 1954, the outstanding increase occurred in the crude metallic minerals. Exports in this crude metallic category more than tripled the 1953 value, largely as a result of the rapid rise in the export of iron and steel scrap. If iron and steel scrap is subtracted from the grand total of exports of nonfuel minerals, the increase over 1953 remains a significant 60 percent. Imports in each of the 3 nonfuel categories increased over 1954, with a 13-percent increase occurring in the metals, 16 percent in the crude nonmetallic minerals and 8 percent in the crude metallic minerals.

TABLE 5.—Value of minerals and mineral products imported and exported by the United States, 1953–55, by commodity group and commodity, in thousand dollars [1]

[U. S. Department of Commerce]

SITC No.[2]	Group and commodity	Imports for consumption [3] 1953	Imports for consumption [3] 1954	Imports for consumption [3] 1955	Exports of domestic merchandise [4] 1953	Exports of domestic merchandise [4] 1954	Exports of domestic merchandise [4] 1955
	CRUDE METALLIC MINERALS [5]						
281-01	Iron ore and concentrates	96,842	119,459	177,345	32,422	24,784	36,993
282-01	Iron and steel scrap	5,870	5,949	7,051	11,219	51,612	177,526
	Ores of nonferrous base metals and concentrates:						
283-07	Manganese	105,673	77,030	71,835	552	592	612
283-11	Tungsten	91,602	76,251	56,155	31	111	65
283-06	Tin	83,713	41,725	36,773			
283-01	Copper	59,939	69,142	77,868	290	1,309	7,326
283-08	Chromium	56,102	34,197	37,854	56	50	76
283-05	Zinc	49,714	54,328	39,556	759		
283-03	Bauxite (aluminum ore) and concentrate	29,585	36,289	36,629	886	666	528
283-04	Lead	15,391	48,306	38,272	269	25	5
*283-19	Columbium	6,891	14,191	19,852		1	10
283-02	Nickel	5,794	5,358	3,264			
*283-19	Titanium:						
	Ilmenite	5,464	4,993	7,031	} 110	78	194
	Rutile	1,791	1,323	1,984			
*283-19	Cobalt	4,952	5,576	5,759			
*283-19	Molybdenum		180	142	7,308	13,989	15,783
*283-19	Other	9,134	7,489	11,016	152	107	1,887
	Nonferrous metal scrap:						
284-01	Aluminum	8,072	4,675	16,364	1,476	12,985	6,501
	Old and scrap copper	4,018	2,081	9,058	17,199	40,234	20,560
	Old brass and bronze and clippings	3,737	1,568	5,145	[7] 13,066	[7] 38,469	[7] 24,507
	Other, not elsewhere included	5,536	4,990	6,916	3,130	7,040	7,030
285-02	Platinum-group metals	11,827	13,643	15,801	1	2	
	Total crude metallic minerals	661,647	628,743	681,670	88,926	192,054	299,603
	METALS (UNWROUGHT)[5] [8]						
681-01	Pig iron and sponge iron	27,958	15,156	15,849	1,145	872	2,056
681-02	Ferroalloys:						
	Ferromanganese	27,181	10,903	12,022	389	615	643
	Ferrochromium	10,398	3,502	8,012	286	996	2,267
	Other	2,812	2,142	3,394	2,708	1,780	3,325
682-01	Copper	362,079	277,981	335,721	70,117	130,625	152,384
687-01	Tin	187,613	142,504	141,787	298	467	504
684-01	Aluminum	115,761	83,573	74,695	937	1,691	2,773
683-01	Nickel (including scrap)	102,750	124,454	149,522	9,674		
686-01	Zinc	50,282	33,987	46,638	4,774	5,532	4,203
685-01	Lead	97,449	70,376	74,753	490	208	154
689-01	Cobalt metal	33,225	35,391	38,585	(9)	(9)	
689-01	Mercury	13,569	10,784	5,149	106	183	155
689-01	Other nonferrous base metals	12,726	9,917	13,575	3,860	8,103	11,028
671-02	Platinum-group metals, including unworked and partly worked	27,620	21,641	32,361	1,531	2,955	2,724
	Total metals	1,071,423	842,311	952,063	96,315	154,027	182,216
	Total metals and metallic minerals	1,733,070	1,471,054	1,633,733	185,241	346,081	481,819
	CRUDE NONMETALLIC MINERALS (except fuels)						
	Diamonds:						
*672-01	Gems, rough or uncut	57,001	[6] 59,424	76,735	415	410	785
*272-07	Industrial	48,989	[6] 48,521	66,051	14	63	16
	Total	105,990	[6] 107,945	142,786	429	473	801
272-12	Asbestos, crude, washed, or ground	59,754	55,857	60,958	540	276	236
271-02	Sodium nitrate	23,268	26,818	21,699	1,126	1,210	553

See footnotes at end of table.

TABLE 5.—Value of minerals and mineral products imported and exported by the United States, 1953–55, by commodity group and commodity, in thousand dollars [1]—Continued

SITC No.[2]	Group and commodity	Imports for consumption [3]			Exports of domestic merchandise [4]		
		1953	1954	1955	1953	1954	1955
	CRUDE NONMETALLIC MINERALS (except fuels)—Continued						
272-13	Mica, unmanufactured (including scrap)	14,700	8,335	10,862	28	79	35
*272-14	Fluorspar	11,245	8,962	8,540	49	50	65
272-11	Stone for industrial uses, except dimension	5,370	5,807	7,106	694	762	738
272-06	Sulfur	51	58	612	36,573	52,524	51,068
271-03	Phosphates, natural, ground or unground	2,545	3,081	2,703	18,368	21,169	20,302
272-04	Clay	2,195	2,485	2,941	7,031	8,350	10,891
	Other nonmetallic minerals (except fuels) [10]	18,195	[6] 20,255	20,473	19,390	19,635	22,011
	Total crude nonmetallic minerals (except fuels)	243,313	[6] 239,603	278,680	84,228	104,528	106,700
	Grand total, minerals and metals (except fuels)	1,976,383	[6] 1,710,657	1,912,413	269,469	450,609	588,519

[1] The grouping of the commodities is based upon Standard International Trade Classification of the United Nations. Basic data were compiled by the Office of the Chief Economist, Bureau of Mines, from copies of unpublished tabulations prepared by the Bureau of the Census for the United Nations, which tabulations represent a tentative conversion of United States import and export classifications to SITC categories. Revisions in these data have been made by the Office of Chief Economist insofar as possible to (1) include for the various classifications the latest revisions compiled by Mae B. Price and Elsie D. Page of the Bureau of Mines, from the records of the U. S. Department of Commerce; (2) incorporate in all years shown changes in assignments of classifications to SITC categories made by the Bureau of the Census; and (3) in some few cases, make other changes in such assignments which it appeared would make the data more comparable and/or more in line with the SITC.

As could be expected, individual commodities and groupings shown or omitted will not in all cases be in accord with usual Bureau of Mines practice as followed in individual commodity chapters in this Minerals Yearbook. In a few cases, values will differ from those for the same commodity in the corresponding chapter because of reclassifications, exclusions, or other reasons usually explained by footnotes in the chapter.

[2] An asterisk indicates that only part of the SITC category indicated is covered, the remainder of the category being covered elsewhere in the major grouping.

[3] Includes items entered for immediate consumption, items withdrawn from bonded storage warehouse for consumption, and ores, etc., smelted and refined under bond—included at time smelted or refined product is withdrawn for consumption or for export. The figures for 1954 are not strictly comparable to the figures for the other years due to the inclusion for the first time of imports individually valued at $250 or less reported on informal entries.

[4] Includes both mineral products of domestic origin and foreign mineral products which have been smelted, refined, manufactured, or otherwise processed in the United States.

[5] Excludes gold and silver.

[6] Revised figure.

[7] Copper-base alloy scrap (new and old) including brass and bronze.

[8] Includes alloys.

[9] Exports, if any, are negligible and included with "Nonferrous metal scrap, other" (284-01; see Crude metallic minerals).

[10] Includes all SITC Nos. 271-04; 272-01, -02, -03, -05, -08, -15, -16, and -19; and those parts of Nos. 672-01, 272-07 and -14 not shown separately above.

Tariffs.[6]—The Trade Agreements Extension Act of 1955 [7] extended to June 30, 1958, the authorization to the President to enter trade agreements with foreign countries. However, the authority for further tariff reductions was more limited than in previous extensions of the act. Two alternative limits to reductions were established in section 3. First, import duties may be reduced by not more than 15 percent of the rate existing on January 1, 1955, but the amount of reduction becoming initially effective may not exceed 5 percent of the existing rate. No further part of any reduction can become effective

[6] Prepared by William A. Vogely, general economist.

[7] Public Law 86, 84th Cong., 1st. sess.

until at least 1 year from the immediately preceding reduction, and no reduction may be initially effective after June 30, 1958. In effect, the first alternative limits the reductions to a maximum of 15 percent of the January 1, 1955, rate, in 3 annual steps of 5 percent. Second, any import duty higher than 50 percent ad valorem may be reduced to 50 percent ad valorem, with no more than one-third of the reduction becoming initially effective and no further part becoming effective until the preceding part has been in effect for at least 1 year. Reductions under the second alternative, in contrast to the first alternative, can become initially effective after June 30, 1958, so that the President's authorization under this alternative remains at full level until the expiration of the act.

In September the Interdepartmental Committee on Trade Agreements announced the intention of the United States to negotiate reciprocal tariff reductions under the new authority.[8] Important mineral commodities included for possible negotiations were manganese ore, tungsten ore, certain ferroalloys, crude aluminum, nickel, and copper. The negotiations were to be held in Geneva, Switzerland, in the spring of 1956.

Other sections of the act were also of importance to the mineral industries. Section 5 amended the escape-clause procedure by requiring the Tariff Commission to make public its findings and recommendations immediately upon transmittal to the President and to publish a summary of its report in the Federal Register. Section 6 defined more sharply the criteria for serious injury from imports and the meaning of a "domestic industry." Section 7 gave the Director of Defense Mobilization the responsibility of informing the President of any article being imported in such quantity as to threaten to impair the national security. If after an immediate investigation the President agrees, he can take any action (under sec. 7) he deems necessary to adjust the imports to a level which will not threaten to impair the national security.

Escape-clause proceedings affecting 2 mineral industries were instituted during 1955, and 1 proceeding for relief under the national defense amendment was begun. Kent Metal & Chemical Corp., Edgewater, N. J., and New Process Metals, Inc., Newark, N. J., applied for relief under the escape clause from imports of ferrocerium (lighter flints) and all other cerium alloys. The Tariff Commission unanimously recommended in its report to the President on December 21, 1955,[9] that the tariff be restored to the original rate of duty provided in the Tariff Act of 1930. The President had not acted by the end of the year on the Commission's report. Pursuant to the resolution of the Senate Committee on Finance dated July 29, 1955, the Tariff Commission undertook an escape-clause investigation of acid-grade fluorspar. Public hearings were held September 27–30, but the

[8] Federal Register, vol. 20, No. 18, Friday, Sept. 23, 1955, p. 7140.
[9] U. S. Tariff Commission, Ferrocerium (Lighter Flints) and All Other Cerium Alloys: Report to the President on Escape-Clause Investigation, 1955.

Commission had not issued its findings by the end of 1955.[10] Simultaneously with the escape-clause investigation the producers of acid-grade fluorspar appealed to the Office of Defense Mobilization under the national security clause mentioned above, but this application was later withdrawn.

Japan became a member of the General Agreement on Tariffs and Trade on September 10, 1955.

CONSUMPTION AND STOCKS

Reported Consumption.—Whereas in the 1953–54 period reported consumption of all but 4 minerals (on which such data is collected) showed sizable decreases, in 1955 every mineral shown in table 6 increased. Only 3 minerals showed gains under 10 percent; a majority increased by 20 percent or more. Largest consumption gains were in tungsten concentrate, chromite, molybdenum, and the platinum group.

TABLE 6.—Reported consumption of principal metals and minerals in the United States, 1954–55

(Thousand short tons, unless otherwise stated)

Commodity	1954	1955	Change from 1954 (percent)
Antimony, primary ... short tons	12,180	12,470	+2
Barite, crude	1,216	1,460	+20
Bauxite ... thousand long tons, dried equivalent	6,428	6,984	+9
Chromite ... gross weight	914	1,584	+73
Cobalt ... thousand pounds	7,350	9,740	+33
Copper, refined	1,255	1,502	+20
Fluorspar, finished	480	570	+19
Iron ore ... thousand long tons, gross weight	94,200	125,000	+33
Lead	1,095	1,213	+11
Magnesium, primary ... short tons	39,220	46,460	+18
Manganese ore ... gross weight	[1] 1,741	2,104	+21
Mercury ... 76-pound flasks	42,800	57,190	+34
Mica splittings ... thousand pounds	6,733	8,998	+34
Molybdenum, primary products (shipments to domestic destinations) ... thousand pounds, Mo content	23,720	35,940	+52
Nickel, exclusive of scrap ... short tons	[1] 94,700	109,300	+15
Platinum-group metals (sales to consumers) ... thousand troy ounces	582	851	+46
Tin ... long tons	82,890	90,480	+9
Titanium concentrate (ilmenite and slag) ... estimated TiO_2 content	424	496	+17
Tungsten concentrate ... thousand pounds, W content	2,019	4,483	+122
Zinc, slab	884	1,120	+27

[1] Revised figure.

Apparent Consumption.—For metals and minerals on which consumption data are not collected, apparent consumption is presented in table 7. Of these minerals, only bromine failed to show an increase over 1954. Increases in asbestos, phosphate rock, and potash were small, but all others increased 10 percent or more. Combining reported and apparent consumption, 30 of the 31 minerals showed consumption gains in 1955.

[10] U. S. Tariff Commission, Operation of the Trade Agreements Program: 9th Rept., July 1955–June 1956, p. 203.

TABLE 7.—Apparent consumption of metals and minerals in the United States, 1954–55 [1]

(Thousand short tons, unless otherwise stated)

Commodity	1954	1955	Change from 1954 (percent)
Asbestos, all grades [2]	724	782	+8
Boron minerals and compounds..........gross weight	[3] 585	702	+20
Bromine and bromine in compounds..........million pounds	182	181	−1
Cadmium, primary [2]..........thousand pounds, Cd content	[3] 7,420	[4] 10,690	+44
Clays	[3] 42,340	48,030	+13
Gypsum, crude	[3] 12,230	14,420	+18
Phosphate rock..........thousand long tons, P_2O_5 content [5]	3,375	3,447	+2
Potash..........K_2O equivalent	1,971	2,050	+4
Salt, common	[3] 20,440	22,480	+10
Sulfur (all forms)..........thousand long tons, S content	[3] 4,913	5,612	+14
Talc and allied minerals [2]	[3] 599	713	+19

[1] Covers commodities on which reported consumption is not collected.
[2] Adjustments are not made for National Strategic Stockpile acquisitions, if any.
[3] Revised figure.
[4] Not strictly comparable with figure for 1954, since 1955 production data do not cover primary compounds not made from metal.
[5] Estimated at 31 percent.

Sales and Orders.[11]—Seasonally adjusted sales of primary metal manufacturing moved steadily upward in the first 6 months, fell sharply in July, and in the last 5 months regained the level reached in June; December 1955 sales were 36 percent higher than those of the previous December. Adjusted sales for all manufacturing, on the other hand, rose only 13 percent in the same period, and the month-to-month increase was more erratic. Sales of stone, clay, and glass also rose 13 percent between December 1954 and December 1955.

New orders (adjusted) in primary metal manufacturing rose rapidly in the first 3 months of 1955, after which they moved erratically about the February-March level, exceeding the March level only in November; December 1955 was 22 percent above December 1954. The increase in the same period for all manufacturing was 18 percent.

Physical Stocks of Mineral Manufacturers, Consumers, and Dealers.—Movements in physical stocks of minerals and metals were somewhat mixed, as they were in 1954, with, however, a slight preponderance of negative changes. The largest decreases in stocks in 1955 occurred in refined pig lead at smelters and refineries (73 percent), slab zinc at primary smelters and secondary distilling plants (68 percent), mercury in the hands of consumers and dealers (59 percent), and antimonial lead at smelters and refineries (33 percent). The largest increases in stocks occurred in tin scrap at consumers' plants (63 percent), fluorspar in the hands of importers (107 percent), refined copper at primary smelting and refining plants (36 percent), and purchased copper scrap in the hands of consumers (41 percent).

[11] Office of Business Economics, U. S. Department of Commerce, Survey of Current Business, vol. 36, various issues.

TABLE 8.—Selected physical stocks of mineral commodities of mineral manufacturers, consumers, and dealers in the United States, at end of year, 1952–55 [1]

Commodity and type of stock	1952	1953	1954	1955 Quantity	1955 Change from 1954 (percent)
Aluminum (short tons):					
Primary, at reduction plants	7,270	39,300	21,100	15,000	−29
Purchased aluminum scrap, consumers (gross weight)	20,300	27,000	18,460	19,970	+8
Arsenic, producers' stocks ... thousand short tons	11.3	10.8	12.5	11.6	−7
Bauxite, at consumers (dried equivalent) [3] thousand long tons	1,921	2,103	[2] 2,287	2,247	−2
Bismuth, consumers' and dealers' stocks thousand pounds	211.5	166.7	252.8	234.3	−7
Cadmium, metal and compounds, producers and distributors (Cd content) ... do	2,186	[2] 3,872	[2] 5,403	4,001	−26
Cement, at mills ... million 376-pound barrels	16.0	19.4	[2] 16.5	17.5	+6
Chromite, at consumers' plants (thousand short tons):					
Metallurgical	364	608	804	628	−22
Refractory	270	260	257	313	+22
Chemical	120	148	206	169	−18
Total	754	1,016	1,267	1,110	−12
Copper (thousand short tons):					
At primary smelting and refining plants (Cu content):					
Refined	26	49	25	34	+36
Blister and material in process	185	223	189	201	+6
In fabricators' hands, refined, including in process and primary fabricated shapes (Cu content)	331	381	361	390	+8
Purchased copper scrap, consumers (gross weight)	107	[4] 157	[4] 108	[4] 152	+41
Ferrous scrap and pig iron, at consumers' plants (thousand short tons):					
Total scrap	6,900	7,150	7,350	7,210	−2
Pig iron	1,970	2,800	2,540	2,290	−10
Total	8,870	9,950	9,890	9,500	−4
Fluorspar (thousand short tons):					
At consumers' plants	252.2	227.5	143.8	140.6	−2
Importers	31.4	15.5	26.1	54.0	+107
Iron ore (thousand long tons):					
At consumers' plants	43,130	[2] 45,240	[2] 43,140	44,360	+3
On Lake Erie docks	6,120	7,670	6,590	6,820	+3
Total	49,250	[2] 52,910	[2] 49,730	51,180	+3
Lead (thousand short tons, Pb content):					
At smelters and refineries:					
Refined pig lead	31.4	65.0	77.9	21.2	−73
Antimonial lead	12.2	[2] 16.1	[2] 14.8	9.9	−33
In base bullion, including in process at and in transit to refineries	40.4	47.5	47.1	47.9	+2
In ore, matte, and in process at smelters	65.8	67.7	62.1	71.8	+16
Total	149.8	[2] 196.3	[2] 201.9	150.8	−25
Consumers' stocks:					
Refined	80.9	[2] 75.8	[2] 82.0	73.5	−10
Antimonial	20.3	[2] 14.9	[2] 17.6	23.1	+31
In unmelted white-metal scrap, percentage metals, copper-base scrap, and drosses, residues, etc	21.3	[2] 23.1	[2] 25.0	20.9	−16
Total	122.5	[2] 113.8	[2] 124.6	117.5	−6
Manganese ore and ferromanganese, at plants, including bonded warehouses (thousand short tons, gross weight):					
Ore [5]	1,249	1,692	1,579	1,362	−14
Ferromanganese (excludes producers' stocks)	143	137	175	152	−13
Mercury, in hands of consumers and dealers thousand 76-pound flasks	33.7	25.9	[2] 22.3	9.1	−59
Molybdenum primary products, producers' stocks (Mo content) ... thousand pounds	3,370	3,890	3,430	3,160	−8

See footnotes at end of table.

TABLE 8.—Selected physical stocks of mineral commodities of mineral manufacturers, consumers, and dealers in the United States, at end of year, 1952–55 [1]—Continued

Commodity and type of stock	1952	1953	1954	1955 Quantity	1955 Change from 1954 (percent)
Nickel, consumers' plants (short tons):					
Metal [6] ... Ni content	5,230	6,610	[2] 8,630	6,920	−20
In other forms, exclusive of scrap [6] ... do	3,000	3,750	[2] 2,140	2,260	+6
Total [6] ... do	8,230	10,360	[2] 10,770	9,180	−15
Purchased nickel scrap (gross weight)	1,360	1,190	1,630	1,400	−14
Platinum-group metals, all forms, held by refiners, importers, and dealers (thousand troy ounces):					
Platinum	130.1	138.8	135.6	146.2	+8
Palladium	116.8	110.2	86.8	111.6	+29
Iridium, osmium, rhodium, and ruthenium	35.5	32.0	34.2	36.1	+6
Total	282.4	281.0	256.6	293.9	+15
Tin, consumers' plants (long tons):					
Pig tin, virgin (includes in transit in United States, at other warehouses, and held by jobbers)	12,900	[2] 14,180	[2] 14,700	18,470	+26
In process (tin content)	11,300	10,850	11,160	11,550	+3
Purchased tin scrap (gross weight)	1,152	[2] 976	[2] 547	894	+63
Titanium concentrate, consumers and distributors (estimated TiO_2 content) ... thousand short tons	334	355	[2] 369	345	−7
Tungsten concentrate, consumers and dealers (W content) short tons	1,410	2,170	1,955	1,750	−10
Zinc (thousand short tons):					
Slab:					
At primary smelters and secondary distilling plants	85.0	[2] 180.0	[2] 123.4	39.3	−68
At consumers' plants	92.3	[2] 85.7	[2] 103.7	123.5	+19
Purchased zinc scrap, at consumers' plants (gross weight)	22.8	25.2	34.6	34.2	−1

[1] Stocks in the National Strategic Stockpile are not included nor Reconstruction Finance Corporation stocks of tin or Government-held nonstrategic stockpiles of bauxite.
[2] Revised figure.
[3] Estimated, using conversion factor of 0.85 for crude and 1.00 for processed.
[4] Includes brass-mill home-scrap stocks.
[5] Excludes small tonnages of dealers' stocks.
[6] Includes amounts in transit to consumers' plants.

Value of Inventories of Primary Metal Manufacturing.[12]—Seasonally adjusted value of inventories for all primary metal manufacturing (including several industries not ordinarily considered part of mineral manufacturing) increased in the last quarter of 1955, ending the year with December 8 percent above January. Value of inventories in stone, clay, and glass products rose steadily during the year with December 11 percent higher than January.

Mine Stocks.—Data on mine stocks are limited to only 12 minerals; the movements of these 12 were mixed in 1955, with increases and decreases about equally divided. These stocks compare two points of time—year end 1954 and year end 1955—and are not in themselves adequate as indicators of stock changes during the year.

Stocks in Bonded Warehouses.—Stocks of metals and minerals in bonded warehouses, as estimated from general imports and imports for consumption data, showed mixed reactions to the upturn in economic activity in 1955. All but two of the minerals for which there was a change in 1955 (magnesium and bromine showed no

[12] Office of Business Economics, U. S. Department of Commerce, Survey of Current Business, vol. 36 various issues.

change) moved in the same direction as in 1954; stock decreases continued for manganese, tungsten ore and concentrate, lead, aluminum, and mica, and stock increases continued for nickel, zinc, cadmium,

TABLE 9.—Stocks of minerals at mines, 1954–55

Commodity and unit	1954	1955	Change from 1954 (percent)
Antimony ore and concentrate .... short tons, Sb content	200	227	+14
Bauxite (thousand long tons):			
Crude	964	1,043	+8
Processed (dried, calcined, and activated)	6	5	−17
Fluorspar, finished .... short tons	[1] 26,370	23,440	−11
Gypsum, crude .... thousand short tons	1,664	1,894	+14
Iron ore .... thousand long tons	7,079	4,563	−36
Mercury .... 76-pound flasks	186	928	+399
Molybdenum concentrate [2] .... thousand pounds, Mo content	5,317	2,730	−49
Phosphate rock .... thousand long tons, P_2O_5 content	[3]	831	------------
Potassium salts .... thousand short tons, gross weight	[1] 526	631	+20
Sulfur (thousand long tons):			
Frasch	3,228	3,181	−1
Recovered	109	120	+10
Titanium concentrate (short tons, estimated TiO_2 content):			
Ilmenite	[1] 33,300	37,230	+12
Rutile	709	87	−88
Tungsten concentrate .... short tons, W content	[1] 181	262	+44

[1] Revised figure.
[2] Includes stocks of concentrate at plants making molybdenum products.
[3] Comparable data not available.

TABLE 10.—Estimated changes in stocks of selected minerals in custom bonded warehouses, Jan. 1–Dec. 31, 1955 [1]

(Short tons, unless otherwise stated)

	Estimated stock change	
	Component	Class
Aluminum	------------	−12
Metal and alloys in crude form	−12	------------
Antimony	------------	+4
Regulus or metal	+4	------------
Barite, crude	------------	−38,534
Cadmium (content) .... pounds	------------	+1,574,601
Cadmium .... do	+1,348,757	------------
Cadmium flue dust .... do	+225,844	------------
Copper (content)	------------	+6,752
Copper ore and concentrate	+5,240	------------
Regulus, black, coarse	+1,512	------------
Fluorspar, finished	------------	+7,247
Acid grade	−22,543	------------
Metallurgical grade	+29,830	------------
Reexport of foreign merchandise, both grades	−40	------------
Lead (content)	------------	−218,422
Ores, flue dust, mattes	+21,046	------------
Pigs and bars	−239,468	------------
Manganese (content)	------------	−36,994
Manganese ore, Battery grade	+1,348	------------
Manganese ore, Metallurgical grade	−79,272	------------
Ferromanganese and manganese-silicon	+40,930	------------
Mercury .... 76-pound flasks	------------	+27
Mica, except scrap .... pounds	------------	−223,807
Unmanufactured .... do	−20,430	------------
Manufactured .... do	−80,594	------------
Reexports of foreign merchandise, both types .... do	−167,828	------------
Nickel (content)	------------	+13,121
Nickel alloy and metal, including scrap	+13,121	------------
Tungsten ore and concentrate (W content)	------------	−81
Zinc (content)	------------	+93,858
Zinc-bearing ores	+93,396	------------
Blocks, pigs, or slabs	+462	------------

[1] Estimated by the subtraction of "imports for consumption" and "reexports of foreign merchandise" from "general imports." All data from the U. S. Department of Commerce. Minerals are those included in net new-supply table which enter bonded warehouses and for which a change occurred in 1955.

antimony, mercury, and fluorspar. Copper reversed its direction from a stock decrease in 1954 to an increase in 1955, and barite changed from an increase in 1954 to a large decrease in 1955. The most significant changes, in terms of total supply, were the large negative changes in lead stocks and the large increase in cadmium stocks.

TRANSPORTATION

Rail and Water.—Reflecting the generally higher level of activity in the nonfuel-mineral industry in 1955, the volume of rail transport

TABLE 11.—Rail and water transportation of mineral products in the United States, 1954–55, by products

(Thousand short tons)

Product	Rail [1]			Water [2]		
	1954	1955	Change from 1954, percent	1954	1955	Change from 1954, percent
Metals and minerals, except fuels:						
Iron ore	88,272	123,051	+39	62,665	89,521	+43
Iron and steel scrap	17,722	25,580	+44	1,364	2,461	+83
Metals and alloys	10,827	13,741	+27			
Other ores and concentrates	13,233	18,500	+40	2,455	2,962	+21
Other scrap	2,142	2,421	+13			
Slag	6,587	7,320	+11	(3)	(3)	(3)
Sand and gravel	68,525	73,980	+8	56,735	59,514	+5
Stone, crushed except limestone	52,107	55,722	+7			
Limestone, crushed	15,174	19,888	+31	25,983	31,555	+21
Cement	31,603	34,268	+8	3,817	4,453	+17
Phosphate rock	23,674	18,830	−20	2,465	2,421	−2
Clays	9,339	10,228	+10	1,511	1,869	+24
Sulfur	4,440	4,852	+9	4,121	4,716	+16
Other	25,323	29,481	+16	4,067	4,880	+20
Total	368,968	437,862	+5	165,183	204,352	+24
Mineral fuels and related products:						
Coal:						
Anthracite [5]	34,220	31,498	−8	1,606	1,559	−3
Bituminous [5]	297,723	352,814	+19	113,782	139,813	+23
Coke [5]	14,266	20,918	+47	503	657	+34
Crude petroleum	3,606	2,829	−21	64,572	63,082	−2
Gasoline	11,189	10,557	−6	80,962	85,771	+6
Distillate fuel oil	10,810	10,792	(4)	62,515	69,894	+12
Residual fuel oil				40,100	43,287	+8
Kerosine	19,439	20,287	+4	10,044	10,043	(4)
Other				10,319	11,980	+16
Total	391,253	449,695	+15	384,403	426,086	+11
Total mineral products	760,221	887,557	+10	549,586	630,438	+6
Grand total all products	1,212,301	1,384,119	+14	653,796	745,033	+14
Mineral products as percent of grand total:						
Metals and minerals, except fuels	30	32		25	27	
Mineral fuels and related products	32	32		59	57	
Total mineral products	62	64		84	85	

[1] Revenue freight originated, excluding forwarder and less than carlot shipments, for which categories commodity detail is not available. Source: Interstate Commerce Commission, Freight Commodity Statistics, Class I Steam Railways in the United States, for years ended Dec. 31, 1954 and 1955: Statements 55100 and 56100.

[2] Domestic traffic, that is, all commercial movements between any point in continental United States or its Territories and possessions and any other such point. Traffic with the Panama Canal Zone is not included. Source: Department of the Army, Waterborne Commerce of the United States, Calendar Year 1954 and 1955, part 5, National Summaries. Traffic with the Virgin Islands, and military cargoes carried in Defense Department vehicles are excluded.

[3] Not separately classified.

[4] Less than 0.5 percent.

[5] Figures for rail shipments include briquets. For water shipment, briquets not reported by types of material and included with "Other."

and water transport of mineral products (except fuels) rose 5 and 24 percent, respectively, over 1954. The resumption of iron-ore shipments after the 1954 slump was the greatest factor in these increases. Only phosphate rock showed a decline from 1954. The transport of nonfuel minerals and metals by rail accounted for 32 percent of all commodities in 1955, a rise of 2 percent from 1954; in water transport, this percent increased from 25 to 27 percent.

Rail Rates.—For the second successive year the index of average freight rates for mine products (including mineral fuels) decreased (from 108 in 1954 to 107 in 1955), approximately matching the decline in the index for all commodities. Rates for mine products were lower in both interstate and intrastate traffic. The index of rates in each of the 5 territories were lower than in 1954 with the exception of the western trunkline for which there was no change; the index for the southern territory fell 3 percent.

TABLE 12.—Indexes of average freight rates on railroad carload traffic in the United States, 1952–55 [1]

(1950=100)

Item	1952	1953	1954	1955
ALL CARLOAD TRAFFIC				
Products of mines [2]	108	109	108	107
Iron ore	110	110	111	110
Clay and bentonite	112	115	114	114
Sand, industrial	114	113	109	108
Gravel and sand, n. o. s.	108	110	108	109
Stone and rock, broken, ground, and crushed	108	110	110	108
Fluxing stone and raw dolomite	110	111	112	113
Salt	108	109	107	108
Phosphate rock	109	112	113	105
Mineral manufactures and miscellaneous	110	112	110	108
Fertilizers, n. o. s.	110	114	113	111
Iron, pig	113	114	113	114
Cement: Natural and portland	110	112	110	104
Lime, n. o. s.	110	113	113	111
Scrap iron and scrap steel	112	115	111	108
Furnace slag	107	107	107	105
Nonmineral categories:				
Products of agriculture	108	110	110	109
Animals and products	110	113	112	112
Products of forests	110	113	113	113
Forwarder traffic	113	114	112	112
All commodities	109	111	109	108
PRODUCTS OF MINES ONLY [2]				
Intraterritorial movements:				
Official	108	109	107	106
Southern	107	109	107	104
Western trunkline	109	109	109	109
Southwestern	107	110	112	111
Mountain Pacific	106	106	108	107
All movements, by type of rate:				
Interstate rates	108	109	108	108
Intrastate rates	107	108	107	107

[1] U. S. Interstate Commerce Commission, Bureau of Transport Economics and Statistics, Indexes of Average Freight Rates on Railroad Carload Traffic 1947-55: Statement R1-1, 1947-55, Washington, November 1956. Indexes are based on the Commission's 1-percent waybill sample.
[2] Includes fuels and related commodities as well as other nonfuel minerals, which are not shown separately below.

LABOR

Employment.[13]—Employment in nonfuel metals and minerals mining remained about the same as in 1954 in spite of the increases in production experienced in this segment of the economy in 1955.

[13] Bureau of Labor Statistics, U. S. Department of Labor, Monthly Labor Review: May 1956, pp. 600-60

	Change in employment 1955 over 1954 (percent)
All industries	+2
Mining (including fuels)	−3
Metals and minerals (except fuels)	0
Metal mining	−2
Nonmetallic mining and quarrying	+1
Fuels	−4
Mineral manufacturing [1]	+8
Manufacturing	+4

[1] Based on categories listed under "Mineral manufacturing" in table 13.

TABLE 13.—Employment in the mineral industries (nonfuel) in continental United States, 1952–55, by industries [1]

(In thousands)

Year and month	Mining					
	Total	Nonmetallic mining and quarrying	Metal			
			Total [2]	Iron	Copper	Lead and zinc
1952	203.6	103.8	99.8	33.5	26.5	21.2
1953	[3] 211.9	[3] 105.9	[3] 106.0	[3] 40.1	28.6	[3] 17.8
1954	202.8	104.7	98.1	35.2	27.4	16.2
1955:						
January	194.2	100.1	94.1	30.3	28.3	16.2
February	194.1	99.8	94.3	30.2	28.6	16.2
March	197.1	102.3	94.8	30.5	28.7	16.3
April	201.6	105.1	96.5	32.0	28.8	16.4
May	203.2	106.1	97.1	33.8	27.5	16.2
June	205.8	107.2	98.6	34.5	27.9	16.3
July	197.5	107.5	90.0	35.8	18.0	16.2
August	201.9	108.9	93.0	36.2	20.6	16.4
September	210.0	109.9	100.1	36.3	29.2	15.1
October	207.8	108.0	99.8	35.5	29.4	15.1
November	206.6	106.7	99.9	35.0	29.7	15.1
December	204.1	104.0	100.1	34.3	30.3	15.2
Year (average)	202.0	105.5	96.5	33.7	27.2	15.9

Year and month	Mineral manufacturing				
	Fertilizers	Cement, hydraulic	Blast furnaces, steelworks, and rolling mills	Smelting and refining of nonferrous metals	
				Primary	Secondary
1952	36.9	40.0	570.7	55.7	12.7
1953	37.2	41.8	653.3	61.0	13.5
1954	36.8	41.7	581.0	62.9	12.4
1955:					
January	35.9	42.4	581.5	65.0	12.3
February	38.2	42.2	594.1	65.2	12.4
March	46.7	42.4	608.4	65.4	12.6
April	47.8	42.7	620.8	65.9	12.6
May	42.7	43.1	632.9	66.2	12.5
June	33.5	43.9	647.6	67.6	12.5
July	29.7	44.4	652.8	56.2	11.6
August	29.6	44.4	657.4	64.5	12.7
September	34.5	44.5	661.9	68.2	13.1
October	35.2	44.2	653.9	68.5	13.1
November	34.3	44.3	656.9	68.7	13.2
December	34.7	44.2	659.0	68.9	13.2
Year (average)	36.9	43.6	635.7	65.8	12.7

[1] U. S. Department of Labor, Bureau of Labor Statistics. Published currently in the Monthly Labor Review, Employment and Payrolls, and other publications. Data are based on reports from cooperating establishments covering both full- and part-time employees who worked during, or received pay for any part of the pay period ending nearest the 15th of the month. Data are for "all employees," those for "production and related workers" are also available in the above publications.
[2] Includes other metal mining; not shown separately.
[3] Revised figure.

Employment in nonmetallic mining and quarrying was up 1 percent; that in metal mining decreased 2 percent. Employment in fuel-mining declined 4 percent, resulting in a 3-percent decline for all mining. Employment in mineral manufacturing, on the other hand, showed an 8 percent rise over 1954.

Employment in the mineral industries (nonfuel) can be seen in greater detail in table 13. As in 1954, employment in nonmetallic mining and quarrying was low in the early part of the year, and high in the last three quarters, though turning downward in November and December. Employment in metal mining showed much greater month-to-month variation, with no discernible quarterly pattern.

Total Wages and Salaries.[14]—That the general increase in activity in the mining and primary metal industries in 1955 was reflected in wages and salaries can be seen in the summary below. The increases in wages and salaries in mining matched the 8-percent increase for all industries. Metal- and nonmetallic-mining increases were slightly greater—11 and 9 percent, respectively. The 22-percent increase in wages and salaries in the primary metal industries was the most dramatic, exceeding all other categories in the summary table.

	Wages and salaries (million dollars)		Change from 1954 (percent)
	1954	1955	
All industries	$195,528	$210,354	+8
Mining	3,393	3,656	+8
Nonfuel mining	904	995	+10
Metal mining	466	519	+11
Nonmetallic mining and quarrying	438	476	+9
Fuels mining	2,489	2,661	+7
Manufacturing	65,948	72,132	+9
Primary metal industries	5,480	6,660	+22

Average Annual Earnings.—Average annual wages and salaries of full-time equivalent employees in nonfuel mining rose 7 percent over 1954 as a result of a 9-percent increase in metal mining and a 6-percent increase in nonmetallic mining and quarrying. Average annual earn-

TABLE 14.—Average annual earnings in mining and primary metal industries, 1954–55 [1]

	1954 [2] (average)	1955 (average)	Change from 1954 (percent)
All industries	$3,660	$3,830	+4.6
Mining	4,372	4,693	+7.3
Nonfuel mining	4,343	4,645	+7.0
Metal mining	4,614	4,990	+9.2
Nonmetallic mining and quarrying	4,093	4,327	+5.7
Fuels mining	4,384	4,710	+7.4
Manufacturing	4,116	4,351	+5.7
Primary metal industries	4,624	5,155	+11.5

[1] Office of Business Economics, U. S. Department of Commerce, Survey of Current Business, National Income Number: Vol. 36, July 1956.
[2] Revised figures.

[14] Office of Business Economics, U. S. Department of Commerce, Survey of Current Business: Vol. 36, No. 7, July 1956, p. 16.

TABLE 15.—Average hours and gross earnings of production and related workers in the mineral industries (nonfuel) in continental United States, 1952–55, by industries [1]

[U. S. Department of Labor]

Year	Mining								
	Total [2]			Metal					
				Total [3]			Iron		
	Weekly		Hourly earnings	Weekly		Hourly earnings	Weekly		Hourly earnings
	Earnings	Hours		Earnings	Hours		Earnings	Hours	
1952	$76.28	44.5	$1.72	$81.65	43.9	$1.86	$80.34	43.9	$1.83
1953	82.27	44.0	1.87	88.54	43.4	2.04	90.74	42.4	2.14
1954	80.84	42.4	1.91	84.46	40.8	2.07	82.03	37.8	2.17
1955	86.33	43.3	1.99	92.20	42.1	2.19	92.23	40.1	2.30
	Mining—metal (continued)						Nonmetallic mining and quarrying		
	Copper			Lead and zinc					
1952	$85.73	45.6	$1.88	$81.60	42.5	$1.92	$71.10	45.0	$1.58
1953	91.60	45.8	2.00	80.06	41.7	1.92	75.99	44.7	1.70
1954	87.33	42.6	2.05	76.73	40.6	1.89	77.44	44.0	1.76
1955	95.70	44.1	2.17	84.22	41.9	2.01	80.99	44.5	1.82
	Mineral manufacturing								
	Fertilizers			Cement hydraulic			Blast furnaces, steelworks, and rolling mills [4]		
1952	$56.23	42.6	$1.32	$67.72	41.8	$1.62	$79.60	40.0	$1.99
1953	59.36	42.4	1.40	73.39	41.7	1.76	87.48	40.5	2.16
1954	61.48	42.4	1.45	75.71	41.6	1.82	83.38	[5] 37.9	2.20
1955	63.75	42.5	1.50	78.66	41.4	1.90	96.39	40.5	2.38
	Electrometallurgical products			*Other*			Primary smelting and refining of nonferrous metals [4]		
1952	$76.04	41.1	$1.85	$79.60	40.0	$1.99	$75.48	41.7	$1.81
1953	80.36	41.0	1.96	87.48	40.5	2.16	80.93	41.5	1.95
1954	79.80	40.1	1.99	83.16	37.8	2.20	80.00	40.2	1.99
1955	87.14	41.3	2.11	96.39	40.5	2.38	84.45	40.6	2.08
	Primary smelting and refining of copper, lead, and zinc			*Primary refining of aluminum*			Secondary smelting and refining of nonferrous metals		
1952	$75.06	41.7	$1.80	$76.08	41.8	$1.82	$68.15	41.3	$1.65
1953	80.41	42.1	1.91	81.81	40.5	2.02	73.63	41.6	1.77
1954	76.61	39.9	1.92	85.05	40.5	2.10	74.80	41.1	1.82
1955	81.61	40.6	2.01	88.62	40.1	2.21	82.03	42.5	1.93

[1] Bureau of Labor Statistics, U. S. Department of Labor, Monthly Labor Review: Vol. 79, No. 5, table A-2; May 1956, p. 612f.
[2] Weighted average of data for metal mining and nonmetallic mining and quarrying, computed by authors of chapter.
[3] Includes other metal mining; not shown separately.
[4] Italicized titles that follow are components of this industry.
[5] Revised figure.

ings in the primary metal industries gained 11.5 percent, the highest of all categories in table 14. As was the case in 1954, only 12 of the seventy-odd industries listed exceeded the average earnings in metal mining in 1955.

Hours and Earnings.—The average number of hours worked in 1955 in nonfuel mining was 0.9 hour higher than in 1954, although still below the 44-hour average of 1953. The 8-cent rise in hourly earnings in mining that accompanied the increase in hours worked resulted in a $5.49 increase over 1954 in average weekly earnings. The $92.20 weekly average in metal mining was $7.74 higher than in 1954, influenced particularly by the recovery of earnings in iron-ore mining from its low level of 1954.

PRICES, COSTS, AND PRODUCTIVITY

Prices.—The price index of 8 of the 10 mineral categories shown in table 16 rose in 1955. The largest increase occurred in iron and steel scrap, although much of the increase represented recovery from the low level of 1954, when the index, on a 1947–49 base, was only 79.8. The other substantial increase occurred in the index of nonferrous metal prices, which rose 15 percent over 1954. The BLS wholesale price index for all commodities increased less than 0.5 percent in this period.

TABLE 16.—Price relatives for selected metals and mineral commodities, January and December 1955 and annual averages, 1954 and 1955 [1]

[1947–49=100]

Commodity	1955		Change from January (percent)	Annual average		Change from 1954 (percent)
	January	December		1954	1955	
Iron ore	157.8	161.0	+2	157.7	160.5	+2
Iron and steel scrap	94.5	126.4	+34	79.8	104.6	+31
Iron and steel products	135.8	147.2	+8	132.9	140.6	+6
Nonferrous metals	127.9	155.8	+22	124.2	142.7	+15
Clay products	135.8	144.6	+6	133.1	140.1	+5
Gypsum products	122.1	122.1	0	122.1	122.1	0
Concrete ingredients	123.1	126.0	+2	121.0	124.9	+3
Building lime, insulation material, and asbestos-cement shingles	119.2	122.1	+2	120.1	121.2	+1
Fertilizer materials	101.6	112.3	+11	113.0	111.6	−1
All commodities (minerals and other)	110.1	111.3	+1	110.3	110.7	(2)

[1] Bureau of Labor Statistics, U. S. Department of Labor, Wholesale Price Index (annual and monthly releases; also published currently in Monthly Labor Review).
[2] Less than 0.5 percent.

Costs.—A list of input items whose costs are of major importance to the mining and metal-producing industry is presented in table 17. Compared with the price increases of the minerals themselves, increases in these cost items were small; the coal and lumber indexes fell 1 and 4 percent, respectively; and no increase in the other items exceeded 4 percent. This favorable relationship between price and cost movements contributed to the improved earning position of mining and metal-producing industries during the year.

TABLE 17.—Price relatives for selected cost items in nonfuel mineral production January and December 1955, and annual averages, 1954 and 1955 [1]

[1947–49=100]

Commodity	1955		Change from January (percent)	Annual average		Change from 1954 (percent)
	January	December		1954	1955	
Coal	105.2	109.4	+4	106.3	104.8	−1
Coke	132.4	138.8	+5	132.5	135.2	+2
Gas	113.0	115.5	+2	108.8	111.6	+3
Petroleum products	111.7	115.6	+3	110.8	112.8	+2
Industrial chemicals	117.3	119.4	+2	117.6	118.1	(2)
Lumber	120.0	126.4	+5	117.3	112.4	−4
Explosives	121.8	129.5	+6	121.8	125.0	+3
Construction machinery and equipment	133.2	143.1	+7	131.6	137.1	+4

1 Bureau of Labor Statistics, U. S. Department of Labor, Wholesale Price Index (annual and monthly releases; also published currently in Monthly Labor Review).
2 Less than 0.5 percent.

Productivity.—Productivity measures, as estimated by the Bureau of Labor Statistics, are presented for copper, iron ore, and lead and zinc mining in table 18. In copper mining indexes of both ore mined and recoverable metal per production worker rose sharply in 1955 to exceed all previous years for which the data have been collected. After 4 years of decline these indexes for iron ore also rose in 1955. The index for lead and zinc has not been published since 1953.

TABLE 18.—Labor productivity indexes for copper, iron ore, and lead and zinc mining, 1946–55 [1]

(1947–49=100)

[Bureau of Labor Statistics]

Year	Copper ores		Iron ores		Lead and zinc ores	
	Crude ore mined per—		Crude ore mined per—		Crude ore mined per—	
	Production worker	Man-hour	Production worker	Man-hour	Production worker	Man-hour
1946–50 (average)	101.7	101.9	99.8	100.8	107.5	107.1
1951	122.8	117.7	124.6	118.6	115.0	110.5
1952	126.9	122.9	121.3	111.7	(2)	(2)
1953	119.9	115.5	122.6	116.9	(2)	(2)
1954	114.4	118.8	99.0	105.8	(2)	(2)
1955	133.0	133.1	135.0	135.8	(2)	(2)
	Recoverable metal per—		Recoverable metal [3] per—		Recoverable metal per—	
	Production worker	Man-hour	Production worker	Man-hour	Production worker	Man-hour
1946–50 (average)	101.1	101.4	99.7	100.8	101.3	101.0
1951	121.1	116.0	118.1	112.4	112.9	108.5
1952	119.6	115.8	114.5	105.4	106.4	103.5
1953	112.2	108.2	114.2	108.9	112.1	111.1
1954	[4] 104.0	108.1	[4] 87.3	[4] 93.3	(2)	(2)
1955	120.8	120.9	120.3	121.0	(2)	(2)

1 Bureau of Labor Statistics, U. S. Department of Labor, Monthly Labor Review: February 1956, vol. 79, No. 2, and later unpublished reports.
2 Not available.
3 Figures refer to usable ore rather than recoverable metal. For iron ore, usable ore is that product with the desired iron content (by selective mining, mixture of ores, washing, jigging, concentrating, sintering, etc.) at or near the mine as part of the mining process.
4 Revised figure.

Relative Labor Costs.—Labor costs per dollar of recoverable metal, based on average hourly earnings, productivity, and prices, moved downward sharply in copper mining in 1955. This resulted from a small increase in the index of average hourly earnings and large increases in physical productivity and price during the year. This continued the downward trend in this index which began in 1952. The index of labor cost per dollar of recoverable metal for iron ore also fell in 1955, reversing the upward trend of the 1950–54 period. New data are not available for lead and zinc.

(1949=100)

	Index of average hourly earnings in mining			Index of value of recoverable metal per man-hour			Index of labor cost per dollar of recoverable metal		
	Copper	Iron ore	Lead and zinc	Copper	Iron ore	Lead and zinc	Copper	Iron ore	Lead and zinc
1949	100	100	100	100	100	100	100	100	100
1950	106	103	102	128	114	110	83	90	93
1951	113	116	113	146	132	130	77	88	87
1952	125	124	122	146	130	115	86	95	106
1953	132	145	122	160	150	92	82	97	133
1954	136	147	120	166	130	(1)	80	113	(1)
1955	144	155	128	233	171	(1)	62	91	(1)

[1] Data not available.

INCOME

National Income Originated.—After a decline in 1954, national income originated in total mining except fuels bounded back with a 22-percent gain in 1955; metal mining gained $244 million or 37 percent, an extremely large increase for a single year. Income originated in the primary metal industries also rose over 30 percent. As a result both total nonfuel-mining and primary-metal industries showed significant increases in their percentages of the total national income.

TABLE 19.—National income originated in the mineral industries in the United States, 1953–55 [1]

(Million dollars)

Industry	1953 [2]	1954 [2]	1955	Change from 1954 (percent)
All industries	302,129	298,335	324,048	+9
Metal mining	750	653	897	+37
Nonmetallic mining and quarrying	631	677	728	+8
Total mining, except fuels	1,381	1,330	1,625	+22
Total mining, including fuels	5,478	5,021	5,583	+11
Primary metal industries	9,268	7,752	10,132	+31
Stone, clays and glass products	3,109	3,096	3,677	+19
(Percent)				
All industries	100.00	100.00	100.00	
Metal mining	.25	.22	.28	
Nonmetallic mining and quarrying	.21	.23	.22	
Total mining, except fuels	.46	.45	.50	
Total mining, including fuels	1.81	1.68	1.72	
Primary metal industries	3.07	2.60	3.13	
Stone, clays and glass products	1.03	1.04	1.13	

[1] Office of Business Economics, U. S. Department of Commerce, Survey of Current Business, National Income Number: July 1956, p. 16. In arriving at national income, depletion charges are not deducted. This affects the data for the mining industries.
[2] Revised figures.

Nonemployee Income.—Nonemployee income, comprised largely of business profits before taxes (although it also contains a small amount of net interest and inventory valuation adjustments) rose 20 percent, indicating that much of the increase in income generated in mining came to rest in this category, as there was no change in net interest, and the inventory adjustment was only a minus $55 million, not large compared with total mining income. Nonemployee income in metal mining more than doubled between 1954 and 1955; that generated in the primary metal industries increased 62 percent.

TABLE 20.—Nonemployee income in the mineral industries in the United States, 1954 and 1955 [1]

	1954 [2] (million dollars)	1955 (million dollars)	Change from 1954 (percent)
All industries	91,435	100,856	+10
Mining	1,307	1,563	+20
Nonfuel mining	376	571	+52
Metal mining	154	340	+121
Nonmetallic mining and quarrying	222	231	+1
Fuels mining	931	992	+7
Manufacturing	18,553	23,964	+29
Primary metal industries	1,715	2,779	+62

[1] Office of Business Economics, U. S. Department of Commerce, Survey of Current Business: July 1956, p. 16. Nonemployee income is defined here as national income minus compensation of employees; in years in which a National Income edition is published this category is called "other."
[2] Revised figures.

Profits and Dividends.—The annual rate of profit on stockholders' equity (after corporate income taxes) in the primary nonferrous metal industries increased from a 10.4 percent quarterly average in 1954 to 15.4 percent in 1955. The 13.5-percent rate of profit in primary iron and steel also was 5 percentage points higher than in 1954; the rate in stone, clay, and glass products was 3.1 percentage points higher. The increases in each of these 3 categories exceeded the comparable increase in all manufacturing which moved from a rate of 9.9 in 1954 to 12.5 in 1955.[15]

Business Failures.—In contrast to the decline in the number of failures recorded by Dun & Bradstreet for manufacturing and for all industries, the number of failures in mining (including fuels)

TABLE 21.—Industrial and commercial failures and liabilities, 1953–55 [1]

	1953	1954	1955
Mining: [2]			
Number of failures	41	42	55
Current liabilities (thousand dollars)	3,034	8,007	5,156
Manufacturing:			
Number of failures	1,816	2,240	2,147
Current liabilities (thousand dollars)	155,820	163,277	151,789
All industrial and commercial industries:			
Number of failures	8,862	11,086	10,969
Current liabilities (thousand dollars)	394,153	462,628	449,380

[1] Bureau of the Census, U. S. Department of Commerce, Statistical Abstract of the United States, 1956; p. 503; from monthly data published in Dun's Statistical Review, Dun & Bradstreet, Inc., New York, N. Y.
[2] Including fuels.

[15] Federal Trade Commission and Securities Exchange Commission, United States Manufacturing Corporations, Quarterly Financial Report: 1st quarter, 1956.

increased in 1955. As can be seen in table 21 the liabilities involved in the failures of mining firms were much lower than in 1954 while liabilities involved in all industries were only slightly lower than in 1954.

INVESTMENT

New Plant and Equipment.—Expenditures on new plant and equipment by fuel and nonfuel mining concerns during 1955 were estimated at $957 million, $18 million lower than in 1954 and $29 million lower than in 1953. Expenditures by primary iron and steel concerns and by producers of stone, clay, and glass products each rose substantially over 1954, but expenditures by the primary nonferrous metal and the chemical and allied-products groups were lower than in 1954. Expenditures on new plant and equipment by manufacturing companies increased about 4 percent. Although 1955 annual expenditures in mining were lower than in 1954, each quarterly expenditure was higher than the preceding one, with nearly one-third of the annual total occurring in the last quarter.

McGraw-Hill, in a survey designed to estimate capital expenditures through 1959, found a 3-percent increase in capacity in iron and steel in 1954–55, a 7-percent increase in the manufacture of nonferrous metals, and a 6-percent increase in stone, clay, and glass products.[16]

TABLE 22.—Expenditures on new plant equipment in mining and selected mineral-manufacturing industries, 1953–55 [1]

(Million dollars)

Industry	1953	1954	1955	1955 January-March	1955 April-June	1955 July-September	1955 October-December
Mining [2]	986	975	957	186	235	248	288
Manufacturing	11,908	11,038	11,439	2,249	2,795	2,899	3,499
Primary iron and steel	1,210	754	863	154	211	214	283
Primary nonferrous metals	412	246	214	41	45	58	71
Stone, clay, and glass products	346	361	498	88	106	121	183
Chemicals and allied products	1,428	1,130	1,016	231	230	239	317
Petroleum and coal products	2,668	2,684	2,798	490	730	741	836

[1] U. S. Securities and Exchange Commission, Statistical Series Release 1384, June 8, 1956. It should be noted that estimates are based on companies classified on the basis of the major activity of the entire company. For example, all capital expenditures of a company engaged in both mining and manufacturing, but primarily manufacturing, would be included under manufacturing capital expenditures.
[2] Including fuels.

Mining Security Issues.—The mining industry (including fuels) accounted for 4.1 percent of all new corporate securities offered in 1955, compared with 5.7 percent in 1954 and 2.6 percent in 1953. The percentage of financing in the form of common stocks continued to be much higher for mining than for all corporate financing, rising to 50 percent in 1955, compared with 43 percent in 1953 and 33 percent in 1954. Mining corporations indicated that 47 percent of the net proceeds of its 1955 financing would be used for new plant and equipment, compared with 52 percent for all corporations reporting.

[16] McGraw-Hill Co., Department of Economics, Business Plans, 1956.

TABLE 23.—Estimated gross proceeds of new corporate securities offered for cash in the United States in 1955 [1]

Type of security	Total corporate		Manufacturing		Mining [2]	
	Million dollars	Percent	Million dollars	Percent	Million dollars	Percent
Bonds	7,420	73	2,043	68	199	48
Preferred stock	635	6	165	6	10	2
Common stock	2,185	21	786	26	206	50
Total	10,240	100	2,994	100	415	100

[1] U. S. Securities and Exchange Commission, Statistical Bulletin: Vol. 15, No. 8, August 1956, p. 4.
[2] Including fuels.

Prices of Mining Securities.—Mining-company common-stock prices (including those for fuels) continued to lag behind the increase that took place in manufacturing and in other industries. The index for mining (including fuels) rose only 15 percent compared with a 38-percent increase in the manufacturing-stock index and 33 percent in the composite index. The increase in the mine-stock index was greater than in 1953–54, but the discrepancy between the rise in the mine-stock index and in those in the manufacturing and composite indexes was also greater.

TABLE 24.—Indexes of common-stock prices, 1952–54 [1]

(1939=100)

Year	Composite [2]	Manufacturing	Mining [3]
1952	195.0	220.2	275.7
1953	193.3	220.1	240.5
1954	229.8	271.3	267.0
1955	304.6	374.4	312.9

[1] Council of Economic Advisers, Economic Indicators (prepared for the Joint Committee on the Economic Report) January 1957, p. 30. These indexes are yearly averages of the weekly closing price indexes of common stock on the New York Stock Exchange, published currently in the U. S. Securities and Exchange Commission Monthly Statistical Bulletin.
[2] Covers, in addition to mining and manufacturing, transportation, utilities, and trade, finance, and service.
[3] Including fuels.

Foreign Investments.—The book value of United States direct private investments in mining and smelting in foreign countries in 1955 increased almost 6 percent over year-end 1954. The addition of $117 million, however, was smaller than gains for both 1954 and 1953. As in 1954, over one-half of the increase occurred in Canada. Investment in petroleum in 1954–55 increased 10 percent, and investment in all industries excluding mining and smelting, and petroleum, increased 9 percent. Earnings [17] on direct private investments in foreign mining and smelting rose from $182 million in 1954 to $288 million in 1955, an increase of 58 percent. Of the $288 millions in earnings, $205 million, or 71 percent, was on investments in Canada and the Latin American Republics.

[17] Office of Business Economics, U. S. Department of Commerce, Survey of Current Business: Vol. 35, No. 8, August 1955, p. 20; vol. 36, No. 8, p. 23.

TABLE 25.—Direct private investments of the United States in foreign mining and smelting industries, 1955 [1]

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

Country	Mining and smelting				All industries			
	Book value, beginning of year [2]	Net capital movements	Undistributed earnings of subsidiaries	Book value, end of year	Book value, beginning of year [2]	Net capital movements	Undistributed earnings of subsidiaries	Book value, end of year
Canada	792	32	38	862	5,871	279	298	6,464
Latin American republics:								
Chile	407	−3	1	404	633	−2	4	636
Mexico	142	5	7	153	524	43	32	599
Peru	171	19	4	193	283	4	14	301
Total [3]	1,001	6	15	1,022	6,244	141	175	6,556
Western European countries	35	(4)	5	40	2,639	129	218	2,986
Western European dependencies	103	−1	9	110	599	−3	40	636
Union of South Africa	69	5	(4)	73	216	23	18	257
All other countries	78	2	7	88	2,057	110	119	2,286
Total, all areas	2,078	43	74	2,195	17,626	679	868	19,185

[1] Office of Business Economics, U. S. Department of Commerce, Survey of Current Business, International Investments and Earnings: Vol. 36, No. 8, August 1956, pp. 14-24. Figures may not add exactly to totals due to rounding. All figures are preliminary except those shown as revised.
[2] Revised figures.
[3] Includes other countries not shown above.
[4] Less than $500,000.

DEFENSE MOBILIZATION

Defense Production Act.[18]—From December 31, 1954, to December 31, 1955, gross transactions certified under the Defense Production Act covering all materials increased only from $8.2 billion to $8.5 billion. Of this amount certified by the Office of Defense Mobilization for the five delegate agencies—General Services Administration (GSA), United States Department of the Treasury, United States Department of Agriculture, Export-Import Bank, and Defense Minerals Exploration (Interior)—$7.6 billion in gross transactions had been consummated by these agencies, a slight decrease from the $7.7 billion total at the end of 1954. Probable ultimate net cost (estimated nonrecoverable cost to the Government of transactions covered by agreements which have, will, or may require the disbursement of funds) in the same period increased by only $19 million to $845 million. Metals and minerals accounted for $5.3 billion of the gross transactions consummated as of the end of 1955, and $750 million of the probable ultimate net cost—70 and 89 percent, respectively, of the total. The value of gross transactions and probable ultimate net cost of all programs for each mineral are ranked by order of magnitude in table 26.

[18] Joint Committee on Defense Production Activities, Fifth Annual Report: House Rept. 1669, 84th Cong., 2d sess., Jan. 25, 1956; and Office of Defense Mobilization, Executive Office of the President, Report on Borrowing Authority for the Quarter Ending Dec. 31, 1955.

TABLE 26.—Costs of mineral programs under the Defense Production Act as of Dec. 31, 1955 [1]

(Million dollars)

Gross transactions consummated			Probable ultimate net cost of transactions consummated		
Program	Amount	Percent	Program	Amount	Percent
Aluminum	1,481	19.4	Tungsten	187	22.2
Copper	799	10.5	Nickel	143	16.9
Nickel	679	8.9	Manganese	99	11.7
Titanium	431	5.6	Titanium	81	9.6
Manganese	392	5.1	Columbium-tantalum	50	5.9
Tungsten	373	4.9	Chrome	27	3.2
Tin	224	2.9	Molybdenum	21	2.5
Molybdenum	175	2.3	Aluminum	20	2.4
Magnesium	129	1.7	Magnesium	18	2.2
Columbium-tantalum	98	1.3	Mica	12	1.4
Cobalt	86	1.1	Zinc	8	.9
Mercury	46	.6	Tin	7	.8
Steel	45	.6	Lead-zinc	7	.8
Chrome	44	.6	Fluorspar	5	.5
Zinc	32	.4	Cryolite	4	.5
Mica	27	.4	Uranium	3	.4
Copper and cobalt	22	.3	Lead-zinc-copper	3	.4
Lead	21	.3	Lead	2	.2
Dolomite	20	.3	Cobalt	2	.2
Fluorspar	17	.2	Mercury	1	.2
Cryolite	16	.2	Graphite	1	.1
Lead-zinc	7	.1	Asbestos	1	.1
Asbestos	4	.1	Copper	(3)	(2)
Uranium	4	.1	Other, including administrative costs	143	16.9
Lead-zinc-copper	3	(2)	Total	845	100.0
Other, including administrative costs	2,465	32.4			
Total	7,645	100.0			

[1] Office of Defense Mobilization, Executive Office of the President, Report on Borrowing Authority for the Quarter Ending Dec. 31, 1955.
[2] Less than 0.5 percent.
[3] Program cost: $17,000.

Domestic Purchase Programs and Loans.—The progress of the domestic purchase programs for tungsten, manganese, chrome ores, mica, beryl, asbestos, and columbium-tantalum is indicated in table 27. Of the $8.5 billion in gross transactions listed on December 31, 1955, 89 percent was involved in these purchase programs, and 83 percent of the $845 million in probable ultimate net costs was in these programs.

The largest percentage increase in mineral deliveries during 1955 was in the columbium-tantalum program which more than doubled the cumulative amount on hand as of December 31, 1954. Each commodity except chrome ore increased during 1955 at least 50 percent over the previous total accumulation.

Loans under the Defense Production Act borrowing authority carried a gross transactions value at the end of 1955 of $393 million, an increase of $54 million over 1954. The probable ultimate net cost of these loans is carried on the Government books as zero. At the end of fiscal year 1955, no new loans had been made under GSA certification by either the Export-Import Bank or the Defense Lending Division of the Treasury (formerly Reconstruction Finance

Corporation). With 1 new loan guarantee of $2.5 million, the total for private bank loans guaranteed by GSA rose to $88.5 million by June 30, 1955.

TABLE 27.—Commodities delivered under United States Government domestic purchase programs, 1954, 1955 [1]

Commodity	Quantity delivered as of Dec. 31, 1954	Quantity delivered as of Dec. 31, 1955	Authorized total purchases
Tungsten concentrates .... thousand short-ton units WO_3..	1,460	2,380	3,000
Manganese ore (thousand long-ton units):			
Butte and Philipsburg depots	1,418	2,037	6,000
Deming Depot	2,213	6,183	6,000
Wenden Depot	5,821	6,108	6,000
Domestic small producers (carload program)	2,276	5,332	19,000
Chrome ores and concentrate [2] .... long tons..	77,399	101,634	200,000
Mica: Block, film, and hand-cobbed short tons hand-cobbed equivalent..	4,816	7,526	25,000
Beryl .... short tons..	557	833	1,500
Asbestos, chrysotile, nonferrous (short tons):			
Crudes No. 1 and No. 2	717	1,261	1,500
Crude No. 3 [3]	333	645	....
Columbium-tantalum ores and concentrates [4] thousand pounds combined contained pentoxides..	7,354	15,164	15,000

[1] General Services Administration, Activities Under the Defense Production Act as amended, Quarterly Report of Purchases Under Domestic Purchase Regulations, as of Dec. 31, 1954, and Dec. 31, 1955.
[2] Purchased with stockpile funds for National Strategic Stockpile.
[3] Crude No. 3 accepted on tie-in basis with other 2 grades, not figured into the quantity authorized.
[4] Mostly foreign. Figures not available for domestic only.

Mineral Research and Exploration Under the Defense Production Act.—Under GSA contracts with the Bureau of Mines the study of new processes for separating columbium (niobium) and tantalum continued during 1955 and was completed through the pilot-plant stage, and the investigation of selenium ore deposits and methods of extraction were continued. The Federal Geological Survey undertook geophysical exploration for chrome ore in Cuba under a GSA contract, and subsequent drilling resulted in the discovery of two ore deposits. Research by private concerns under GSA contracts on metallurgical manganese, titanium, nickel, and cobalt was in various stages.

Accelerated Tax Amortizations.—A review of the mineral segment of the accelerated tax-amortization program is presented in table 28. The increase in the number of certificates involving nonfuel minerals was small in 1953–55 compared with the first 2 years of the program. In 1955 only 25 new certificates were added (out of a total of 1,847 for all industries) representing a value of new facilities certified of $95.4 million. Of the 25, 21 were for metals, 4 for nonmetallic minerals. The percent of certified facilities reported in place as of December 31, 1955, was 74 percent for the metals, 92 percent for the nonfuel nonmetallics.

Defense Minerals Exploration Administration.—Government assistance in the form of encouragement of private exploration for new sources of strategic materials was continued. Through 1955, 220 certifications of discovery or development had been issued by DMEA, 51 of them during 1955. Certifications on projects in 15 States were made on cobalt-nickel, fluorspar, iron ore, lead-zinc-copper, manganese, mercury, mica, thorium, tungsten, and uranium. A total of 216 contract projects were in force December 31, 1955. The Govern-

TABLE 28.—Certificates of necessity on facilities for the production of metals and minerals and reported progress through Dec. 31, 1955 [1]

Commodity	Total number of certificates as of Dec. 31—					Total reported value of facilities certified as of Dec. 31 [2]— (thousand dollars)					Reported value in place as of Dec. 31, 1955 [3] (thousand dollars)			
	1951	1952	1953	1954	1955	1951	1952	1953	1954	1955	Total	Completed	In progress	Percent reported in place Dec. 31, 1955
Major metallic ores and materials:														
Alumina	10	10	10	12	12	130,383	130,383	130,383	132,491	132,491	132,491	132,491	----	100
Aluminum	26	33	35	36	37	514,987	647,431	713,137	713,587	745,119	674,366	598,569	75,797	91
Bauxite	5	8	8	8	8	26,788	30,041	30,041	30,041	30,041	30,025	28,272	1,753	100
Cobalt and nickel	1	6	7	8	8	10,166	35,523	35,634	90,884	90,884	32,609	10,899	21,710	36
Copper	13	25	27	27	30	97,333	201,411	202,445	202,445	220,025	181,798	122,330	59,468	83
Iron, including taconite	61	129	138	140	145	456,878	1,193,720	1,229,839	1,230,998	1,238,524	762,780	318,484	444,296	62
Lead and zinc	38	48	48	49	50	50,975	57,795	57,795	57,814	63,314	54,384	45,784	8,600	86
Manganese	2	9	9	9	9	4,258	18,756	18,756	18,756	18,756	19,127	15,052	4,075	102
Molybdenum	2	3	3	3	3	15,098	22,994	22,994	22,994	22,994	22,994	22,994	----	100
Titanium	3	5	6	11	14	17,510	29,982	55,782	104,610	117,779	77,163	14,151	63,012	66
Uranium	4	6	7	9	15	6,863	7,117	8,242	17,966	34,364	26,757	11,778	14,979	78
Other metallic ores and materials:														
Antimony	----	1	1	1	1	----	194	194	194	194	194	194	----	100
Cadmium	2	2	2	2	2	276	276	276	276	276	276	276	----	100
Columbium-tantalum	----	1	1	3	3	----	485	485	3,685	3,685	3,685	3,685	----	100
Germanium	----	1	1	1	1	----	110	110	110	110	110	110	----	100
Magnesium	8	8	8	8	8	7,024	7,024	7,024	7,024	7,024	7,024	7,024	----	100
Mercury	----	----	----	----	1	----	----	----	----	302	302	302	----	100
Platinum	1	1	1	1	1	28	28	28	28	28	28	28	----	100
Rare earths	1	2	2	2	3	160	815	815	815	4,219	1,108	655	453	26
Selenium	----	1	1	2	2	----	26	26	101	101	101	101	----	100
Silicon	2	2	2	2	2	3,306	3,306	3,306	3,306	3,306	3,306	3,306	----	100
Tungsten	5	9	15	17	17	1,976	3,963	5,751	5,960	5,960	5,960	5,960	----	100
Zirconium	----	2	2	3	3	----	3,180	3,180	3,244	3,244	3,244	3,244	----	100
Total metallic	184	312	334	354	375	1,344,009	2,394,560	2,526,243	2,647,329	2,742,740	2,039,832	1,345,689	694,143	74
Major nonmetallic ores and materials:														
Lime, limestone, and dolomite	26	42	44	44	44	20,228	30,476	48,697	48,697	48,697	44,722	29,072	15,650	92
Phosphate rock	----	5	6	6	6	----	10,720	11,621	11,621	11,621	11,568	5,786	5,782	100
Refractory magnesias	6	9	10	10	10	18,923	19,414	19,691	19,691	19,691	14,611	14,611	----	74
Soda ash	1	1	1	1	1	16,200	16,200	16,200	16,200	16,200	16,200	16,200	----	100
Sulfur [4]	3	6	6	6	6	6,915	22,342	22,342	22,342	22,342	20,492	20,492	----	92

Other nonmetallic ores and materials:														
Arsenic	1	1	1	1	1	465	465	465	465	465	465	465		100
Barite		3	6	6	6		1,000	2,271	2,271	2,271	2,200	2,200		97
Borates	1	1	1	1	1	1,966	1,966	1,966	1,966	1,966	1,966	1,966		100
Bromine	1	7	7	7	7	122	5,061	5,061	5,061	5,061	5,061	5,061		100
Cryolite	4	7	8	9	9	2,039	2,628	5,128	5,293	5,293	5,248	5,128	120	99
Diamond recovery			1	1	1			48	48	48	48	48		100
Diatomite		3	3	3	3		6,355	6,355	6,355	6,355	6,355	6,355		100
Fluorspar and fluorides	2	8	9	9	9	555	2,990	4,282	4,282	4,282	4,282	4,282		100
Garnet	1	1	1	1	1	299	299	299	299	299	299	299		100
Gypsum		1	1	1	1		158	158	158	158	158	158		100
Lithium		4	4	4	4		1,270	1,270	1,270	1,270	1,270	1,270		100
Mica	2	2	2	2	3	526	526	526	526	1,462	1,462	1,462		100
Mullite	1	1	1	1	1	47	47	47	47	47	47	47		100
Quartz crystal	2	5	5	5	5	443	632	632	632	632	632	632		100
Refractory clay	1	1	1	1	1	1,213	1,213	1,213	1,213	1,213	1,213	1,213		100
Rutile and monazite	2	4	4	4	7	318	712	712	712	2,182	1,708	819	889	78
Salt		1	1	1	1		451	451	451	451	451	451		100
Sand	1	2	2	2	2	393	805	805	805	805	805	805		100
Total nonmetallic	55	115	125	126	130	70,652	125,730	150,240	150,405	152,811	141,263	118,822	22,441	92
Total metallic and nonmetallic	239	427	459	480	505	1,414,661	2,520,290	2,676,483	2,797,734	2,895,551	2,181,095	1,464,511	716,584	75

[1] Source: Unpublished records of Emergency Procurement Service, General Services Administration, BDSA, U. S. Department of Commerce, Office of Defense Mobilization, and Reports of Progress (BDSAF-1) through Dec. 31, 1955, where available.

[2] The final costs estimated on BDSAF Report of Progress forms, where available; otherwise, value is amount originally certified.

[3] Latest available BDSAF-1 report which for some facilities covered the period through Dec. 31, 1955. Some were not so recent.

[4] Mined only.

ment's share of the exploration program, as of December 31, 1955, was $24.4 million out of a total contracted amount of $39.8 million, or approximately 60 percent. Comparable amounts as of the end of 1954 were $20.9 and $34.5 million, respectively, with the Government percentage the same as in 1955.

National Strategic Stockpile Program.[19]—As of December 31, 1955, stockpile objectives were valued at $11.2 billion, consisting of $6.9 billion in minimum objectives and long-term objectives of $4.3 billion, all of the latter associated with metals and minerals. Of the short-term objective total of $6.9 billion, $5.5 billion was in inventory and on order, with $1.4 billion to be acquired; of the long-term objective, $1.3 billion was in inventory and on order, with $3.0 billion yet to be acquired.

The principal metals involved in 1955 minimum objective stockpiling were cobalt, nickel, and Metallurgical-grade chromite. Under the long-term objective the principal stockpile items were tin, aluminum, tungsten, metallurgical manganese, lead, and zinc. All tin came from the Texas City smelter, and the lead and zinc purchases continued to be made to support the domestic component of the mobilization base. The largest quantities of materials stockpiled came from stockpile purchases in the open market. The following metals had stockpiled inventories at the end of 1955 which covered the minimum objective:

Abrasives, Crude Aluminum Oxide.
Aluminum.
Asbestos, Chrysotile.
Asbestos, Crocidolite.
Bauxite, Metal Grade, Surinam type.
Cadmium.
Columbite.
Diamonds, Industrial.
Lead.
Manganese, Battery Grade.
Manganese Ore, Metallurgical.
Mica, Muscovite Splittings.
Quartz Crystals.
Fluorspar, Acid Grade.
Graphite, Madagascar—Crystalline Fines.
Graphite, Madagascar—Crystalline Flake.
Graphite, Other than Ceylon and Madagascar—Crystalline.
Rare Earths.
Tantalite.
Tin.
Tungsten.
Vanadium.
Zinc.

The long-term objective was achieved in 1955 for the three asbestos grades, graphite (Madagascar—Crystalline Flake), graphite (Other than Ceylon and Madagascar—Crystalline), Rare Earths, Tantalite, and Vanadium.

Surplus agricultural commodities were bartered for the delivery of minerals valued at about $200 million during the year. Title III of the Agricultural Trade Development and Assistance Act of 1954 expands and extends the authority of the Commodity Credit Corporation to barter its holdings if the materials obtained can be used

[19] Office of Defense Mobilization, Executive Office of the President, Stockpile Reports to the Congress: January–June 1955, and July–December 1955.

to fill minimum and long-term objectives without weakening the domestic mobilization base. Title I of the act authorizes the exchange of surpluses with other nations for foreign currencies for several purposes including the purchase of strategic materials. Materials acquired under this authority are to be placed in a "supplemental stockpile," which is additional to the minimum and long-term objectives. By the end of 1955 no materials had been purchased for the supplemental stockpile under Title I.

Office of Minerals Mobilization.—Effective November 12, 1954, the Office of Defense Mobilization, in Defense Mobilization Order I-7 Amendment (Revised), delegated to the U. S. Department of the Interior:

"The functions conferred upon the Director of the Office of Defense Mobilization by section 304 of Executive Order 10480 relative to the encouragement of exploration, development and mining of strategic and critical metals and minerals * * *"

Defense Mobilization Order I-13 of the same date outlining the Department of the Interior responsibilities is reprinted below:

I-Gen-DMO-13
November 12, 1954

EXECUTIVE OFFICE OF THE PRESIDENT

OFFICE OF DEFENSE MOBILIZATION

Defense Mobilization Order-I-13

SUBJECT: ASSIGNMENT OF DEFENSE MOBILIZATION RESPONSIBILITIES TO THE U. S. DEPARTMENT OF THE INTERIOR

By virtue of the authority vested in me pursuant to the National Security Act of 1947, as amended; Reorganization Plan No. 3 effective June 12, 1953; the Defense Production Act of 1950, as amended; Executive Order 10480 of August 15, 1953, as amended; the Strategic and Critical Materials Stock-Piling Act of 1946, as amended; and in order to facilitate the coordination of Federal policies and programs for current defense activities and readiness for any future mobilization, it is hereby ordered:

1. The Secretary of the Interior will be responsible for the development of preparedness measures relating to those industries assigned to him by and pursuant to Executive Order 10480 as amended and DMO-I-7 and DMO-VII-5. These industries include: (1) solid fuels; (2) petroleum and gas, including pipelines; (3) electric power; (4) metals and minerals for assigned aspects of production and processing, listed in Appendix A to DMO-VII-5, as amended, and for the encouragement of exploration, development and mining; and (5) fisheries' commodities or products as assigned by the Secretary of Agriculture. Such preparedness measures should be undertaken within a work program which is consistent with the Defense Mobilization Assumptions and Objectives for the Government as a whole. To assure such consistency, the work program will be submitted to the Director of the Office of Defense Mobilization for review.

2. The Secretary of the Interior shall:

a. (1) Exercise as required, the priorities and allocations authority assigned to him by and pursuant to Executive Order 10480; (2) when designated, serve as allotting agency under the Defense Materials System; and (3) advise with respect to orders, regulations and directives as they may affect industries assigned to him.

b. Develop, assemble and evaluate data as to the productive capacity and supplies of products, including both domestic and foreign sources, of the assigned industries under partial and full mobilization conditions.

c. Recommend establishment or modification of expansion goals and develop and recommend expansion programs, including advice regarding probable financial incentives and aids, for overcoming shortages of capacity or supply under partial or full mobilization conditions.

d. Analyze the problems involved in maintaining an adequate mobilization base and recommend necessary programs.

e. Develop, assemble and evaluate data as to materials, equipment, transportation, and other requirements of such assigned industries under partial and full mobilization conditions.

f. Assemble, as requested by the Office of Defense Mobilization, data on requirements for the products of the assigned industries as presented by or obtained on behalf of other agencies of the Federal Government.

g. Develop programs for the encouragement of the exploration, development and mining of critical and strategic minerals and metals, and administer exploration programs including programs of development relating thereto.

h. Screen and make recommendations on requests for tax amortization, loans, guarantees and procurement contracts for the assigned industries.

i. Develop and maintain programs, including the necessary orders and regulations, for the operation of the assigned industries under partial and full mobilization conditions, and cooperate with the Office of Defense Mobilization and other appropriate agencies in planning other production and distribution controls related thereto.

j. Provide guidance and leadership to assigned industries in the development of plans and programs to insure the continuity of essential production in event of attack, and cooperate with the Department of Commerce in the identification and rating of essential facilities.

k. Assist the Office of Defense Mobilization in formulating plans for the stockpiling of strategic and critical materials and, to the extent necessary, in the acquisition of such materials and the expansion of domestic sources of supply.

l. Develop and maintain plans to insure the continuity of the essential functions of the Department in event of an attack on the United States.

3. The work program to be undertaken by the Department of the Interior shall indicate the priority and scope of the work to be carried on in each of the areas enumerated above and the industries to be covered. Reports on progress shall be submitted as requested by the Office of Defense Mobilization.

4. This Order is intended to state the responsibilities of the Department of the Interior and does not affect any delegation of authority heretofore conferred upon the Secretary of the Interior.

5. This Order shall take effect on November 12, 1954.

OFFICE OF DEFENSE MOBILIZATION,
Arthur S. Flemming,
Director

To carry out the Department's functions in the mobilization area, on January 6, 1955, Secretary of the Interior Douglas McKay established the Office of Minerals Mobilization. Funds were appropriated to this office, and operations began July 1, 1955.

With the assistance of the Bureau of Mines and the Geological Survey, comprehensive mobilization base evaluations were made for antimony, lead, manganese, selenium, and zinc, with recommendations for establishing and maintaining adequate national defense supply positions for those metals. At the request of ODM, appraisals were made of the effect on these bases and supply positions of such factors as technological developments and changes in tariff rates. Expansion-goal studies were completed on 27 of the critical minerals.

Atomic Energy Commission.[20]—The Atoms-for-Peace program made considerable progress during 1955 as 27 nations entered agreements with the United States to develop civil uses of atomic energy. President Eisenhower authorized 100 kilograms of uranium–235, in addition to the 100 kilograms set aside in late 1954, to supply the fuel needed for research reactors under the agreements. Libraries of unclassified technical material published by the Atomic Energy Commission were presented to 23 other nations.

---

[20] U. S. Atomic Energy Commission, Semiannual Reports: July 1955 and January 1956.

The International Conference on the Peaceful Uses of Atomic Energy, in Geneva, August 8–20, 1955, brought together scientists and engineers of 73 nations. To handle the AEC's part in the Atoms-for-Peace program and other measures of international cooperation, a new Division of International Affairs was created.

Domestic production of uranium ore and concentrate reached record levels during 1955—July through December production reached 1,600 tons of U_3O_8—as it became a larger and more significant component of nonferrous metal mining, both from the standpoint of value of product and employment. Foreign production also continued to increase, and the construction of new ore-processing facilities in Union of South Africa and in Canada promised greater foreign production in the immediate future.

WORLD REVIEW

World Production.—Of the 45 principal metals and minerals total world production of only 2 decreased in 1955. This contrasts with 1953–54 when a third of them decreased. Corundum and arsenic production declined 20 and 10 percent, respectively, in 1954–55. World production of graphite, beryllium concentrates, iron ore, and rutile increased over 20 percent. Increases exceeding 10 percent occurred in the production of 20 of the 45 commodities, indicating an outstanding year for the world mineral-producing economy. The United Nations index of world mine production which includes fuels [21] was 9 percent above 1954.

Indexes of production of mining and quarrying in selected European countries showed a sizable gain in 1955 after only a slight increase

TABLE 29.—Index numbers of production in mining and quarrying and production in basic metal industries in selected OEEC countries, 1950–55 [1]

(1953=100)

Year	All member countries	Austria	Belgium-Luxembourg	France	Germany, West	Greece	Italy	Netherlands	Norway	Sweden	Turkey	United Kingdom
					MINING AND QUARRYING							
1950	87	74	91	87	81	22	69	98	70	81	69	96
1951	94	88	99	94	91	41	75	100	77	89	77	99
1952	98	93	101	103	97	58	88	100	88	99	83	100
1953	100	100	100	100	100	100	100	100	100	100	100	100
1954	101	109	96	104	104	123	104	100	100	90	88	101
1955	105	116	100	112	110	132	127	101	107	102	97	99
					BASIC METAL INDUSTRIES							
1950	84	68	88	93	79	42	71	73	84	80	------	94
1951	98	81	114	107	94	74	91	83	92	90	------	100
1952	104	91	111	112	105	90	101	81	97	102	------	103
1953	100	100	100	100	100	100	100	100	100	100	------	100
1954	112	119	108	109	116	103	116	117	104	106	------	108
1955	130	140	125	128	141	98	143	132	125	122	------	117

[1] Organization for European Economic Cooperation, Several Statistics: No. 2, November 1956, pp. 10, 14.

[21] United Nations Statistical Office, Monthly Bulletin of Statistics: Vol. 10, No. 10, October 1956, p. vi.

during the 3 years 1952–54. The total index gain for all OEEC countries was 4 percent for 1954–55. Largest gains occurred in Greece, Italy, Norway, Sweden, and Turkey, with the United Kingdom showing a 2-percent decrease. The index for basic metal industries gained 16 percent for all OEEC countries. Gains were large in France, West Germany, Italy, the Netherlands, and Norway. Only the indexes for Greece and Sweden decreased from 1954.

World Prices. The index of annual average prices of commodities of mineral origin exchanged in international trade increased 6 percent.[22] The 1955 price experience for mineral-origin commodities compares with a 3-percent decrease for all commodities in world trade.

[22] United Nations Statistical Office, Monthly Bulletin of Statistics: Vol. 10, October 1956, p. vii.

Review of Metallurgical Technology

By Oliver C. Ralston [1] and Earl T. Hayes [2]

THE 400th Anniversary of the death of Georgius Agricola at the age of 61 occurred on November 21 of this year. At the time of his death textbooks on mining and metallurgy had not been published because printing had not been developed. Agricola's book, De Re Metallica, written in Latin, occupied 20 years of his life and was printed only 40 years after the Gutenberg Bible. Herbert Hoover, with the help of his wife, Lou Henry, translated this first complete review on mining and metallurgy into English and thereby honored himself and Agricola. Now we have many annual reviews by well-known authors and obscure writers, followers of the renowned citizen of Saxony, and today publication in English is more universal than Latin was in 1555.

An outstanding event affecting metallurgy was the International Conference on Peaceful Uses of Atomic Energy, at Geneva, Switzerland, August 8–20, 1955. This event accelerated declassification of thousands of technical reports by the Atomic Energy Commission. Not only has the information become available on the most modern metallurgy of uranium, thorium, plutonium, americium, and other actinides, but also of the lanthanides or rare earths, which are important in the ashes of fission of the actinides. This torrent of technical literature has included details on the most advanced uses of separative processes like ion exchange, chromatography, liquid-liquid or solvent extraction, resin-in-pulp or char-in-pulp, thermal diffusion, and many others. It will require years to assimilate this information and convert it into the common tools of extractive and physical metallurgy.

MINERAL DRESSING

The growing importance of studies of air and stream pollution has demanded further improvement of the methods of measuring amounts[3] and sizes and shapes of suspended particles. Lincoln T. Work [3] reviewed this special aspect of the subject.

Grinding and size reduction are always under active discussion and development. Fahrenwald [4] and Zannaras [5] discuss the widely discussed ball mill at Copper Hill, Tenn. One of the outstanding big machines of the year was a gyratory crusher built by Allis Chalmers for the taconite crushing plant at Babbitt, Minn., weighing about 1,250,000 pounds and crushing 3,500 tons of coarse taconite per hour.

[1] Chief metallurgist.
[2] Assistant chief metallurgist.
[3] Work, Lincoln T., Size Reduction: Ind. Eng. Chem., vol. 48, March 1956, pp. 556–559.
[4] Fahrenwald, A. W., Discussion: Eng. Min. Jour., vol. 155, 1954, p. 79.
[5] Zannaras, J. P., Discussion: Eng. Min. Jour., vol. 156, 1955, pp. 100, 115.

Impact crushers have received attention and discussion in the United States, Canada, and Germany. However, for general primary crushing they have failed, but for brittle materials, cemented ore, or ore of good cleavage they are good, says James W. Franklin.[6] Autogenous grinding, as in the Aero-fall mill, was reviewed by Franklin and showed very low liner wear. However, such grinding is efficient for self-grinding only of certain ores with definite characteristics, not well explained.

Classification of ground mineral material has been advanced mainly in the centrifugal fields of cyclones, in liquid or in gas suspension. Wet cyclones as classifiers are stated by Lincoln T. Work[7] to be of value mainly in the 150 to 5 micron range. They may also be used for thickening if same loss of extreme fines is not significant, say Tangel and Brison.[8]

Losses of extremely fine sizes of solids in fluid suspension, particularly from the pollution standpoint, can be of practical, though not economic, importance. Use of electrostatic fume precipitators for ultraclarification is discussed by H. J. White[9] and by W. T. Sproull[10] the latter in two-stage apparatus. However, for radioactive dusts at the Hanford, Wash., plant of Atomic Energy Commission glass-fiber filters have been used to assure proper functioning a greater fraction of the time, say A. G. Blasewitz and B. F. Judson.[11]

Ultrafine particles in aqueous suspensions usually cause trouble or expense in their flocculation, sedimentation, and filtration. There was considerable activity during the year in testing the numerous polyelectrolytes offered by the trade for this purpose, after considerable success of several flocculants in uranium ore settling before classification. On some of the uranium ores being leached, the colloidal slimes cause so much trouble that prior calcination to a suitable temperature to destroy their colloidal character has been necessary. Considerable saving in investment on thickeners and filters by the use of these new flocculants alone, or in combination with the older usual flocculants, like lime or alum, has been proved.

Single-phase flow of fluids is a well-developed subject; but multiphase flow, such as fluidized solids, moving beds, gas streams carrying dusts, etc., is very adequately discussed in a special review of the subject by Murray Weintraub of the Bureau of Mines.[12]

Concentration of uranium ores by all of the various mechanical separation processes has been in varied use for some years, but the Geneva Convention released reports in detail. However, hydrometallurgy usually has made such a high extraction of uranium in comparison with mechanical concentration that only an occasional ore is treated. Where the low uranium content of an ore will not justify its shipment to the nearest leaching plant, some concentration of otherwise valueless material is practiced.

Flotation processes continue to occupy much of the millman's literature. Nathaniel Arbiter[13] of Columbia University reviewed flotation practice.

---

6 Franklin, James W., Ore Dressing: Eng. Min. Jour., vol. 157, February 1956, pp. 133-136.
7 Work cited in footnote 3.
8 Tangel, O. F., and Brison, R. J., Wet Cyclones: Chem. Eng., vol. 62, No. 6, 1955, pp. 234-238.
9 White, H. J., Electrical Precipitation: Ind. Eng. Chem., vol. 47, 1955, pp. 932-939.
10 Sproull, W. T., Collecting High-Resistivity Dusts and Fumes: Ind. Eng. Chem., vol. 47, 1955, pp. 940-944.
11 Blasewitz, A. G., and Judson, B. F., Filtration of Radioactive Aerosols by Glass Fibers: Chem. Eng. Prog., vol. 51, January 1955, pp. 6J-11J.
12 Weintraub, Murray, Flow of Fluids: Ind. Eng. Chem., vol. 48, March 1956, pp. 532-539.
13 Arbiter, Nathaniel, Flotation: Ind. Eng. Chem., vol. 48, March 1956, pp. 527-531.

The iron ranges concentrated more ore than ever during 1955; their concentrate, as well as imported ores, made it more difficult for producers of high-silica ore to market their product. The use of dense-medium concentrators increased, and cyclones carried more of the burden than ever. The later found wider use in classifying fine material from coarse and were replacing hydroseparators on account of the much less vertical clearance required and the excellence of their separations. Ni-hard linings for the cyclones were almost universal. Humphrey spirals found wider use as gravity concentrators. Flotation has been none too popular, but seems headed for increasing use on fines. Magnetic separation continued to be employed for both coarse and fine feeds. For ores containing little magnetite, difficulties in cyclones were mitigated by putting a magnetic separator ahead of the cyclones.

The old concentrating table was improved. An all-aluminum lightweight deck at Nichols, Fla., with aluminum riffles, is detachable and can be quickly removed, thrown away, and replaced with a new top, thus saving time for repairs or reriffling, says James W. Franklin.[14]

PYROMETALLURGY

In producing high-purity titanium it was thought that presence of a certain amount of hydrogen in the finished metal had little importance. However, during the year a real "hydrogen scare" shook the confidence of many users. Those producers who melted the final metal under argon or helium suffered the most from rejects of brittle, unsuitable metal, and finally virtually everyone included at least one melting stage in vacuum to extract the offending hydrogen as the last step in producing pure metal. The effects of the scare had not been entirely overcome by the end of the year.

In the iron and steel industry there was growing scarcity of suitable scrap for the open-hearth furnaces. More electric furnaces were also coming into use and competing for the best grades of scrap. The continued dearth of smelting stock and the rise in price of scrap brought about serious investigation of processes for reducing iron ores directly to metal by medium-temperature treatment with reducing gases or powdered fuels. Products from iron powder made directly from iron oxide powder through spongy iron to nodules, balls, lumps, etc., in the higher temperature ranges were investigated, and the literature covering some hundreds of direct processes, was followed with interest. Promoters of "sponge-iron" processes began their activities about one generation early. Gaseous reduction methods for producing sponge received more attention in 1955 because of its success in removing sulfur. Expiration of many basic patents provided an opportunity to use and improve their processes.

HYDROMETALLURGY

The declassification of information on uranium extraction has brought a flood of papers on leaching processes. The sulfuric-acid leach of oxidized minerals of uranium has been in wide use in South Africa, United States, Canada, Australia, and the Belgian Congo. Moreover, the sodium carbonate-bicarbonate solution as a leaching

[14] Work cited in footnote 6.

agent for the more limy uranium ores has been in considerable use. Where the leaching solutions are too dilute to permit good recovery by chemical precipitation, the use of ion exchange, or liquid extraction, permits discard of the main body of leach solution, then the exchanger or liquid is regenerated with small quantities of strong solutions of appropriate regenerating materials to give an enriched solution of uranium. It is understood that only a small fraction of the available declassified information has as yet been digested in the various publications.

The pressure-leaching plant at Fort Saskatchewan was brought up to full-rated capacity by Sherritt-Gordon, and nickel and most of the copper were being sold. A cobalt semifinished product was accumulated. Research at the cobalt pressure plant at Salt Lake City (Calera Mining Co.) was working out its difficulties, and the plant will probably be pronounced in acceptable though not fully satisfactory operating condition soon.

PHYSICAL METALLURGY

This was the year that vacuum melting came of age. The American industry had a capacity of 4,000 tons of specialty metal per year by the end of 1955 but was growing at such a rapid rate that exact production figures could not be obtained at the year end. In Europe the Bochumer Verein plant at Bochum, Germany, had cast over 10,000 tons of metal, including a half-dozen heats of 150 tons each. Although the shift to vacuum melting in titanium metallurgy was occasioned by the demand for lower hydrogen contents, the consumable-electrode process showed promise in the specialty steel trade. Vacuum melting followed three forms: In the first, the consumable-electrode process developed for the titanium and zirconium industries, the material is melted into ingots as large as 20 to 24 inches in diameter. In the second method of melting, involving the more conventional induction melting in vacuum, Vacuum Metals Corp. of Syracuse, N. Y., produced ingots up to 1 ton. The third method of lowering the gaseous content of molten metal used by Bochumer Verein consisted of outgassing the metal at about 2 mm. vacuum at either the ladle pouring stage, or degassing in the ladle followed by conventional atmosphere casting.

Between Air Force and industrial backing the year saw many new extrusion and forging presses put into operation. Aluminum Company of America installed a 50,000-ton and a 35,000-ton forging press at Cleveland, and similar units were put into operation at the Wyman-Gordon Co., while several 8,000- to 12-000-ton extrusion presses were installed by Kaiser, Harvey Machine, and Curtiss-Wright. These presses were primarily for forming and shaping aluminum.

Magnesium became available in widths up to 72 inches compared with the previous maximum of 48 inches. Titanium also became available in continuous, 36-inch-wide, cold-rolled coils.

A magnesium-base-thorium-zirconium alloy promised to retain good mechanical properties in the range 400°–700° F.

Following a pattern reminiscent of the early days of aluminum metallurgy, it was discovered that titanium could be welded successfully. Numerous studies were made to determine the effect of gas contaminants, resulting alloy structures, and comparisons of filler versus nonfiller welds. By the end of 1955 titanium metal and several alloys as well could be welded successfully.

Shell molding continued to gain in favor as a standard foundry procedure, and over 400 foundries in the United States, including the four largest, were using shell molding as one of their standard procedures. So successful has shell molding become that one major automobile manufacturer switched from forged crankshafts to those cast by the shell-molding procedure.

Of great interest was declassification of the Reactor Handbook.[15] This handbook discusses all metals, alloys, and ceramics used in reactors and covers such diverse fields as physical and mechanical properties, corrosion behavior, physical and chemical constants, health hazards, and specific nuclear properties.

Standard ultrasonic testing equipment was used to determine the position of voids and porosity in zirconium ingots from 4 to 12 inches in diameter.[16] Another important contribution to the zirconium picture was the publication of a book, The Metallurgy of Zirconium.[17] This book covered all details of zirconium from the source of the ore through its extraction and refining to production and use of the finished metal and its alloys.

For the first time complete physical properties of hafnium metal were described.[18] The metal is exceedingly sensitive to small additions of oxygen, but when metal of comparable atomic oxygen percent additions is compared with zirconium and titanium the properties are not vastly different. The recrystallization temperature of hafnium is about 200° higher than that of zirconium or titanium.

The metallurgy of arc-cast ductile molybdenum in ingots up to 1,000 pounds each was discussed fully in a series of articles by Deuble.[19] Forging and rolling of these ingots was carried out in the temperature range of 1,150°–1,300° C., while extrusions required temperatures of 1,400° C.

Machining by electric spark continued to be a subject of considerable study both here and abroad. The Germans and Russians published numerous papers on types of electrodes used, rate of machining, surface finish produced, and other variables of the process.

---

[15] U. S. Atomic Energy Commission, The Reactor Handbook: Vol. 3, sec. 1, 1955, p. 610.

[16] Wood, F. W., and Borg, J. O., Ultrasonic Inspection of Zirconium and Its Alloys: Bureau of Mines Rept. of Investigation, 5126, 1955, 8 pp.

[17] Lustman, B., and Kerze, F., Metallurgy of Zirconium: McGraw-Hill Book Co., New York, 1955, p. 776.

[18] Goodwin, J. G., and Hurford, W. J., Jour. Metals, vol. 1, 1955, pp. 1162–1168.

[19] Deuble, N. L., Large Molybdenum Ingots by Arc Casting: Metal Progress, vol. 67, No. 4, 1955, pp. 87–90; Arc-Cast-Molybdenum-Ingot to Bar, Sheet, or Wire: Metal Progress, vol. 67, No. 5, 1955, pp. 89–92; Arc-Cast-Molybdenum-Fabrication Parts: Metal Progress, vol. 67, No. 6, 1955, pp. 100–105; Applications of Arc-Cast Molybdenum: Metal Progress, vol. 68, No. 2, 1955, pp. 77–89.

Review of Mining Technology

By Paul T. Allsman,[1] James E. Hill,[2] and Walter E. Lewis[3]

THIS CHAPTER reviews the highlights on the development of mining technology during 1955 and presents a special report on the theory and application of rock bolting to mining. Improvements in mining technology usually cannot be assigned to a single year. However, in reviewing the published literature over the period, certain developments seem to stand out as more significant than others; among these is rock bolting. Although the use of rock bolts has been expanding for some years, new concepts of the engineering and scientific principles related to the practice became better known, and improvements will continue. It might be said that rock bolting reached maturity in 1955, and special recognition of this fact seems appropriate here.

SPECIAL REPORT ON ROCK BOLTING

New applications for rock bolting were reported in 1955.[4] Mine support by rock bolting, especially in coal mines, has gained favor year by year. There are no accurate statistics on the growth of the use of rock bolting in metal or nonmetal mines; however, the Division of Health and Safety, Bureau of Mines, collects data that are useful in estimating trends in rock bolting in coal mines through coal mine inspectors' reports.[5] These reports indicate that in 1955 a total of 430 coal mines used rock bolts, and the number of bolts installed per month was 3 million, which is an increase of 1 million a month over 1954. Fourteen percent of the coal mines used slotted-type bolts, 71 percent used expansion shells, and the remaining 15 percent used some of each type.

Despite the fact that no statistics are available on the growth of rock bolting in metal or nonmetal deposits, the use of bolts in these types of deposits is known to be large and constantly increasing. Although Bureau of Mines research on rock bolting has been confined to bedded deposits, the theoretical data developed in this research are also applicable to nonbedded deposits.

Early in 1947 the Bureau of Mines became interested in adapting bolting of the roof to coal mining.[6] A report published in September

---

[1] Chief mining engineer.
[2] Assistant chief mining engineer.
[3] Mining engineer, Bureau of Mines.
[4] Sall, George W., Mining at Powhatan No. 1; Min. Cong. Jour., vol. 41, No. 3, March 1955, pp. 27-32. Kirk, Nathaniel, Roof Bolting Reduces Accidents and Costs: Min. Cong. Jour., vol. 41, No. 12, December 1955, pp. 38-40.
[5] Thomas, Edward, Summary of Coal-Mine Inspectors' Reports on Roof Bolting for Calendar Year 1955: Bureau of Mines, unpub. rept., January 1956.
[6] Thomas, E., Seeling, C. H., Prez, F., and Hansen, M. V., Control of Roof and Prevention of Accidents from Falls of Rock and Coal: Bureau of Mines Inf. Circ. 7471, 1948, pp. 8-9.

1947 discussed the general aspects of roof support by rock bolting.[7] At that time is was recognized that the use of suspension roof supports was not new. The St. Joseph Lead Co., operating in southeast Missouri, apparently was the first large mining company to prove the practicability of the principle by applying it systematically for securing a roof over 20 years earlier. Rock bolts have been installed largely by methods determined by experimentation previous to their wider use throughout the mine. Very little investigative work has been done by which mathematical formulas could be applied to determine beforehand the spacing of bolts, the effective angle of installation, the best anchoring device, or the best diameters of drill holes and rods.

To test stratified mine-roof structures accurately under laboratory conditions, an improved centrifugal-testing apparatus was designed and built in the Bureau of Mines laboratory at College Park, Md.[8] As designed, the centrifugal-testing apparatus provides a means of simulating gravity loading in a model. By employing strain gages the state of strain in the model can be determined for all loads up to failure, as well as the actual distribution of stress and whether the loaded model behaved as a beam with rigidly fixed ends or as some other type of beam.

As the apparatus was found suitable for testing, in that the stress distribution produced in the simple beam models agreed with theory, it was decided to test models of bolted mine roof. In effect, the research was directed toward developing a scientific method of designing safe and efficient rock-bolting systems for a mine roof based on the physical and mechanical properties and the observable structure and sequence of the mine-roof strata. As this research proceeded in the laboratory, basic research in rock bolting in underground mines continued. Under a cooperative agreement with the Youngstown Mines Corp., the facilities of the Dehue mine, Dehue, W. Va. were made available to the Bureau for investigations relating to all phases of rock bolting. Four reports had been published on this mine research by the end of 1955.[9]

Experience and tests soon demonstrated that in bolting to insure good roof control the rock bolts should be installed immediately after the exposure of new roof, and they should be preloaded enough to minimize sag of the roof over the opening. The problem of measuring the preloading stress on a bolt was partly solved by using a commercial-type torque wrench. Tests on slotted-type roof bolts conventionally installed indicated that a torque of 260 foot-pounds applied to the nut will produce a load of 10,000 plus or minus 2,700 pounds on the bolt. In spite of errors introduced by frictional effects in the nut-bolt-bearing-plate assembly, the torque wrench is considered to be a practical instrument for checking the tightness of slotted-type roof bolts.

---

[7] Thomas, Edward, Barry, A. J., and Metcalfe, Arthur, Suspension Roof Support, Progress Report 1: Bureau of Mines Inf. Circ. 7533, 1949, 13 pp.

[8] Panek, Louis A., Centrifugal Testing Apparatus for Mine-Structure Stress Analysis: Bureau of Mines Rept. of Investigations 4883, 1952, 22 pp.

[9] Barry, A. J., Panek, L. A., and McCormick, John A., Use of Torque Wrench to Determine Load in Roof Bolts—Part 1. Slotted-Type Bolts: Bureau of Mines Rept. of Investigations 4967, 1953, 7 pp. Anchorage Testing of Mine-Roof Bolts—Part 1. Slotted-Type Bolts: Bureau of Mines Rept. of Investigations 5040, 1954, 12 pp. Use of Torque Wrench to Determine Load in Roof Bolts—Part 2. Expansion-Type ¾-inch Bolts. Bureau of Mines Rept. of Investigations 5080, 1954, 17 pp. Anchorage Testing of Mine-Roof Bolts—Part 2. Expansion-Type ¾-inch Bolts, 1956, 19 pp.

Tests on the torque-load relationship for ¾-inch, expansion-type mine roof bolts disclosed that a torque of 200 foot-pounds applied to the bolt will produce a load of 7,960 plus or minus 2,880 pounds 90 percent of the time. For most installations with this type of bolt, the torque wrench can be considered accurate enough. These data were determined for flat, mild-steel (C–1020) bearing plates. Some manufacturers market embossed bearing plates and hardened washers, either of which will alter the torque-tension relationships. Therefore, when either of these devices or combinations or any other type is used, the values given should be redetermined locally.

Apparatus and procedure were developed for testing the anchorage effectiveness of slotted-type mine-roof bolts. In determining the anchorage effectiveness of slotted-type bolts, it was found that, if the driving distance of the bolt exceeded 1.25 inches, satisfactory anchorage was obtained; thus, driving distance could be used as a criterion for satisfactory anchorage.

The results of one part of laboratory research on the theory of model testing, as applied to rock bolting directed toward development of a scientific method of designing safe and efficient rock-bolting systems, were published in March 1956.[10] The research period was from 1952 through 1955.

The theory of model testing as applied to rock bolting required investigation of theoretical and experimental stress analysis under centrifugal testing conditions. By using dimensional analysis, a general expression for a rock-bolting design formula in terms of the structural variables was obtained, which, in turn, was transferred into an exact equation by experimental testing of models. The exact equation can be used for designing rock-bolting systems. Basically, complete understanding of the model-prototype similarity requirements by the use of dimensional analysis is unnecessary if the final result of the experimental work is acceptable.

The basic design formulas for rock-bolting systems are presented in Report of Investigations 5155. These design formulas provide a means of determining how much support is provided by various bolting plans rather than indicating how much support is needed. However, if an existing bolting system is inadequate, the formulas can be used to determine the present reinforcement factor and the most effective way to increase it. Use of the equations and their application is simplified if the physical properties of the rock are determined beforehand.

As in any mine-support computations, of the formulas as well as the chart presented in Report of Investigations 5155 requires basic practical knowledge of mine roof control. The basic principles of reinforcing a bedded mine roof with bolts are presented in Report of Investigations 5156. It was necessary to develop the basic principles of rock-bolting patterns by using elementary beam theory and the results of tests designed to prove or disprove certain fundamental premises. Although complete understanding of the results of the testing is unnecessary, if the data of the experimental work are accepted, an understanding of the elementary beam theory is required in order that intelligent use can be made of the physical properties of the rock acting as the mine roof.

---

[10] Panek, Louis A., Theory of Model Testing as Applied to Roof Bolting: Bureau of Mines Rept. of Investigations 5154, 1956, 11 pp. Design of Bolting Systems to Reinforce Bedded Mine Roof: Bureau of Mines Rept. of Investigations 5155, 1956, 16 pp. Principles of Reinforcing Bedded Mine Roof With Bolts: Bureau of Mines Rept. of Investigations 5156, 1956, 26 pp.

Formulas for computing the bending stress, shearing stress, and maximum deflection, with detailed diagrams of flexure of gravity-loaded beams, are presented in Report of Investigations 5156. Determination of the physical properties of the rock will permit computation of the shearing and bending stress and deflection of the beam over a certain span. Suitable rock-bolting patterns can then be determined by the combined use of the design formulas presented in Report of Investigations 5155, and the employment of the essential principles involved in using vertical bolts.

The Bureau expects to continue research work in the use of rock bolts and their space patterns. The primary effort in 1956 was to be directed toward the testing of bedded roofs with unequal thickness of strata.

INDUSTRIAL ENGINEERING

Industrial engineering, operations research, or whatever the reader is inclined to call the use of statistical methods for solving engineering problems, appears to stand out in the literature review during 1955 because it is relatively new to the mining field. It promises to grow rapidly as a new tool for mining engineers, as new uses are found and its value is proved.

The use of mathematically controlled statistics and procedures to solve problems of method, cost control, principles of design, and ore reserves gained impetus during 1955. Obtaining cost reduction through industrial engineering requires the breakdown of total cost of production into its various components.[11] The variable component factors can then be determined and transferred to a mathematical formula that can often be solved quickly by using digital computers or similar equipment. The best possibility for the mathematical research procedure appears to be the ability of the method to analyze the different parts of the problem in relationship to the whole problem.[12] In a cost analysis, the cost factors are apportioned scientifically.

The method of solving a specific dragline problem by mathematical research techniques was reported in detail.[13] The procedure included developing a mathematical solution analogous to the operation of a dragline in such a way as to predict consequences of alternative methods under consideration.

The reliability of ore-reserve estimates was tested at nickel deposits in Riddle, Oreg., by using an analytical approach to the problem.[14] The combined talents of a mining engineer, geologist, logician, and mathematician were used to provide a scientific measure of the reliability of an ore-reserve estimate. The effort of the research procedure was directed toward obtaining evidence from existing drilling data to support, in a probability sense, the hypothesis that actual mining results would not show deviations in grade of ore from the original estimate exceeding a given amount.

The use of statistics as a mathematical tool to provide critical and unbiased processes by which data can be examined and conclusions reached also received considerable attention in foreign countries. A

---

[11] Hurley, Victor L., Cost Reduction Through Industrial Engineering: Min. Cong. Jour., vol. 41, No. 9, September 1955, pp. 46–49.

[12] Ware, Thomas M., Operations Research and the Mine of Tomorrow: Eng. and Min. Jour., vol. 156, No. 8, August 1955, pp. 75–83.

[13] Dunlap, Jack W., and Jacobs, Herbert H., How Operations Research Solved the Dragline Problem: Eng. and Min. Jour., vol. 156, No. 8, August 1955, pp. 79–83.

[14] Van Voorhis, W. R., Andrews, L. E., and Creelman, G. D., Operations Research Applied to Ore Reserves at Riddle: Min. Cong. Jour., vol. 41, No. 9, September 1955, pp. 71–76.

paper presented at the 1955–56 meeting of the Institution of Mining Engineers in England covered the principles and application of statistics to coal-mining problems.[15] The types of problems to which simple statistical procedures can be applied included the reliability of an average, comparison of two averages to decide whether there is a real difference between them, representation of routine data in a manner that allows the ready detection of abnormal fluctuations, analysis of the extent of relationship between two or more variables, and the use of statistics in the planning or design of experimental investigations.

OTHER MINING TECHNOLOGIES

The wireline core barrel was used more widely in diamond drilling in 1955.[16] The greatest advantage of the wireline core barrel is that the core can be recovered from the hole without removing the string of drill rods.

An electronic method was used at the Kelley mine, Butte, Mont., to locate deviated drill holes.[17] The method consisted of introducing a radio signal into the bottom of the drill hole and establishing bearings between the source of the signal and stations on the working levels at the estimated bottom elevation of the hole by a radio direction finder. The location of the hole was determined to be the point of intersection of the different bearings.

Eight companies either manufactured or distributed portable exploration drilling equipment suitable for packing to inaccessible areas.[18] The drills are light and operated by self-contained gasoline engines.

Shaft-sinking practices were of a varied nature during 1955. A shallow man- and air-shaft was bored with a new type 75-inch core drill for the Trotter Coal Co. in Morgantown, W. Va.[19] Twelve oil-well-type cutters are mounted on the cutting ring of the drill bit. The cutters are arranged in pairs and cut a 4-inch kerf. A total of 467 feet of hole 75 inches in diameter was cored. The drill cut through 81½ feet of limestone, 99½ feet of sandstone, and 286 feet of shales. Tractor shovels were used for mucking an incline shaft near Shoals, Ind.[20] The shaft (22 feet wide with a 12-foot ceiling) was sunk 2,000 feet at an inclination of 17½°. Because of the steep grade, considerable difficulty was at first experienced in mucking. The problem was solved successfully with front-dump, tractor-mounted shovels.

The Anaconda Copper Mining Co., Butte, Mont., extended the Kelley supply shaft in 1953 by raising at full size from the access levels provided by the main Kelley shaft.[21] Accumulated data indicated that the distance in raising in ground good enough to stand over three or more compartments is limited only by the wearing of chute lining by rock passing through the chute.

---

[15] Hebden, J., and Maguire, Valerie M., Some Simple Principles and Applications of Statistics: Trans. Inst. Min. Eng., vol. 115, 1955–56, pp. 179–206.
[16] Engineering and Mining Journal, Revolution in Diamond Drilling: Vol. 156, No. 10, October 1955, pp. 79–81.
[17] Corbett, Robert P., How Radio Locates Drill Holes Underground: Eng. and Min. Jour., vol. 156, No. 9, September 1955, pp. 90–91.
[18] Mining Engineering, Ultra-Portable Exploration Drills: Vol. 7, No. 7, July 1955, pp. 643–644.
[19] Coal Age, New Drill Cuts 75-inch Hole: Vol. 60, No. 1, January 1955, pp. 81–82.
[20] Canadian Mining Journal, Tractor Shovels Solve Problem of Mucking Incline Shaft: Vol. 76, No. 4, April 1955, p. 66.
[21] Road, A. D., Why Anaconda Raised the Kelley Supply Shaft: Eng. and Min. Jour., vol. 156, No. 5, May 1955, pp. 85–89.

The method of sinking a shaft by the freezing or Poetsch method in Carlsbad, N. Mex., in 1951 was described.[22] The freezing was accomplished to a depth of 350 feet. Circular spacing of freeze holes for introduction of the circulating brine was 3 feet. A wall was formed by the uniform, simultaneous formation of ice around each freeze hole.

Two shafts sunk in the Carlsbad, N. Mex., area by the Southwest Potash Corp. required special grouting and concreting procedures.[23] Because of the solubility of potash salts in water, it was necessary to seal off overlying water-bearing horizons. Grout holes were drilled in a radial pattern from the shaft excavation into the water-bearing formations on dips of 60°, 65°, and 70°. Grout was pumped into each hole at a maximum pressure of 500 p. s. i.

Friction-drive hoists have been used successfully in Europe for many years. Installation in 1955 of the Koepe hoisting system at Cleveland-Cliffs iron mines, Ishpeming, Mich., and Falconbridge Nickel Mines of Canada has resulted in increased interest in the United States in friction-drive hoists.

Studies indicate that the economies offered by friction-drive hoists for large mines are proportionally greater for small mines.[24] A low first cost and daily economy may be obtained with a modified Koepe system. In the modified system the standard friction-drive elevator hoist is used, and the tail rope is eliminated, which is not important in a shallow shaft depth. The greatest saving is elimination of the hoist house and solid foundation required in conventional hoisting.

Mining-method changes during 1955 were most noticeable in the older mining districts. Anaconda Copper Mining Co. was expanding its open-pit operations in Butte as an auxiliary production unit to the Kelley underground mine.

In the Quebec, Canada, asbestos region, new properties were developed, and block-caving underground methods constantly improved;[25] however, because the costs of open-pit mining were lowered, new properties used this method.

Mining coal by augering has served to up coal recovery with efficiency at the Old King Mining Co. mine is Hardburly, Ky.[26] Pillars 6 to 12 inches thick are left between holes, depending on the firmness of the coal, and the roof. Auger mining proved to be highly productive under favorable conditions.

Technically advanced hydraulic mining methods are employed in Florida.[27] To maintain the 1955 production of 10 million tons of shipping-grade phosphate rock required mining 30 million tons of crude ore. The crude ore was dug by dragline and placed near hydraulicking monitors. The crude ore was then "gunned" to break it up and sluice it to a pit pump, which, in turn, pumped the material through a pipeline to the concentrator.

---

[22] Latz, John E., How Deep Freeze Solved a Tough Shaft-Sinking Problem: Eng. and Min. Jour., vol. 156, No. 10, October 1955, pp. 96–99.

[23] Herbert, Ira A., How Southwest Potash Corp. Sank and Sealed Two Concrete Shafts: Eng. and Min. Jour., vol. 156, No. 5, May 1955, pp. 76–81.

[24] Mayo, Robert S., Koepe Hoisting System Offers Lower Initial Costs for Small Mines: Eng. and Min. Jour., vol. 156, No. 8, August 1955, pp. 100–101.

[25] Antenides, Lloyd E., Asbestos Mines Improve Caving Schemes: Eng. and Min. Jour., vol. 157, No. 1, January 1956, pp. 100–103.

[26] Vaughn, George W., More Coal by Augering: Coal Age, vol. 60, No. 1, January 1955, pp. 84–86.

[27] Huges, C. V. O., Modern Hydraulic Mining in Florida: Min. Eng., vol. 8, No. 1, January 1956, pp. 31–35.

General mine support and the maintenance of a safe roof or back in coal, nonmetal, and metal mines was an ever-present problem in 1955. The mechanics of the use of yieldable steel arches for roof support were discussed in an article in the Mining Congress Journal.[28] Reportedly, yieldable steel arches give roof support to heavy swelling ground, which permits the rock to relax into a natural pressure arch and an economical readjustment of the sets after removal of the excess rock.

Methods for drilling blast holes in open-pit mines (either ore or overburden) consisted essentially of rotary or churn drills or jet piercing. The diameter of the blast holes drilled by each method is variable. Chino mines at Santa Rita, N. Mex., using rail haulage, improved blasting efficiency by churn-drilling 12-inch holes in place of 9-inch diameter holes.[29] The larger diameter holes resulted in a saving in churn-drill footage necessary to blast down a bench, saving in loading time, saving in track work because it was not necessary to move the track for blasting, and better fragmentation, less heave, and greater back break. A rotary drill also was tested, which appeared to give better results than the old churn-drill type.

Rotary drills producing 12¼-inch-diameter blast holes were found to be advantageous in anthracite stripping in the Southern anthracite field of Pennsylvania.[30] In typical overburden of the area, new drills completed an average of 129 feet per shift (7 hours) of 12¼-inch blast hole, which is a large gain over the 39 feet per shift of 9-inch hole drilled by each of the churn drills formerly used. With the new drills, 6 men do the work of 25.

Erie Mining Co. has been successful in drilling taconite on the Mesabi iron range by jet piercing.[31] Other methods of drilling (churn and rotary) have been tested, but the best results were obtained with jet piercing. Conventional churn drills have drilled about 12 feet per shift of 9-inch hole in taconite. Jet-piercing rigs drill an average of 15 feet per hour of 6½-inch hole.

Experiments with a decentralized, hot-compressed-air system have been carried out in the 12-million-ton-per-year underground mine of Kiruna iron mines in Sweden.[32] The experiments so far have been promising.

European coal-mining regions have been utilizing rotary percussion drilling as a means of increasing underground rock-drilling efficiency, and research on the method was continuing in the United States.[33] The combined system of rotary percussion drilling superimposes a rapid percussive impact on a continuous rotary action in an effort to produce maximum penetration rates in hard rock.

Bureau of Mines research studies of the rotary drilling of oil shale were described.[34] The experimental procedures and the rotary-drill test equipment were presented, with theories of rock drillability, rotary-bit cutting action, and bit design.

---

[28] Sleeman, R. W., Yieldable Steel Arches for Roof Support: Min. Cong. Jour., vol. 41, No. 11, November 1955, pp. 30–33.

[29] Ballmer, G. J., and Harris, K. V. N., Factors in Selection of Drill-Hole Size at Chino: Min. Cong. Jour., vol. 41, No. 11, November 1955, pp. 74–76, 105.

[30] Davis, Harold, Big Drills Pace Big Draglines: Coal Age, vol. 60, No. 1, January 1955, pp. 64–68.

[31] Ramsey, R. H., Teamwork on Taconite: Eng. and Min. Jour., vol. 156, No. 3, March 1955, p. 91.

[32] Westlund, C., Use of Hot Compressed Air at Kiruna: Canadian Min. Jour., vol. 77, No. 1, January 1956, pp. 51–52.

[33] Lacabanne, W. D., and Pfleider, E. P., Rotary Percussion Blasthole Machine May Revolutionize Drilling: Min. Eng., vol. 7, No. 9, September 1955, pp. 850–855.

[34] Rose, C. K., and Utter, Stephen, Cutting Action of Rotary Bits in Oil Shale: Bureau of Mines Rept. of Investigations, 5174 1955, 24 pp.

For prospecting, long-hole underground drilling, under certain conditions and in certain areas of the Picher lead-zinc field, Oklahoma was found to be more economic than surface churn-drill holes.[35] The long holes were drilled with airleg or jumbo-mounted drifters, and holes up to 93 feet have been drilled. The holes were spotted underground from information obtained by detailed geological observation. Cost of the underground long-hole drilling was about $1.50 per foot, compared with a contracted churn-drill hole (6½-inch) of $1.95 a foot.

Renabie Mines, Ltd., Ontario, Canada, reported on the cost of using the long blasthole method to recover stope sills and floor pillars.[36] Equipment performance costs on the drills amounted to $0.618 per foot drilled, equal to $0.299 per ton of ore broken. Total costs, including drilling, labor and supplies, drill repairs and labor, loading labor, and blasting supplies, was $0.5465 per ton of ore broken.

Research on drill steel continued during 1955. A testing program under actual service conditions at the Climax, Colo., molybdenum mine was described.[37] The tests were made by test engineers in working places separated from the actual production areas.

The methods of obtaining the most use out of hollow drill steel were discussed in two articles.[38] Correct heat treatment will improve the useful life of a drill rod, but a rod can also be made useless by incorrect heat treatment. All steels do not respond in the same manner to a given heat treatment, and the selection of the heat treatment depends on the composition of the steel.

Mechanization of ore-, coal-, and rock-handling facilities underground continued in 1955 at a rapid pace. Development of the rubber-tired shuttle car opened a new era in mechanical mining in coal.[39] Adoption of the diesel-electric shuttle car in the Carlsbad, N. Mex., mines was rapid after successful experiments with the first unit.[40] The first unit was placed in service in 1952, and because of the increased efficiency, a second unit was put in service in 1953. These two units have proved conclusively that diesel-equipped shuttle cars have a definite place in underground mining at Carlsbad mines.

A new piece of equipment, comprising a self-contained shovel loader and hopper, drawn by a tractor, has been developed at American Zinc Co. Grandview mine near Metaline Falls, Wash., and has resulted in speeding development and tunnel work.[41] The combine loads a full string of cars by running over the top of the cars and dropping the rock into them. Special flanges on the top, at the sides of the cars, guide the loader on its course over them.

Higher capacity stripping equipment to meet the changing economic picture in central Pennsylvania was installed by Bradford Coal.[42]

---

35 Clarke, S. S. and Brockie, Douglas C., Jackleg Drilling in the Tri-State District; Longhole Prospecting and Production: Min. Eng., vol. 8, No. 1, January 1956, pp. 27–30.

36 Cross, P. S., Renabie Long-Hole Drilling Campaign Yields Useful Operating Cost Data: Eng. and Min. Jour., vol. 156, No. 6, June 1955, pp. 100–102.

37 Gelwix, Max, and Goth, John W., Testing Drill Steel at Climax: Min. Cong. Jour., vol. 41, No. 8, October 1955, pp. 59–63.

38 Payson, Peter, The Connecting Link in Percussion Drilling—Heat Treatments: Min. Cong. Jour., vol. 41, No. 1, January 1955, pp. 43–46.
Anderson, Floyd R., The Connecting Link in Percussion Drilling—Mechanical Treatment of Drill Steel: Min. Cong. Jour., vol. 41, No. 3, March 1955, pp. 43–46.

39 Husk, W. L., Shuttle-Car Haulage: Min. Cong. Jour., vol. 41, No. 4, April 1955, pp. 83–86, 124.

40 London, H. A., Diesel Equipment in Underground Mining: Min. Cong. Jour., vol. 41, No. 4, April 1955, pp. 94–99, 125.

41 Engineering and Mining Journal, New Jumbo Carloading Combine Speeds Development and Tunnel Work: Vol. 157, No. 3, March 1956, pp. 92–95.

42 Coal Age, Bigger Equipment: Step to Higher Efficiency: Vol. 60, No. 12, December 1955, pp. 58–61.

The largest unit in service in 1955 was a 12-cubic-yard dragline, which will be used to strip a 70-foot cover to recover a 30-inch coal seam.

In August 1955 a new bucket-wheel excavator was placed in service in the Fortuna open-pit mine near Cologne, Germany.[43] It can dig 71 cubic feet of loose soil per second, and the maximum daily output of the unit is 130,795 cubic yards, solid measure. The largest unit under construction in 1955 will have a total cutting height of 230 feet. It can cut 164 feet above or 66 feet below excavator level. With further excavators of the same size, it will permit mining brown coal by open-pit methods down to depths of 820 feet.

Installation of skip haulage for open-pit mines has proved advantageous in certain type deposits on the Mesabi iron range.[44] Deep and narrow ore bodies subject to rapid increase in depth, which discourage use of conveyor belts and necessary accompanying crushing plants, are ideal for skip haulage. The installation of skips requires only a short, level haul for trucks and involves low maintenance and investment, with high flexibility. The inclination of the skip track can vary according to the slope of the open pit, whereas an 8-percent grade is the economical limit (except for short hauls) for truck haulage; railroads must stay within a 3-percent grade; conveyors are limited to about a 40-percent grade (18° incline) and require crushing equipment, which often has to be moved. The skip installations were subjected to comparison with trucks and conveyors. A cost analysis indicated that the skip gave the lowest operating cost per ton.

Off-road "transporters" have been developed.[45] The transporters resemble a trackless freight train with each unit of the train driven by an electric motor within each wheel. Each unit car of the freighter follows in the tracks of the first car by a steering arrangement on the car ahead. One car of the freighter carries the electric generating plant, which distributes power to all motors within the wheels of the cars.

New principles of belt-conveyor design have been developed. In one type of design the load is borne by twin steel ropes upon which the belt is carried by means of a steel strap across the underside of the belt.[46] Shoes on each end of the strap bear on the ropes. The ropes are supported along their entire length by ball-bearing pulleys set at approximately 18-foot centers. The steel ropes take the drive, the belt acting only as carrier. Another new concept of belt-conveyor design is suspending the belt-carrying idlers between two parallel, stationary, wire ropes fastened either to the head and tail sections of the conveyor or to roof anchors.[47]

Pumping tests were made at the Fad shaft, Eureka Corp., Eureka, Nev., to evaluate the feasibility of unwatering the shaft and the associated ore zone.[48] The pumping test consisted of determining the ability of the formations to transmit water to the shaft and ore-zone area. The shaft was pumped at 3,600 g. p. m., and the rate of lowering of the water level was observed in the shaft and at all other available points. The rate of rise after pumping had ceased was observed for

[43] Canadian Mining Journal, Large Bucket-Wheel Excavator: Vol. 76, No. 12, December 1955, pp. 59–60.
[44] Seawright, J. S., Skip System Simplifies Costly Problems of Elevating Ore From Open-Pit Mines: Min. Eng., vol. 7, No. 6, June 1955, pp. 542–544.
[45] Engineering and Mining Journal, Off-Road Transporters: Vol. 156, No. 11, November 1955, p. 35.
[46] Grindrod, John, British Cable Belt Conveyor: Canadian Min. Jour., vol. 76, No. 4, April 1955, pp. 67–68.
[47] Canadian Mining Journal, New Rope Belt Conveyor: Vol. 76, No. 12, December 1955, p. 48.
[48] Stuart Wilbur T., Pumping Test Evaluates Water Problem at Eureak, Nev.: Min. Eng., vol. 7, No. 2 February 1955, pp. 148–156.

10 days. Observations were made after the test that a certain formation not intersected by the Fad shaft area could not be unwatered to the desired level by pumping from the Fad shaft only, and that additional water must be withdrawn closer to the point of mining operations, to unwater the formation.

Unwatering of the Osceola mine at Calumet, Mich., by Calumet & Hecla, Inc., was expected to be completed by July 1956. This unwatering project was one of the largest undertaken in recent years and will require approximately 3 years to complete.[49] One of the major problems of the project was the unusual properties of the water. Sampling showed that the water was divided into two distinct layers—an upper layer of relatively salt-free water and a lower layer of rather high salt content. In addition, the lower layer was corrosive and supersaturated with methane gas. The unusual water properties required motor and pump materials of special metals and neoprene-coated pipe for resistance to corrosive action. That the lower layer of water was supersaturated with methane gas was proved conclusively when, during the collection of samples, evolution of gas was greatly assisted by striking the side of the sampler a blow with a hammer. Without the agitation induced by the hammer blow, pressure in the sampler could be decreased below atmospheric without effecting gas release. A subsequent sharp hammer blow produced violent evolution.

Industrial use of television was reported by the Calumet & Hecla Co.[50] In the Centennial mine, Calumet, Mich., two horizontal guide sheaves are necessary in the shaft to prevent the skip ropes from slapping against the rails and timbers. Television cameras are focused on the two sheaves, and the image of the sheaves and rope is relayed to a monitor at the hoist house, enabling the hoistman to watch the rope and sheaves and determine instantly when the rope is off the sheaves.

The design features of explosionproof units employed in the constructing permissible machines were the subject of a Bureau of Mines bulletin.[51] Permissible mine equipment approved in 1953 and 1954 was the subject of a report published in 1955.[52]

The Bureau of Mines granted approval for the first conventional, diesel-driven crawler tractor with bulldozer blade designed for use in noncoal underground mines. A specially designed exhaust conditioner used a water-cooling principle to reduce exhaust temperatures to below 160° F.

---

[49] Kromer, A. S., Marcotte, R. J., Campbell, C. A., Spencer, R. R., and Ostlender, P. H., Unwatering the Osceola Lode: Min. Eng., vol. 8, No. 4, April 1956, pp. 375-381.

[50] Mining World, How Television Sees 1,200 Feet Down Calumet & Hecla's Centennial Shaft: vol. 17, No. 1, January 1955, p. 52.

[51] Gleim, E. J., James, R. S., and Brunot, H. B., Explosion-Proof Design and Wiring for Permissible Mining Equipment: Bureau of Mines Bull. 541, June 1955, 40 pp.

[52] Kearns, R. A., and Brunot, H. B., Permissible Mine Equipment Approved During the Calendar Years 1953 and 1954: Bureau of Mines Inf. Circ. 7722, 1955, 12 pp.

Statistical Summary of Mineral Production

By Kathleen J. D'Amico[1]

CONTINUING the practice begun in 1954, this summary is identical to the summary, in volume III of this series, of mineral production in the United States, its Territories and possessions, and the Commonwealth of Puerto Rico and of principal minerals imported into and exported from the United States. For further details on production see commodity and area chapters. A summary table comparing world and United States mineral production also is included.

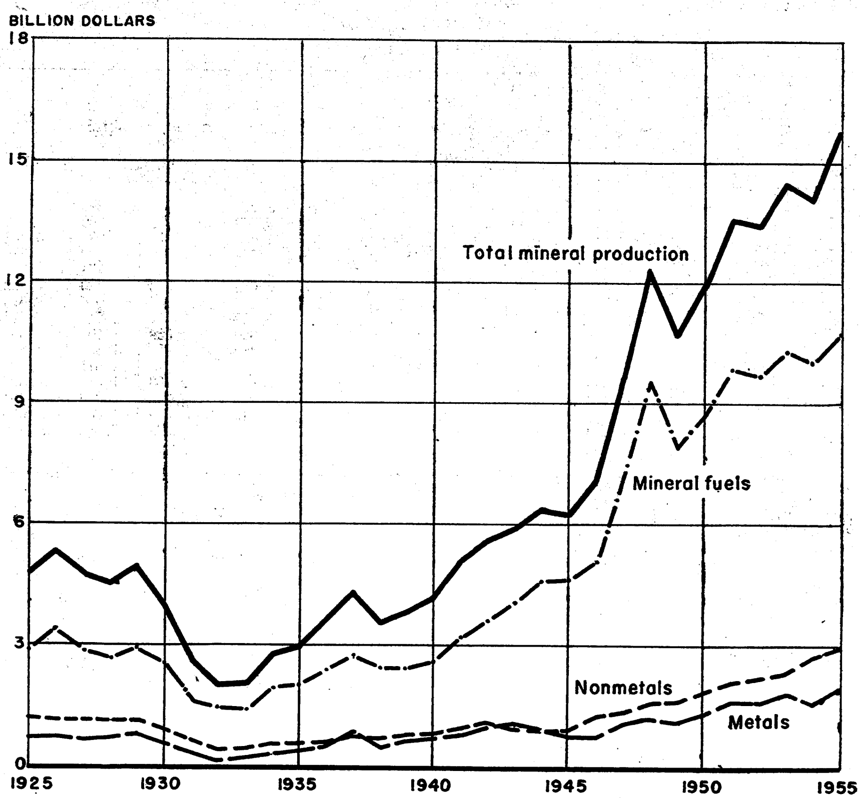

FIGURE 1.—Value of mineral production in continental United States, 1925–55.

[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. 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.

Data for clays and stone in 1954–55 include output used in making cement and lime. Mineral-production totals have been adjusted to eliminate duplication of these values.

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, 1925–55, by mineral groups [1]

(Million dollars)

Year	Mineral fuels	Nonmetallic minerals (except fuels)	Metals	Total	Year	Mineral fuels	Nonmetallic minerals (except fuels)	Metals	Total
1925	2,910	1,187	715	4,812	1941	3,228	989	890	5,107
1926	3,371	1,219	721	5,311	1942	3,568	1,056	999	5,623
1927	2,875	1,201	622	4,698	1943	4,028	916	987	5,931
1928	2,666	1,163	655	4,484	1944	4,574	836	900	6,310
1929	2,940	1,166	802	4,908	1945	4,569	888	774	6,231
1930	2,500	973	507	3,980	1946	5,090	1,243	729	7,062
1931	1,620	671	287	2,578	1947	7,188	1,338	1,084	9,610
1932	1,460	412	128	2,000	1948	9,502	1,552	1,219	12,273
1933	1,413	432	205	2,050	1949	7,920	1,559	1,101	10,580
1934	1,947	520	277	2,744	1950	8,689	1,822	1,351	11,862
1935	2,013	564	365	2,942	1951	9,779	2,079	1,671	13,529
1936	2,405	685	516	3,606	1952	9,616	2,163	[2] 1,617	[2] 13,396
1937	2,798	711	756	4,265	1953	10,249	2,342	[2] 1,800	[2] 14,391
1938	2,436	622	460	3,518	1954	[2] 9,912	[3] 2,619	[2] 1,507	[2] 14,038
1939	2,423	754	631	3,808	1955	10,774	[3] 2,959	2,044	15,777
1940	2,662	784	752	4,198					

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

[2] Revised figure.

[3] The total has been adjusted to eliminate duplicating the value of clays and stone.

TABLE 2.—Mineral production in continental United States 1952–55 [1]

Mineral	1952		1953		1954		1955	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
MINERAL FUELS								
Asphalt and related bitumens (native):								
Bituminous limestone and sandstone	1,570,698	$4,687,512	1,440,544	$4,349,327	1,337,822	$3,686,227	1,427,207	$4,110,719
Gilsonite	60,740	1,779,815	60,505	2,184,328	75,943	2,724,023	82,822	3,117,310
Carbon dioxide, natural (estimated) thousand cubic feet	737,000	226,250	670,600	203,450	638,900	210,700	702,417	233,640
Coal:								
Bituminous [3]	463,137,264	2,276,189,066	453,577,946	2,232,698,609	386,796,876	[3] 1,752,847,309	463,993,712	2,086,623,737
Lignite	3,017,300	7,211,912	2,851,032	6,793,648	4,242,806	10,330,000		
Pennsylvania anthracite	40,582,558	379,714,076	30,949,152	299,139,687	29,083,477	247,870,023	26,204,554	206,096,662
Helium cubic feet	145,810,332	1,896,096	157,652,134	2,102,721	189,873,071	3,202,206	235,868,000	3,880,708
Natural gas million cubic feet	8,013,457	623,649,460	8,396,916	774,966,250	8,742,546	882,501,350	9,405,351	978,357,000
Natural-gas liquids:								
Natural gasoline and cycle products thousand gallons	5,102,244	371,468,000	5,327,448	406,242,000	5,385,282	402,418,000	5,844,904	423,775,000
LP-gases	4,285,386	161,692,000	4,692,870	191,598,000	5,204,304	178,994,000	5,972,698	195,231,000
Peat	210,582	1,729,511	204,209	1,617,947	[3] 244,163	[3] 2,257,591	273,669	2,282,865
Petroleum (crude) thousand 42-gallon barrels	2,289,836	5,785,230,000	2,357,082	6,327,100,000	2,314,988	6,424,930,000	2,484,428	6,870,380,000
Total mineral fuels		9,616,000,000		10,249,000,000		[3] 9,912,000,000		10,774,000,000
NONMETALLIC MINERALS (EXCEPT FUELS)								
Abrasive stone: [4]								
Grindstones and pulpstones	3,974	$247,434	2,499	$169,951	2,218	$163,995	2,799	$195,761
Millstones	(5)	9,285	(5)	18,375	(5)	(6)	(5)	(6)
Pebbles (grinding)	2,804	93,949	2,472	81,159	3,070	99,491	2,130	68,268
Tube-mill liners (natural)	1,739	67,724	1,219	68,688	933	59,471	(6)	(6)
Asbestos	53,864	4,713,032	54,456	4,857,359	47,621	4,697,962	44,568	4,487,428
Barite	941,825	8,797,944	944,212	9,435,749	883,283	[3] 8,508,177	1,108,103	10,809,119
Boron minerals	583,828	14,105,000	715,228	17,668,000	790,449	26,714,440	924,496	33,816,464
Bromine pounds	156,201,577	30,639,292	164,143,348	35,372,386	187,399,110	41,312,669	184,453,846	39,855,508
Cement 376-pound barrels	250,821,410	637,746,171	260,696,761	698,268,154	274,703,163	763,413,017	306,128,477	884,380,979
Clays	42,287,073	131,032,163	42,297,853	125,023,924	42,494,806	[3] 123,161,336	48,101,969	139,533,164
Emery	10,352	141,911	10,562	143,974	9,758	132,313	10,735	151,455
Epsom salts from epsomite	(6)	(6)	200	8,000	(6)	(6)	100	5,000
Feldspar long tons	420,831	3,696,018	452,600	4,594,450	411,018	3,490,466	465,378	3,801,291
Fluorspar	331,273	15,353,634	318,036	15,736,908	245,628	12,332,779	279,540	12,590,398
Garnet (abrasive	11,390	981,841	10,520	988,797	14,183	971,353	11,835	1,191,456
Gem stones (estimated)	(5)	490,000	(5)	492,000	(5)	[3] 603,000	(5)	808,257
Graphite	5,081	594,618	6,281	(6)	(6)	(6)	(6)	(6)

See footnotes at end of table.

TABLE 2.—Mineral production in continental United States 1952–55 [1]—Continued

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
NONMETALLIC MINERALS (EXCEPT FUELS)—continued								
Gypsum	8,415,300	$22,896,051	8,292,876	$23,175,073	8,995,960	$27,383,515	10,683,733	$33,937,560
Iron oxide-pigment materials (crude)	-----	-----	-----	-----	[3] 16,259	[3] 128,676	16,190	157,379
Lime	8,055,609	94,795,435	9,659,414	111,777,018	8,612,360	101,273,040	10,463,083	126,687,909
Lithium minerals	15,611	1,052,000	(6)	(6)	(6)	(6)	-----	-----
Magnesite	510,750	2,871,548	553,147	3,223,759	284,015	1,391,392	486,088	2,712,942
Magnesium compounds from sea water and brines (except for metals) MgO equivalent	121,525	9,392,913	136,824	10,459,502	[3] 113,774	[3] 9,468,674	155,779	12,703,930
Marl:								
Calcareous (except for cement)	260,213	187,148	277,354	173,347	206,257	152,491	183,044	128,340
Greensand	4,600	177,847	6,821	193,404	2,838	198,909	5,704	217,671
Mica:								
Scrap	75,236	1,954,286	73,259	1,823,840	81,073	1,733,772	95,432	2,058,035
Sheet pounds	697,989	908,135	1,068,706	2,153,584	[7] 668,788	2,393,041	642,113	3,370,397
Perlite	164,845	1,002,920	198,751	1,439,658	219,703	1,762,100	286,157	2,281,632
Phosphate rock long tons	12,064,892	72,458,982	12,503,830	76,631,755	13,821,100	86,669,081	12,265,248	75,379,250
Potassium salts K_2O equivalent	1,598,354	53,754,316	1,731,607	65,403,202	1,918,157	71,818,934	[7] 2,003,803	[7] 76,634,067
Pumice	597,044	2,266,981	1,338,206	2,509,501	1,552,074	2,934,837	1,674,182	3,293,100
Pyrites long tons	994,342	4,947,000	922,647	5,006,499	908,715	7,159,496	994,443	8,293,064
Quartz from pegmatites and quartzite	246,604	1,013,637	245,755	1,384,398	(8)	(8)	(8)	(8)
Salt (common)	19,532,276	70,870,767	20,775,073	78,129,657	20,660,379	105,470,444	22,693,349	123,257,240
Sand and gravel	424,605,508	344,568,531	432,285,569	369,214,099	[3] 549,401,256	496,671,727	581,724,503	526,841,554
Sand and sandstone (ground)	792,802	6,922,586	784,792	6,873,591	(9)	(9)	(9)	(9)
Slate	739,640	12,706,651	698,589	12,638,465	760,921	12,960,614	760,440	12,913,777
Sodium carbonate (natural)	323,479	7,828,033	419,206	10,627,460	527,282	13,536,345	613,594	15,000,966
Sodium sulfate (natural)	236,825	3,217,000	248,230	3,340,760	249,701	3,890,303	284,549	5,381,313
Stone [10]	301,736,339	460,115,552	302,248,274	473,079,603	[3] 407,426,662	[3] 605,986,855	465,592,511	700,105,894
Strontium minerals (crude)	-----	-----	50	1,000	12	300	177	4,425
Sulfur:								
Frasch-process mines long tons	5,141,392	110,925,000	5,224,202	141,054,000	5,328,040	142,014,215	5,839,300	163,155,874
Other mines do	4,686	91,310	152,473	769,140	185,085	(6)	199,899	(6)
Sulfur, recovered elemental do	226,258	5,660,794	315,019	8,059,243	399,950	11,208,576	458,021	12,585,310
Talc, pyrophyllite, and soapstone	[11] 593,147	[11] 11,347,317	[12] 631,538	[12] 3,524,035	[12] 618,994	[12] 3,492,548	[12] 725,708	[12] 4,527,847
Titanium-iron concentrate (nontitanium use)	(6)	(6)	1,585	7,500	(6)	(6)	1,350	7,400
Tripoli	35,459	1,043,124	36,183	1,138,635	41,625	1,458,762	[13] 47,362	[13] 631,366
Vermiculite	208,906	2,657,826	189,535	2,445,381	195,538	2,537,577	204,040	2,702,225
Value of items that cannot be disclosed: Aplite, brucite (1952–54), calcium-magnesium chloride, diatomite, iodine, kyanite, olivine, sharpening stones (1952–54), wollastonite, and values indicated by footnote 6. Excludes value of clays used for cement (1952–53)	-----	6,484,763	-----	12,474,546	-----	[3] 22,580,162	-----	30,805,418
Total nonmetallic minerals	-----	2,163,000,000	-----	2,342,000,000	-----	[3] [14] 2,619,000,000	-----	[14] 2,959,000,000

METALS								
Antimony ore and concentrate.....antimony content..	4,434	(15)	2,161	(15)	16 766	(15)	16 633	(15)
Bauxite..................long tons, dried equivalent..	1,667,047	$10,776,254	1,579,739	$13,439,141	1,994,896	$16,403,388	1,788,341	$14,542,638
Beryllium concentrate..................gross weight..	515	233,757	751	354,681	669	303,649	500	267,927
Chromite......................................do....	21,304	1,776,981	58,817	3,432,872	160,412	6,955,653	146,171	6,018,379
Cobalt (content of concentrate)...............pounds..	836,372	(15)	1,775,489	(15)	2,219,396	(15)	2,438,546	(15)
Columbium-tantalum concentrate pounds, gross weight..	5,385	16,723	14,867	29,780	32,829	57,262	12,954	22,125
Copper (recoverable content of ores, etc.)............	925,359	447,873,756	926,448	531,781,152	835,468	492,926,757	998,569	744,932,549
Gold (recoverable content of ores, etc.)....troy ounces..	1,652,704	57,844,640	1,704,510	59,657,850	1,588,799	55,607,965	1,630,848	57,079,680
Iron ore, usable (excluding byproduct iron sinter) long tons, gross weight..	97,236,397	590,346,970	117,197,537	790,491,229	3 76,125,664	3 525,817,676	105,236,869	748,602,065
Lead (recoverable content of ores, etc.)...............	390,161	125,631,842	342,635	89,770,370	325,419	89,164,759	338,024	100,731,152
Manganese ore (35 percent or more Mn)..gross weight..	115,379	8,251,774	157,536	12,480,009	206,128	15,175,533	287,254	21,650,794
Manganiferous ore (5 to 35 percent Mn)..........do....	1,009,018	5,116,985	1,239,390	6,946,612	558,332	3,079,380	911,636	5,128,255
Manganiferous residuum.........................do....	215,255	(15)	293,758	(15)	214,931	(15)	213,370	(15)
Mercury.............................76-pound flasks..	12,519	2,492,533	14,297	2,759,750	17,497	4,626,032	18,914	5,491,679
Molybdenum (content of ore and concentrate)..pounds..	42,717,443	40,844,575	53,823,235	52,361,505	3 64,021,249	64,070,350	64,708,668	66,919,039
Nickel (content of ore and concentrate)...............	------------	------------	11	(15)	14	(15)	4,411	(15)
Silver (recoverable content of ores, etc.)..troy ounces..	39,419,344	35,676,497	37,535,451	33,971,479	36,907,686	33,403,320	37,164,049	33,635,342
Tin (content of ore and concentrate)..........long tons..	17	45,324	(15)	(15)	(15)	(15)	(15)	(15)
Titanium concentrate:								
Ilmenite........................gross weight..	522,515	8,022,752	512,176	7,222,641	531,895	3 7,375,344	573,192	10,267,647
Rutile....................................do....	(15)	(15)	6,476	702,791	7,305	869,677	9,182	1,122,000
Tungsten ore and concentrate...60-percent WO_3 basis..	7,603	28,943,162	9,587	35,932,751	13,691	51,433,357	16,412	60,841,157
Vanadium...................................pounds..	3 5,142,799	(15)	3 6,114,851	(15)	3 6,051,784	(15)	6,571,655	(15)
Zinc (recoverable content of ores, etc.)...............	666,001	222,981,864	517,430	125,320,890	473,471	102,179,867	514,671	126,608,833
Zirconium concentrate................................	(15)	(15)	21,234	793,685	17,959	820,041	28,913	1,425,641
Value of items that cannot be disclosed: Magnesium chloride for magnesium metal, platinum-group metals (crude), rare-earth metal concentrate, and values indicated by footnote 15..................	------------	3 30,363,712	------------	3 32,771,910	------------	3 36,910,152	------------	38,882,549
Total metals...	------------	3 1,617,000,000	------------	3 1,800,000,000	------------	3 1,507,000,000	------------	2,044,000,000
Grand total mineral production....................	------------	3 13,396,000,000	------------	3 14,391,000,000	------------	3 14,038,000,000	------------	15,777,000,000

1 Production as measured by mine shipments, sales, or marketable production (including consumption by producers). Excludes uranium ores and monazite.
2 Includes small quantity of anthracite mined in States other than Pennsylvania.
3 Revised figure.
4 Excludes sharpening stones, value for which is included with "Nonmetallic minerals, undistributed."
5 Weight not recorded.
6 Figure withheld to avoid disclosing individual company confidential data; value included with "Nonmetallic minerals, items that cannot be disclosed."
7 Final figure. Supersedes preliminary figure given in commodity chapter.
8 Beginning with 1954, quartz from pegmatites and quartzite included with stone.
9 Beginning with 1954, sand and sandstone (ground) included with sand and gravel or stone.
10 Excludes abrasive stone, bituminous limestone, bituminous sandstone, and ground soapstone, all included elsewhere in table. Also excludes limestone for cement and lime, 1952–53.
11 Sold or used by producers. Quantity and value of ground material.
12 Mine production of crude material.
13 Data not comparable with earlier years.
14 The total has been adjusted to eliminate duplicating the value of clays and stone.
15 Figure withheld to avoid disclosing individual company confidential data.
16 Antimony content.

TABLE 3.—Minerals produced in United States, by States, and Alaska, Hawaii, and Puerto Rico in 1955

State	Abrasive stone	Antimony	Aplite	Asbestos	Asphalt	Barite	Bauxite	Beryllium	Boron	Bromine	Calcium-magnesium chloride	Carbon dioxide	Cement	Chromite	Clays	Coal	Cobalt	Columbium-tantalum	Copper
Alabama					√		√						√		√	√			
Arizona				√		√		√					√		√	√		√	√
Arkansas	√					√	√						√		√	√			
California				√		√			√	√	√	√	√	√	√	√			√
Colorado								√				√	√		√	√		√	√
Connecticut								√							√			√	
Delaware															√				
Florida													√		√				
Georgia						√	√	√					√		√	√			
Idaho		√				√							√		√		√	√	√
Illinois													√		√	√			
Indiana	√												√		√	√			
Iowa													√		√	√			
Kansas													√		√	√			
Kentucky					√								√		√	√			
Louisiana													√		√				
Maine								√					√		√			√	
Maryland													√		√	√			
Massachusetts															√				
Michigan										√	√		√		√				√
Minnesota	√												√		√				
Mississippi													√		√				
Missouri					√	√							√		√	√	√		√
Montana						√							√	√	√	√			√
Nebraska													√		√				
Nevada						√									√				√
New Hampshire	√							√							√			√	
New Jersey															√				
New Mexico						√		√				√			√	√		√	√
New York													√		√				
North Carolina	√			√				√							√				√
North Dakota															√	√			
Ohio	√										√		√		√	√			
Oklahoma					√								√		√	√			
Oregon												√	√	√	√				√
Pennsylvania													√		√	√	√		√
Rhode Island																			
South Carolina						√							√		√				

South Dakota								√					√		√	√		√	
Tennessee						√							√		√	√			√
Texas	√				√					√			√		√				√
Utah					√							√	√		√	√			√
Vermont				√											√				√
Virginia			√					√					√		√	√			
Washington	√					√						√	√	√	√	√			√
West Virginia	√									√	√		√		√	√			
Wisconsin	√												√		√				
Wyoming													√		√	√			
Alaska														√	√	√			
Hawaii																			
Puerto Rico													√		√				

TABLE 3.—Minerals produced in United States, by States, and Alaska, Hawaii, and Puerto Rico in 1955—Continued

State	Diatomite	Emery	Epsomite	Feldspar	Fluorspar	Garnet (abrasive)	Gem stones	Gold	Graphite	Gypsum	Helium	Iodine	Iron ore	Iron oxide pigments	Kyanite	Lead	Lime	Magnesite	Magnesium chloride	Magnesium compounds	Manganese
Alabama													√				√				
Arizona	√			√			√	√		√						√	√				√
Arkansas							√			√							√				√
California	√			√	√	√	√	√		√		√	√			√	√	√		√	√
Colorado				√	√		√	√		√			√	√		√					
Connecticut				√													√				
Delaware																					
Florida						√											√				
Georgia				√			√						√	√							√
Idaho						√	√	√		√						√					
Illinois					√											√	√				
Indiana										√							√				
Iowa										√							√				
Kansas										√	√					√					
Kentucky					√																
Louisiana										√							√				
Maine				√			√										√				
Maryland																	√				
Massachusetts																	√				
Michigan							√			√			√				√			√	
Minnesota							√						√				√				√
Mississippi																					
Missouri													√	√		√	√				
Montana					√		√	√		√			√			√	√				√
Nebraska							√														
Nevada	√				√		√	√		√			√			√	√	√			√
New Hampshire				√			√														
New Jersey							√						√				√			√	√
New Mexico	√				√		√	√			√		√			√				√	√
New York		√				√	√			√			√	√		√	√				
North Carolina				√			√	√								√					
North Dakota																					
Ohio										√							√				
Oklahoma										√						√	√				
Oregon	√						√	√					√			√					
Pennsylvania							√	√					√	√			√				
Rhode Island									√												
South Carolina															√						

South Dakota				√			√	√		√			√				√				
Tennessee								√					√				√				√
Texas				√			√		√	√	√		√				√		√	√	
Utah					√		√	√		√			√			√	√				
Vermont							√	√									√				
Virginia				√			√			√				√	√	√	√				√
Washington	√		√				√	√		√			√			√	√	√			
West Virginia																	√				
Wisconsin													√			√	√				
Wyoming							√	√		√			√								
Alaska																√					
Hawaii																	√				
Puerto Rico																	√				

TABLE 3.—Minerals produced in United States, by States and Alaska, Hawaii, and Puerto Rico, in 1955—Continued

State	Mercury	Mica	Molybdenum	Natural gas	Natural-gas liquids	Nickel	Olivine	Peat	Perlite	Petroleum	Phosphate rock	Platinum group metals	Potassium salts	Pumice	Pyrites	Rare-earth metals	Salt	Sand and gravel
Alabama		√		√						√							√	√
Arizona	√	√	√	√					√					√				√
Arkansas				√	√					√								√
California	√	√	√	√	√			√	√	√		√	√	√	√	√	√	√
Colorado		√	√	√	√				√	√				√	√	√	√	√
Connecticut		√						√										√
Delaware																		√
Florida				√				√		√	√					√		√
Georgia		√						√										√
Idaho	√	√				√		√			√			√		√		√
Illinois				√	√			√		√								√
Indiana				√				√		√								√
Iowa								√										√
Kansas				√	√					√				√			√	√
Kentucky				√	√					√								√
Louisiana				√	√					√							√	√
Maine		√						√										√
Maryland				√									√					√
Massachusetts								√										√
Michigan				√	√			√		√			√				√	√
Minnesota								√										√
Mississippi				√	√					√								√
Missouri				√		√				√								√
Montana				√	√					√	√			√	√			√
Nebraska				√	√					√				√				√
Nevada	√		√						√	√				√			√	√
New Hampshire		√						√										√
New Jersey								√										√
New Mexico		√	√	√	√				√	√			√	√			√	√
New York				√				√		√							√	√
North Carolina		√					√											√
North Dakota				√	√					√				√				√
Ohio				√	√			√		√							√	√
Oklahoma				√	√					√							√	√
Oregon	√					√								√				√
Pennsylvania		√		√	√			√		√					√			√
Rhode Island																		√
South Carolina		√																√

South Dakota		√								√								√
Tennessee				√						√	√				√			√
Texas	√			√	√					√				√			√	√
Utah			√	√	√				√	√	√		√	√			√	√
Vermont															√			√
Virginia		√		√						√					√		√	√
Washington							√	√						√				√
West Virginia				√	√					√							√	√
Wisconsin																		√
Wyoming				√	√					√	√			√				√
Alaska												√						√
Hawaii														√			√	√
Puerto Rico																		√

TABLE 3.—Minerals produced in United States, by States and Alaska, Hawaii, and Puerto Rico, in 1955—Continued

State	Silver	Slate	Sodium salts	Stone	Strontium	Sulfur, sulfur ore, and recovered elemental	Talc, pyrophyllite, and soapstone	Tin	Titanium concentrate	Tripoli	Tungsten	Vanadium	Vermiculite	Wollastonite	Zinc	Zirconium
Alabama				√			√									
Arizona	√			√							√	√			√	
Arkansas		√		√		√	√									
California	√	√	√	√	√	√	√		√		√				√	
Colorado	√			√				√			√	√			√	
Connecticut				√												
Delaware				√												
Florida				√					√							√
Georgia		√		√			√									
Idaho	√			√					√		√				√	
Illinois	√			√		√				√					√	
Indiana				√		√										
Iowa				√												
Kansas				√												
Kentucky				√											√	
Louisiana				√		√										
Maine		√		√												
Maryland		√		√			√									
Massachusetts				√												
Michigan	√			√												
Minnesota				√												
Mississippi				√												
Missouri	√			√											√	
Montana	√			√			√				√		√		√	
Nebraska				√												
Nevada	√			√		√	√				√				√	
New Hampshire				√												
New Jersey				√		√									√	
New Mexico	√			√		√					√				√	
New York	√	√		√			√		√					√	√	
North Carolina	√			√			√				√		√			
North Dakota				√												
Ohio				√		√										
Oklahoma				√		√				√					√	
Oregon	√			√							√					
Pennsylvania	√	√		√		√	√			√						
Rhode Island				√												
South Carolina				√									√			
South Dakota	√			√												

Tennessee	√			√											√	
Texas	√		√	√		√	√									
Utah	√			√							√	√			√	
Vermont	√	√		√			√									
Virginia	√	√		√			√		√						√	
Washington	√			√			√				√				√	
West Virginia				√		√										
Wisconsin				√											√	
Wyoming	√		√	√		√										
Alaska	√			√				√								
Hawaii				√												
Puerto Rico				√												

TABLE 4.—Value of mineral production in continental United States, 1952–55, by States, in thousand dollars, and principal minerals produced in 1955

State	1952	1953	1954	1955 Value	1955 Rank	1955 Percent of U. S. total	1955 Principal minerals in order of value
Alabama	158, 382	187, 087	154, 639	186, 453	19	1. 18	Coal, iron ore, cement, stone.
Arizona	232, 824	258, 471	254, 479	378, 277	12	2. 40	Copper, sand and gravel, cement, zinc.
Arkansas	117, 687	127, 090	131, 745	132, 822	24	. 84	Petroleum, bauxite, stone, cement.
California	1, 215, 130	1, 393, 987	1, 429, 627	1, 457, 554	2	9. 24	Petroleum, natural gas, cement, natural gasoline.
Colorado	189, 852	212, 690	255, 852	286, 121	17	1. 81	Petroleum, molybdenum, coal, cement.
Connecticut	7, 125	7, 917	9, 581	10, 428	45	. 07	Stone, sand and gravel, lime, clays.
Delaware	677	659	947	1, 658	48	. 01	Sand and gravel, stone, clays.
District of Columbia	7	15					
Florida	82, 878	92, 336	106, 510	108, 957	28	. 69	Phosphate rock, stone, cement, clays.
Georgia	51, 450	51, 395	55, 828	60, 417	33	. 38	Clays, stone, cement, sand and gravel.
Idaho	77, 895	67, 063	69, 689	68, 513	29	. 43	Lead, silver, phosphate rock, copper.
Illinois	460, 005	462, 443	473, 077	533, 464	7	3. 38	Petroleum, coal, stone, sand and gravel.
Indiana	162, 031	169, 781	165, 369	183, 479	20	1. 16	Coal, cement, stone, petroleum.
Iowa	52, 481	51, 994	58, 798	63, 555	32	. 40	Cement, stone, sand and gravel, coal.
Kansas	403, 370	413, 231	449, 587	470, 830	9	2. 98	Petroleum, natural gas, cement, salt.
Kentucky	398, 446	381, 742	327, 503	391, 068	11	2. 48	Coal, petroleum, natural gas, stone.
Louisiana	848, 401	965, 237	998, 057	1, 156, 637	3	7. 33	Petroleum, natural gas, natural gasoline, salt.
Maine	8, 981	10, 503	10, 716	12, 991	44	. 08	Cement, sand and gravel, stone, slate.
Maryland	26, 847	27, 085	30, 743	35, 491	39	. 23	Sand and gravel, cement, stone, coal.
Massachusetts	17, 812	17, 191	18, 851	22, 109	42	. 14	Stone, sand and gravel, lime, clays.
Michigan	254, 518	286, 487	279, 940	363, 787	13	2. 31	Iron ore, cement, copper, petroleum.
Minnesota	397, 440	542, 545	351, 474	501, 151	8	3. 18	Iron ore, sand and gravel, stone, cement.
Mississippi	101, 875	107, 868	110, 563	122, 620	25	. 78	Petroleum, natural gas, sand and gravel, clays.
Missouri	140, 977	128, 207	131, 280	151, 626	23	. 96	Lead, cement, stone, lime.
Montana	122, 069	132, 184	126, 412	166, 993	22	1. 06	Copper, petroleum, zinc, manganese ore.
Nebraska	20, 597	33, 281	42, 393	54, 237	35	. 34	Petroleum, cement, sand and gravel, stone.
Nevada	64, 231	73, 523	89, 138	113, 231	27	. 72	Copper, tungsten, manganese ore, sand and gravel.
New Hampshire	1, 945	1, 805	2, 112	2, 605	46	. 02	Sand and gravel, stone, feldspar, mica.
New Jersey	57, 468	51, 945	47, 044	57, 495	34	. 36	Stone, sand and gravel, iron ore, zinc.
New Mexico	288, 474	336, 545	373, 519	435, 911	10	2. 76	Petroleum, potassium salts, copper, natural gas.
New York	180, 751	186, 868	192, 738	216, 907	18	1. 37	Cement, iron ore, stone, sand and gravel.
North Carolina	34, 726	38, 451	41, 651	41, 210	37	. 26	Stone, tungsten contentrate, sand and gravel, mica.
North Dakota	12, 057	19, 237	22, 223	44, 123	36	. 28	Petroleum, coal, sand and gravel, LP-gases.
Ohio	292, 689	302, 242	293, 659	340, 457	14	2. 16	Coal, stone, cement, lime.

Oklahoma	621, 351	679, 003	650, 205	711, 089	6	4. 51	Petroleum, natural gas, natural gasoline, cement.
Oregon	26, 674	24, 449	32, 268	31, 736	40	. 20	Sand and gravel, stone, cement, nickel.
Pennsylvania	1, 145, 633	1, 121, 622	925, 545	971, 064	4	6. 16	Coal, cement, stone, petroleum.
Rhode Island	1, 250	1, 462	1, 461	1, 834	47	. 01	Sand and gravel, stone, graphite.
South Carolina	14, 686	17, 771	17, 744	20, 197	43	. 13	Cement, clays, sand and gravel, vermiculite.
South Dakota	30, 455	33, 823	37, 874	40, 526	38	. 26	Gold, sand and gravel, stone, cement.
Tennessee	100, 932	98, 050	105, 686	119, 316	26	. 76	Coal, cement, phosphate rock, zinc.
Texas	3, 379, 813	3, 647, 913	3, 730, 705	3, 993, 310	1	25. 31	Petroleum, natural gas, natural gasoline, LP-gases.
Utah	265, 676	298, 589	255, 495	331, 929	15	2. 10	Copper, coal, iron ore, gold.
Vermont	17, 891	20, 302	20, 483	23, 884	41	. 15	Stone, slate, asbestos, copper.
Virginia	164, 679	152, 979	129, 603	172, 541	21	1. 09	Coal, stone, cement, lime.
Washington	56, 139	54, 577	53, 300	67, 334	30	. 43	Sand and gravel, cement, stone, zinc.
West Virginia	825, 733	790, 110	636, 311	755, 512	5	4. 79	Coal, natural gas, sand and gravel, stone.
Wisconsin	55, 710	55, 212	54, 286	65, 813	31	. 42	Sand and gravel, stone, iron ore, cement.
Wyoming	206, 828	255, 906	281, 306	297, 752	16	1. 89	Petroleum, coal, clays, sodium carbonate and sulfate.
Total	13, 396, 000	14, 391, 000	14, 038, 000	15, 777, 000		100. 00	Petroleum, coal, natural gas, cement.

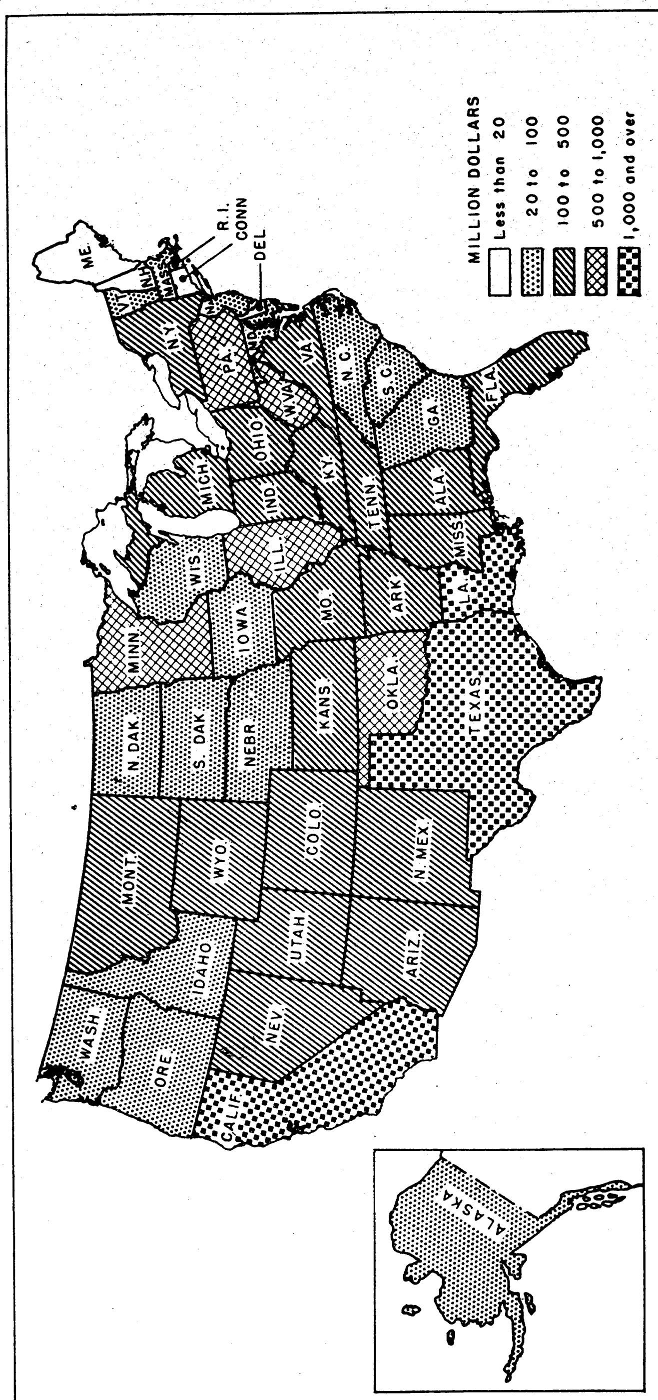

FIGURE 2.—Value of mineral production in continental United States and Alaska, 1955, by States.

TABLE 5.—Mineral production in the United States, 1952–55, by States [1]

ALABAMA

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Cement [2] .... 376-pound barrels	10,642,409	$25,084,379	10,427,542	$25,701,421	11,121,599	$28,582,683	13,720,615	$38,350,044
Clays	1,264,412	1,903,956	1,198,093	1,815,606	1,330,900	2,258,211	(3)	(3)
Coal	11,383,427	70,759,815	12,532,061	79,370,036	10,282,506	67,338,242	13,088,477	79,337,006
Iron ore (usable) .... long tons, gross weight	7,243,214	37,940,412	7,446,130	55,640,338	5,913,462	33,327,083	6,813,670	44,657,215
Lime	424,028	4,458,604	470,541	5,018,156	421,807	4,488,167	462,194	5,185,706
Natural gas .... million cubic feet	4	160	41	2,000	87	5,000	282	20,000
Petroleum (crude) .... thousand 42-gallon barrels	1,279	(3)	1,694	3,290,000	1,584	3,690,000	1,411	2,910,000
Sand and gravel	3,722,555	2,955,630	3,710,707	3,002,683	3,966,345	3,450,858	3,680,173	3,523,524
Stone (except for cement and lime, 1952–53)	3,052,150	7,948,410	3,957,452	8,154,467	7,393,530	11,608,937	8,269,355	11,867,191
Talc	------	------	------	------	------	------	1,500	8,000
Value of items that cannot be disclosed: Native asphalt, bauxite, pozzolan cement, graphite (1952–53), mica, salt, and values indicated by footnote 3	------	7,330,582	------	5,092,087	------	4,855,545	------	4,325,207
Total Alabama	------	158,382,000	------	187,087,000	------	[4] 154,639,000	------	[4] 186,453,000

ARIZONA

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Brucite	------	------	100	$1,250	------	------	------	------
Clays	247,329	$579,175	197,401	715,248	253,672	$814,202	254,443	$868,664
Coal	5,003	33,000	5,140	32,135	10,925	68,110	8,898	59,286
Copper (recoverable content of ores, etc.)	395,719	191,527,996	393,525	225,883,350	377,927	222,976,930	454,105	338,762,330
Fluorspar	434	(3)	1,951	113,270	(3)	(3)	------	------
Gem stones	(5)	(3)	(5)	(3)	(5)	(3)	(5)	97,000
Gold (recoverable content of ores, etc.) .... troy ounces	112,355	3,932,425	112,824	3,948,840	114,809	4,018,315	127,616	4,466,560
Gypsum	11,314	28,285	13,484	43,824	(3)	(3)	(3)	(3)
Lead (recoverable content of ores, etc.)	16,520	5,319,440	9,428	2,470,136	8,385	2,297,490	9,817	2,925,466
Lime	53,019	757,390	96,408	1,238,204	88,932	1,131,334	112,028	1,437,632
Manganese ore (35 percent or more Mn) .... gross weight	203	(3)	(3)	(3)	------	------	1,444	(3)
Mercury .... 76-pound flasks	------	------	------	------	163	43,096	477	138,497
Mica (scrap)	(3)	(3)	3,721	114,870	1,682	17,773	1,353	8,742
Molybdenum (content of ore and concentrate) .... pounds	2,022,832	1,987,418	1,446,557	1,425,552	1,538,088	1,524,936	1,496,819	1,510,521
Perlite	2,747	14,568	1,511	9,824	1,296	6,990	10,568	83,956
Pumice	(3)	(3)	123,797	425,985	80,883	125,927	92,136	372,735
Sand and gravel	1,824,330	1,635,903	3,446,821	2,680,470	3,764,080	3,067,076	7,755,347	6,518,905
Silver (recoverable content of ores, etc.) .... troy ounces	4,701,330	4,254,941	4,351,429	3,938,263	4,298,811	3,890,641	4,634,179	4,194,166

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States [1]—Continued

ARIZONA—Continued

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Stone (except limestone for cement and lime, 1952–53)	235,020	$355,709	442,358	$618,748	1,205,452	$1,914,315	1,600,939	$2,328,566
Tungsten ore and concentrate ... 60-percent WO_3 basis	71	251,136	134	468,858	132	456,965	181	676,389
Zinc (recoverable content of ores, etc.)	47,143	15,651,476	27,530	6,331,900	21,461	4,635,576	22,684	5,580,264
Value of items that cannot be disclosed: Asbestos, barite, beryllium concentrate (1953–55), cement, columbium-tantalum concentrate (1955), diatomite (1954–55), feldspar, natural gas (1955), quartz (1952–53), vanadium, vermiculite (1952–54), and values indicated by footnote 3		[6] 6,495,214		[6] 8,010,194		[6] 8,171,649		9,201,394
Total Arizona		[6] 232,824,000		[6] 258,471,000		[4] [6] 254,479,000		[4] 378,277,000

ARKANSAS

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Barite	428,522	[7] $3,963,828	380,763	[7] $3,945,583	370,621	$3,488,483	462,986	$3,755,094
Bauxite ... long tons, dried equivalent	1,603,833	10,235,254	1,529,976	12,975,992	1,949,368	15,993,887	1,721,243	14,026,190
Clays	552,576	1,513,934	529,126	1,734,414	617,450	2,556,367	738,637	2,375,882
Coal	873,088	6,839,113	775,207	6,143,757	477,268	3,589,217	577,726	4,319,146
Gem stones							(5)	4,000
Iron ore (usable) ... long tons, gross weight	115	(3)	254	(3)	716	(3)		
Lead (recoverable content of ores, etc.)	4	1,288						
Manganese ore (35 percent or more Mn) ... gross weight	2,246	(3)	6,123	526,647	13,728	1,020,752	23,744	1,727,286
Manganiferous ore (5 to 35 percent Mn) ... do	896	(3)						
Natural gas ... million cubic feet	42,325	1,735,000	41,510	2,200,000	33,471	1,841,000	32,123	1,799,000
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	61,782	4,580,000	58,422	4,123,000	50,778	3,234,000	47,483	3,239,000
LP-gases ... do	49,098	2,079,000	55,188	2,562,000	58,506	2,521,000	57,088	2,169,000
Petroleum (crude) ... thousand 42-gallon barrels	29,440	72,420,000	29,681	77,170,000	29,130	79,520,000	28,369	76,880,000
Sand and gravel	5,011,095	4,977,219	4,903,835	4,955,383	6,611,860	6,566,806	9,003,162	7,662,942
Slate	(3)	(3)	34,516	315,858	41,845	379,076	(3)	(3)
Stone (except limestone for cement and lime, 1952–53)	[8] 2,967,479	[8] 3,346,201	[8] 3,545,350	[8] 5,069,750	4,604,067	5,929,638	6,176,313	8,025,634
Zinc (recoverable content of ores, etc.)	26	8,632						
Value of items that cannot be disclosed: Abrasive stones, cement, gypsum, lime, soapstone (1954–55), stone (dimension miscellaneous 1952), recovered elemental sulfur, and values indicated by footnote 3		5,987,245		5,367,669		5,742,325		7,615,676
Total Arkansas		117,687,000		127,090,000		[4] 131,745,000		[4] 132,822,000

CALIFORNIA

Antimony ore and concentrate...antimony content..	9	(3)						
Boron minerals...	583,828	$14,105,000	715,228	$17,668,000	790,449	$26,714,440	924,496	$33,816,464
Cement...376-pound barrels..	29,786,245	79,457,745	32,002,317	90,872,741	32,761,990	98,251,245	35,087,213	103,803,894
Chromite...gross weight..	14,713	[7] 1,269,000	26,512	2,078,461	30,661	2,285,250	22,105	1,834,277
Clays...	2,743,130	4,852,266	2,429,888	4,952,723	2,722,850	4,477,174	2,860,395	5,027,381
Coal (lignite)...	2,998	30,700			(3)	(3)	7,650	76,500
Copper (recoverable content of ores, etc.)...	800	387,200	382	219,268	362	213,580	613	457,298
Gem stones...	(5)	100,000	(5)	(3)	(5)	(3)	(5)	(3)
Gold (recoverable content of ores, etc.)...troy ounces..	258,176	9,036,160	234,591	8,210,685	237,886	8,326,010	251,737	8,810,795
Gypsum...	1,236,430	2,721,134	1,199,489	2,855,983	1,161,502	2,803,862	1,307,625	3,273,724
Iron ore (usable)...long tons, gross weight..	1,463,239	(3)	1,697,652	(3)	1,270,292	(3)	1,776,536	(3)
Lead (recoverable content of ores, etc.)...	11,199	3,606,078	8,664	2,269,968	2,671	731,854	8,265	2,462,970
Lime...	238,957	3,752,738	301,422	4,653,303	212,381	3,387,981	268,009	4,372,789
Magnesium compounds from sea water and bitterns (partly estimated) MgO equivalent...	50,277	3,529,362	55,886	3,483,483	40,969	2,715,689	58,042	3,833,409
Manganese ore (35 percent or more Mn)...gross weight..	8,081	(3)	5,413	(3)	831	45,091	3,136	270,519
Manganiferous ore (5 to 35 percent Mn)...do....	56	(3)	534	10,355	(3)	(3)		
Marl, calcareous...			6,028	21,102	5,464	21,965	(3)	(3)
Mercury...76-pound flasks..	7,241	1,441,683	9,290	1,793,249	11,262	2,977,560	9,875	2,867,206
Natural gas...million cubic feet..	517,450	86,414,000	531,346	104,675,000	507,289	104,502,000	538,178	119,476,000
Natural-gas liquids:								
Natural gasoline and cycle products..thousand gallons..	870,996	64,945,000	910,350	85,691,000	923,160	89,293,000	929,649	89,003,000
LP-gases...do....	393,792	16,700,000	397,572	21,961,000	396,186	22,262,000	360,902	19,379,000
Peat...	10,527	76,706	9,196	73,897	(3)	(3)	(3)	(3)
Perlite...	(3)	(3)	15,282	112,790	14,811	103,148	15,653	125,113
Petroleum (crude)...thousand 42-gallon barrels..	359,450	801,570,000	365,085	909,060,000	355,865	907,460,000	354,812	887,030,000
Pumice...	129,780	793,716	433,105	647,910	566,664	651,638	797,306	1,099,459
Salt (common)...	1,148,693	4,880,392	1,123,365	6,263,059	1,185,844	6,126,194	1,314,535	6,751,420
Sand and gravel...	53,051,260	43,633,125	58,429,528	53,224,203	70,524,612	68,138,578	64,878,648	66,820,360
Silver (recoverable content of ores, etc.)...troy ounces..	1,099,658	995,246	1,036,372	937,969	309,575	280,181	954,181	863,582
Stone (except limestone for cement and lime, 1952–53)...	14,374,930	17,697,085	14,497,348	18,472,652	23,303,756	37,541,114	[9] 24,708,321	[9] 37,164,384
Strontium minerals (crude)...			50	1,000	12	300	177	4,425
Sulfur ore...long tons..	(3)	(3)	152,203	(3)	185,085	(3)	199,599	(3)
Talc, pyrophyllite and soapstone...	[10] 120,574	[10] 2,868,255	[11] 126,442	[11] 1,132,700	[11] 133,474	[11] 1,211,201	[11] 166,551	[11] 1,552,783
Tungsten ore and concentrate...60-percent WO_3 basis..	2,980	11,360,569	2,382	8,939,146	3,512	13,209,371	4,383	16,200,924
Zinc (recoverable content of ores, etc.)...	9,419	3,127,108	5,358	1,232,340	1,415	305,640	6,836	1,681,656
Value of items that cannot be disclosed: Asbestos (1953, 1955), barite, bromine, calcium-magnesium chloride, carbon dioxide, diatomite, feldspar, abrasive garnet (1954–55), iodine, lithium minerals (1952–54), magnesite, mica (1952, 1954–55), molybdenum, platinum-group metals (crude), potassium salts, pyrites, quartz (1952–53), rare earth metal concentrate (1953–55), ground sandstone (1952–53), slate, sodium carbonate and sulfate, stone (dimension crushed marble 1953), recovered elemental sulfur, titanium iron concentrate (nontitanium use), wollastonite (1952), and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)...		35,779,821		[6] 42,473,296		43,737,983		56,730,574
Total California...		1,215,130,000		[6] 1,393,987,000		[4] 1,429,627,000		[4] 1,457,554,000

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States[1]—Continued

COLORADO

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Beryllium concentrate....gross weight..	54	$24,588	75	$39,515	60	$27,130	46	$22,950
Clays	568,730	1,087,154	777,969	1,429,780	854,791	1,002,873	464,231	1,117,901
Coal	3,623,015	19,215,657	3,547,850	19,197,732	2,899,791	16,078,581	3,567,930	20,100,174
Columbium-tantalum concentrate....pounds, gross weight..	[3]	[3]	[3]	[3]	4,967	9,897	4,325	7,254
Copper (recoverable content of ores, etc.)	3,606	1,745,304	2,941	1,688,134	4,523	2,668,570	4,323	3,224,958
Feldspar....long tons..	38,268	224,385	43,508	267,642	[3]	[3]	46,114	313,716
Fluorspar	29,185	1,505,968	53,276	2,872,360	59,197	3,197,252	[3]	[3]
Gem stones	[5]	[3]	[5]	[3]	[5]	[3]	[5]	48,000
Gold (recoverable content of ores, etc.)....troy ounces..	124,594	4,360,790	119,218	4,172,630	96,146	3,365,110	88,577	3,100,195
Gypsum	[3]	[3]	62,936	233,043	64,650	252,910	76,649	329,321
Iron ore (usable)....long tons, gross weight..	----	----	900	3,825	6,049	[3]	3,666	[3]
Lead (recoverable content of ores, etc.)	30,066	9,681,252	21,754	5,699,548	17,823	4,883,502	15,805	4,709,890
Manganiferous ore (5 to 35 percent Mn)....gross weight..	76	[3]	----	----	----	----	----	----
Mica (scrap)	[3]	[3]	1,599	19,455	[3]	[3]	699	12,596
Molybdenum (content of ore and concentrate)....pounds..	24,557,149	[3]	33,851,083	[3]	42,544,795	[3]	45,836,694	[3]
Natural gas....million cubic feet..	34,260	1,884,000	28,509	1,654,000	45,705	3,976,000	49,152	4,866,000
Peat	2,312	20,230	6,067	[3]	9,028	[3]	----	----
Petroleum (crude)....thousand 42-gallon barrels..	30,381	77,470,000	36,402	98,650,000	46,206	127,990,000	52,653	144,800,000
Pumice	[3]	[3]	47,919	99,700	[3]	[3]	70,530	162,605
Salt (common)	----	----	----	----	----	----	3,688	17,400
Sand and gravel	8,461,039	6,268,367	12,438,600	8,609,151	13,552,406	9,026,993	12,911,783	8,914,429
Silver (recoverable content of ores, etc.)....troy ounces..	2,813,643	2,546,489	2,200,317	1,991,398	3,417,072	3,092,623	2,772,073	2,508,866
Stone (except limestone for cement and lime, 1952–53)	1,708,872	2,566,401	[8] 884,104	[8] 1,750,726	1,804,004	2,112,093	2,149,019	3,508,053
Tin (content of ore and concentrate)....long tons..	13	33,723	[3]	[3]	[3]	[3]	[3]	[3]
Tungsten ore and concentrate....60-percent WO_3 basis..	625	2,354,664	817	2,902,490	927	3,420,563	1,152	4,079,341
Vanadium	4,197,914	[3]	4,530,612	[3]	4,528,472	[3]	4,595,359	[3]
Zinc (recoverable content of ores, etc.)	53,203	17,663,396	37,809	8,696,070	35,150	7,592,400	35,350	8,696,100
Value of items that cannot be disclosed: Carbon dioxide, cement, lithium minerals (1953–54), natural-gas liquids, perlite, pyrites, rare-earth metal concentrate (1955), stone (crushed basalt 1953), vermiculite (1954), and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)	----	[6] 41,199,963	----	[6] 52,712,795	----	[6] 67,874,211	----	76,871,285
Total Colorado	----	[6] 189,852,000	----	[6] 212,690,000	----	[4, 6] 255,852,000	----	[4] 286,121,000

CONNECTICUT

Beryllium concentrate .... gross weight			33	$14,321	13	$7,976	5	$3,185
Clays	157,500	$157,500	438,200	448,260	288,807	284,652	324,832	314,577
Feldspar .... long tons	10,929	87,432	9,829	63,049	9,280	60,463	(3)	(3)
Lime	(3)	(3)	(3)	(3)	(3)	(3)	34,917	503,253
Mica (sheet and scrap)	(3)	(3)	(3)	(3)	(3)	(3)	3	12,988
Peat	10,300	(3)	7,475	30,450	5,856	23,724	(3)	(3)
Sand and gravel	2,581,247	1,933,214	3,025,840	2,347,750	4,846,282	4,314,557	4,345,068	4,079,661
Stone (except limestone for lime, 1952–53)	2,837,045	4,101,060	[8] 2,826,568	[8] 4,235,327	2,829,198	4,269,430	[8] 3,641,992	[8] 5,451,550
Value of items that cannot be disclosed: Columbium-tantalum concentrate (1953–55), quartz (1952–53), stone (dimension basalt 1953, crushed granite and dimension limestone 1955), and values indicated by footnote 3		845,491		778,303		[6] 724,979		123,084
Total Connecticut		7,125,000		17,917,000		[12] 9,581,000		[12] 10,428,000

DELAWARE

Sand and gravel	515,399	$382,484	520,817	$399,685	971,647	$752,528	2,297,074	$1,407,196
Stone	94,911	251,759	80,364	215,382	(3)	(3)	78,791	227,450
Value of items that cannot be disclosed: Nonmetals and values indicated by footnote 3		42,805		43,930		194,706		22,872
Total Delaware		677,000		659,000		947,000		1,658,000

FLORIDA

Clays	197,711	$2,071,185	257,911	$2,952,359	371,948	$3,337,130	412,766	$4,815,855
Natural gas .... million cubic feet	15	1,000	34	2,000	35	3,000	36	4,000
Peat	23,729	154,164	27,678	185,524	37,449	168,004	61,098	231,829
Petroleum (crude) .... thousand 42-gallon barrels	591	(3)	543	(3)	548	(3)	495	(3)
Phosphate rock .... long tons	9,205,138	54,085,524	9,331,002	56,524,701	10,437,197	64,499,877	8,747,282	53,640,301
Sand and gravel	4,154,613	3,848,077	3,731,432	3,199,368	3,468,842	2,661,152	5,065,503	4,349,148
Stone (except limestone for cement and lime, 1952–53)	7,836,634	9,577,541	[8] 9,428,959	[8] 11,309,421	[8] 14,225,356	[8] 16,832,066	[8] 17,027,967	[8] 22,966,008
Titanium concentrate:								
Ilmenite .... gross weight	(3)	(3)	151,109	2,322,451	157,157	2,411,823	(3)	(3)
Rutile .... do	(3)	(3)	6,476	702,791	7,305	869,677	9,182	1,122,000
Zirconium concentrate	(3)	(3)	21,234	793,685	17,959	820,041	28,913	1,425,641
Value of items that cannot be disclosed: Cement, abrasive garnet, lime, monazite (1955), stone (dimension limestone 1953–55), and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)		13,140,989		14,343,637		15,955,786		22,787,056
Total Florida		82,878,000		92,336,000		[4] 106,510,000		[4] 108,957,000

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States [1]—Continued

GEORGIA

Minera	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Clays	2,562,182	$23,137,507	2,651,153	$23,455,315	2,711,422	$24,106,926	2,953,278	$26,144,672
Coal	32,100	160,500	14,100	70,500	8,090	40,450	12,471	62,360
Gem stones	---	---	---	---	---	---	(5)	400
Gold (recoverable content of ores, etc.) troy ounces	---	---	2	70	---	---	---	---
Iron ore (usable) long tons, gross weight	319,959	1,439,251	259,964	1,100,725	221,576	871,901	256,700	994,289
Iron oxide pigment materials (crude)	---	---	---	---	(3)	(3)	6,139	35,607
Lime	7,854	87,587	9,345	95,484	(3)	(3)	---	---
Mica (sheet) pounds	13,010	18,852	14,063	73,806	(3)	(3)	(3)	(3)
Peat	2,150	38,000	2,305	(3)	5,150	60,920	(3)	(3)
Sand and gravel	2,133,970	2,029,367	2,051,058	1,900,987	2,703,281	2,466,352	2,987,570	2,198,905
Sand and sandstone (ground)	1,765	17,650	(3)	(3)	(13)	(13)	(13)	(13)
Stone (except limestone for cement and lime, 1952–53)	7,132,082	17,166,108	7,112,024	17,756,302	8,057,600	21,384,227	[8] 7,488,452	[8] 14,249,830
Talc and soapstone	[10] 56,491	[10] 653,144	[11] 57,891	[11] 202,619	[11] 50,536	[11] 176,876	[11] 53,828	[11] 117,656
Value of items that cannot be disclosed: Asbestos (1952–54), barite, bauxite (1955), beryllium concentrate, cement, feldspar (1954–55), manganese ore (1954–55), manganiferous ore (1955), scrap mica, slate, stone (dimension and crushed marble and crushed sandstone 1955), and minerals indicated by footnote 3. Excludes value of clays used for cement (1952–53)	---	6,701,729	---	6,739,022	---	[6] 7,481,432	---	17,495,020
Total Georgia	---	51,450,000	---	51,395,000	---	[4, 6] 55,828,000	---	[4] 60,417,000

IDAHO

Minera	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Antimony ore and concentrate antimony content	4,173	(3)	(3)	(3)	764	(3)	633	(3)
Beryllium concentrate gross weight	---	---	1	$491	(3)	(3)	---	---
Clays	23,533	$24,683	26,229	21,339	(3)	(3)	35,003	$29,910
Cobalt (content of concentrate) pounds	196,516	(3)	1,211,039	(3)	1,702,272	(3)	1,691,334	(3)
Copper (recoverable content of ores, etc.)	3,213	1,555,092	3,136	1,800,064	4,828	$2,848,520	5,618	4,191,028
Gold (recoverable content of ores, etc.) troy ounces	32,997	1,154,895	17,630	617,050	13,245	463,575	10,572	370,020
Gypsum	400	1,200	150	450	(3)	(3)	(3)	(3)
Lead (recoverable content of ores, etc.)	73,719	23,737,518	74,610	19,547,820	69,302	18,988,748	64,163	19,120,574
Mercury 76-pound flasks	887	176,602	(3)	(3)	609	161,013	1,107	321,417
Mica: Scrap	170	5,100	---	---	(3)	(3)	---	---
Sheet pounds	20,020	115,572	24,216	223,266	(3)	(3)	(3)	(3)

Nickel (content of ore and concentrate)	----------	----------	11	(3)	13	(3)	33	(3)
Peat	----------	----------	----------	----------	500	(3)	(3)	(3)
Phosphate rock ... long tons	866, 330	2, 950, 160	1, 001, 969	4, 149, 943	1, 092, 817	5, 686, 609	1, 329, 959	6, 038, 088
Pumice	88, 085	141, 253	85, 224	159, 833	(3)	(3)	(3)	(3)
Sand and gravel	3, 925, 863	2, 745, 201	3, 776, 180	2, 841, 440	6, 717, 700	4, 568, 919	8, 652, 138	3, 933, 876
Sand and sandstone (ground)	9, 500	80, 000	5, 304	43, 865	(13)	(13)	(13)	(13)
Silver (recoverable content of ores, etc.) ... troy ounces	14, 923, 165	13, 506, 218	14, 639, 740	13, 249, 704	15, 867, 414	14, 360, 811	13, 831, 458	12, 518, 168
Stone (except limestone for cement, 1952–53)	[8] 1, 630, 034	[8] 2, 441, 236	1, 141, 626	2, 260, 875	2, 329, 005	3, 012, 613	[8] 1, 524, 810	[8] 1, 866, 076
Titanium-iron concentrate (nontitanium use)	----------	----------	1, 585	7, 500	----------	----------	1, 330	7, 000
Tungsten ore and concentrate ... 60-percent WO_3 basis	333	1, 245, 499	441	1, 665, 983	471	(3)	642	(3)
Zinc (recoverable content of ores, etc.)	74, 317	24, 673, 244	72, 153	16, 595, 190	61, 528	13, 290, 048	53, 314	13, 115, 244
Value of items that cannot be disclosed: Barite, cement, columbium-tantalum concentrate (1953, 1955), abrasive garnet, gem stones (1955), fluorspar (1953, 1955), monazite (1955), quartz (1953), stone (crushed limestone 1952, 1955), vanadium (1952–54), and values indicated by footnote 3	----------	[6] 3, 340, 915	----------	[6] 3, 878, 015	----------	[6] [12] 6, 307, 935	----------	[12] 7, 001, 832
Total Idaho	----------	[6] 77, 895, 000	----------	[6] 67, 063, 000	----------	[6] 69, 689, 000	----------	68, 513, 000

ILLINOIS

Cement ... 376-pound barrels	8, 710, 621	$20, 600, 347	8, 651, 385	$21, 961, 761	9, 109, 076	$23, 147, 871	9, 397, 098	$25, 031, 521
Clays	2, 337, 023	3, 871, 051	2, 305, 202	4, 573, 001	2, 027, 092	3, 482, 450	2, 338, 579	3, 978, 972
Coal	45, 789, 982	187, 827, 712	46, 009, 891	181, 597, 998	41, 971, 136	160, 213, 063	45, 932, 114	167, 937, 815
Fluorspar	188, 293	9, 481, 223	163, 303	8, 567, 026	107, 830	5, 989, 219	166, 337	7, 838, 471
Lead (recoverable content of ores, etc.)	4, 262	1, 372, 364	3, 391	888, 442	3, 232	885, 568	4, 544	1, 354, 112
Lime	460, 775	5, 917, 038	519, 992	6, 986, 560	532, 051	7, 420, 849	644, 181	9, 416, 136
Natural gas ... million cubic feet	10, 183	1, 650, 000	9, 282	1, 559, 000	9, 475	1, 345, 000	8, 033	1, 036, 000
Petroleum (crude) ... thousand 42-gallon barrels	60, 089	165, 850, 000	59, 026	170, 590, 000	66, 798	199, 060, 000	81, 423	236, 940, 000
Sand and gravel	19, 584, 308	19, 214, 195	21, 521, 806	20, 540, 549	24, 443, 055	26, 164, 387	26, 362, 360	28, 138, 973
Sand and sandstone (ground)	267, 180	2, 342, 549	276, 215	2, 461, 767	(13)	(13)	(13)	(13)
Silver (recoverable content of ores, etc.) ... troy ounces	3, 781	3, 422	2, 338	2, 116	1, 160	1, 050	3, 075	2, 783
Stone (except limestone for cement and lime, 1952–53)	22, 334, 887	28, 326, 060	22, 938, 732	29, 736, 966	26, 407, 088	31, 134, 135	28, 865, 724	35, 621, 394
Zinc (recoverable content of ores, etc.)	18, 816	6, 246, 912	14, 556	3, 347, 880	14, 427	3, 116, 232	21, 700	5, 338, 200
Value of items that cannot be disclosed: Iron oxide pigments (1954), natural-gas liquids, peat, recovered elemental sulfur (1953–55), tripoli, and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)	----------	7, 302, 545	----------	9, 629, 924	----------	13, 060, 485	----------	13, 068, 501
Total Illinois	----------	460, 005, 000	----------	462, 443, 000	----------	[4] 473, 077, 000	----------	[4] 533, 464, 000

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States [1]—Continued

INDIANA

Mineral	1952		1953		1954		1955	
	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	1,331,298	$1,700,209	1,654,112	$2,514,227	1,946,069	$2,990,716	1,729,299	$2,938,010
Coal	16,350,202	64,977,328	15,812,485	62,353,519	13,400,188	48,913,455	16,149,310	58,000,085
Marl, calcareous (except for cement)	16,414	9,021	13,540	6,398	28,536	18,515	17,080	10,543
Natural gas ... million cubic feet	836	79,000	701	49,000	735	44,000	1,226	152,000
Peat	10,115	49,775	6,919	41,049	(3)	(3)	(3)	(3)
Petroleum (crude) ... thousand 42-gallon barrels	12,037	33,100,000	12,823	37,570,000	11,204	33,160,000	10,988	31,980,000
Sand and gravel	11,546,014	9,279,908	11,203,059	9,500,914	14,405,098	11,879,316	17,081,982	14,306,348
Stone (except limestone for cement and lime, 1952–53)	9,126,837	21,965,454	9,212,887	22,297,183	11,181,838	27,460,119	14,124,406	34,679,589
Value of items that cannot be disclosed: Abrasive stones, cement, gypsum (1955), lime, pyrites (1952–53), recovered elemental sulfur, and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)		30,870,155		35,448,379		[6] 42,448,082		43,887,787
Total Indiana		162,031,000		169,781,000		[4] 165,369,000		[4] 183,479,000

IOWA

Mineral	1952		1953		1954		1955	
	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	9,336,727	$22,849,597	9,111,358	$23,330,177	9,858,889	$27,044,464	10,429,943	$29,538,987
Clays	864,667	2,681,789	913,413	974,539	882,849	920,859	(3)	(3)
Coal	1,380,733	5,297,074	1,388,006	5,262,373	1,196,698	4,502,561	1,258,357	4,401,857
Gypsum	1,122,409	2,797,704	1,151,692	2,939,654	1,106,626	3,035,651	1,337,160	4,176,710
Lead (recoverable content of ores, etc.)					4	1,096		
Peat	14,500	110,334	17,233	(3)	(3)	(3)	(3)	(3)
Sand and gravel	10,796,979	6,032,898	10,385,322	6,400,827	12,199,656	9,276,530	11,770,836	8,344,832
Stone (except limestone for cement 1952–53)	9,899,404	13,036,726	10,715,078	13,215,352	13,240,087	16,388,141	15,705,412	18,555,176
Value of items that cannot be disclosed: Nonmetals and minerals indicated by footnote 3				224,242		251,173		1,252,282
Total Iowa		[16] 52,481,000		[16] 51,994,000		[4] 58,798,000		[4] 63,555,000

KANSAS

Cement [15] ......376-pound barrels..	8, 811, 762	$20, 956, 886	8, 546, 250	$21, 428, 536	9, 076, 328	$23, 874, 179	9, 454, 270	$25, 854, 037
Clays..........	665, 582	789, 293	670, 694	749, 579	(3)	(3)	767, 662	873, 016
Coal..........	2, 028, 601	7, 902, 590	1, 715, 004	7, 101, 386	1, 372, 294	5, 602, 808	742, 282	3, 165, 868
Helium..........cubic feet..	38, 509, 000	491, 000	42, 782, 800	563, 923	37, 530, 000	593, 163	42, 750, 000	662, 619
Lead (recoverable content of ores, etc.)..........	5, 916	1, 904, 952	3, 347	876, 914	4, 033	1, 105, 042	5, 498	1, 638, 404
Natural gas..........million cubic feet..	412, 544	34, 241, 000	420, 607	36, 172, 000	412, 369	43, 711, 000	471, 041	52, 286, 000
Natural-gas liquids:								
Natural gasoline..........thousand gallons..	115, 206	7, 286, 000	(3)	(3)	(3)	(3)	118, 599	6, 318, 000
LP-gases..........do....	77, 406	3, 116, 000	(3)	(3)	(3)	(3)	92, 596	2, 643, 000
Petroleum (crude)..........thousand 42-gallon barrels..	114, 807	293, 910, 000	114, 566	308, 180, 000	119, 317	335, 280, 000	121, 669	340, 670, 000
Pumice..........	(3)	(3)	(3)	(3)	23, 433	92, 899	2, 320	59, 710
Salt (common)..........	911, 744	6, 850, 027	905, 227	7, 480, 556	876, 667	7, 778, 406	910, 866	8, 432, 325
Sand and gravel..........	8, 380, 065	5, 023, 593	8, 728, 291	5, 668, 308	10, 421, 554	7, 194, 171	10, 664, 986	6, 909, 666
Stone (except limestone for cement, 1952–53)..........	8, 830, 871	12, 051, 740	8, 769, 152	11, 303, 950	10, 377, 008	12, 941, 822	[9] 12, 483, 390	[9] 15, 946, 190
Zinc (recoverable content of ores, etc.)..........	25, 482	8, 460, 024	15, 515	3, 568, 450	19, 110	4, 127, 760	27, 611	6, 792, 306
Value of items that cannot be disclosed: Natural cement, fire clay, gypsum, and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)..........	....	386, 847	....	10, 137, 870	....	9, 721, 342	....	1, 615, 934
Total Kansas..........	....	403, 370, 000	....	413, 231, 000	....	[4] 449, 587, 000	....	[4] 470, 830, 000

KENTUCKY

Clays..........	880, 874	$5, 101, 266	711, 209	$3, 118, 352	571, 481	$2, 994, 926	875, 699	$4, 416, 131
Coal..........	66, 114, 341	317, 386, 725	65, 060, 478	302, 871, 877	56, 964, 408	236, 736, 940	69, 019, 910	288, 665, 344
Fluorspar..........	48, 308	1, 863, 262	47, 244	2, 100, 493	35, 831	1, 510, 344	8, 899	308, 140
Lead (recoverable content of ores, etc.)..........	60	19, 320	52	13, 624	80	21, 920	....	....
Natural gas..........million cubic feet..	73, 427	15, 934, 000	71, 405	15, 638, 000	72, 713	16, 579, 000	73, 214	17, 352, 000
Natural-gas liquids:								
Natural gasoline..........thousand gallons..	30, 660	2, 191, 000	35, 406	2, 394, 000	28, 224	1, 552, 000	34, 991	2, 492, 000
LP-gases..........do....	156, 198	3, 963, 000	176, 232	4, 993, 000	189, 966	5, 066, 000	189, 247	6, 451, 000
Petroleum (crude)..........thousand 42-gallon barrels..	11, 918	32, 890, 000	11, 518	33, 520, 000	13, 791	40, 270, 000	15, 518	44, 850, 000
Sand and gravel..........	3, 334, 261	2, 656, 053	3, 052, 155	2, 899, 932	4, 729, 606	4, 401, 793	4, 898, 705	5, 298, 102
Stone (except limestone for cement, 1952–53)..........	[8] 8, 817, 859	[8] 10, 816, 707	[8] 7, 429, 505	[8] 9, 268, 237	10, 129, 725	13, 285, 786	11, 933, 899	15, 579, 312
Zinc (recoverable content of ores, etc.)..........	3, 280	1, 088, 960	489	112, 470	458	98, 928	....	....
Value of items that cannot be disclosed: Native asphalt, cement, and stone (dimension sandstone, 1952–53)..........	....	4, 535, 564	....	4, 811, 752	....	5, 625, 951	....	6, 445, 725
Total Kentucky..........	....	398, 446, 000	....	381, 742, 000	....	[4] 327, 503, 000	....	[4] 391, 068, 000

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States [1]—Continued

LOUISIANA

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Clays	390,136	$433,808	624,427	$951,612	[16] 713,940	[16] $940,940	[16] 651,268	[16] $659,099
Gypsum	(3)	(3)	(3)	(3)	(3)	(3)	335,371	586,900
Natural gas ... million cubic feet	1,237,143	82,889,000	1,293,644	106,079,000	1,399,222	124,531,000	1,680,032	189,844,000
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	672,042	48,579,000	665,532	55,421,000	665,070	54,330,000	782,328	59,158,000
LP-gases ... do	297,444	14,890,000	287,280	12,654,000	292,226	11,620,000	291,138	10,323,000
Petroleum (crude) ... thousand 42-gallon barrels	243,929	645,090,000	256,632	721,150,000	246,558	722,370,000	271,010	793,280,000
Salt (common)	2,553,448	7,807,693	3,061,234	9,189,526	3,088,686	11,101,456	3,562,636	15,406,993
Sand and gravel	6,005,119	6,736,524	4,538,387	5,162,248	7,910,152	9,686,635	8,574,020	10,941,860
Stone	(3)	(3)	-----	-----	[9] 2,043,872	[9] 3,127,124	[9] 3,252,585	[9] 4,961,657
Sulfur (Frasch-process) ... long tons	1,449,668	32,015,000	1,609,364	43,453,000	1,853,563	49,222,394	2,072,418	58,027,704
Value of items that cannot be disclosed: Cement, bentonite, lime (1953–55), recovered elemental sulfur, and values indicated by footnote 3. Excludes clays used for cement (1952–53)	-----	9,959,888	-----	11,176,929	-----	[6] 13,334,241	-----	15,308,896
Total Louisiana	-----	848,401,000	-----	965,237,000	-----	[6] [12] 998,057,000	-----	[12] 1,156,637,000

MAINE

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Beryllium concentrate ... gross weight	(3)	(3)	(3)	(3)	(3)	(3)	22	$12,672
Cement ... 376-pound barrels	1,457,250	$3,750,483	2,001,464	$5,422,272	1,973,249	$5,425,184	2,348,517	6,875,445
Clays	26,050	26,050	29,661	27,476	26,872	26,872	32,598	32,598
Feldspar ... long tons	18,644	147,371	17,637	117,090	(3)	(3)	26,282	188,961
Gem stones	-----	-----	-----	-----	(5)	(3)	(5)	5,000
Mica:								
Scrap	(3)	(3)	(3)	(3)	(3)	(3)	71	1,922
Sheet ... pounds	(3)	(3)	(3)	(3)	10,320	36,894	21,121	128,721
Peat	1,695	57,541	2,428	73,564	(3)	(3)	(3)	(3)
Sand and gravel	7,078,078	2,187,531	8,071,937	2,608,386	7,460,620	2,538,143	7,528,903	2,855,585
Stone (except limestone for cement and lime, 1952–53)	[8] 316,874	[8] 1,795,768	[8] 248,501	[8] 1,215,439	1,023,709	2,355,385	1,192,361	2,542,228
Value of items that cannot be disclosed: Columbium-tantalum concentrate (1953–55), lime, quartz from pegmatites or quartzite (1952–53), slate, stone (crushed limestone (1952–53), and values indicated by footnote 3	-----	1,015,827	-----	1,038,883	-----	[6] 865,077	-----	857,353
Total Maine	-----	8,981,000	-----	10,503,000	-----	[12] 10,716,000	-----	[12] 12,991,000

MARYLAND

Clays	771,922	$1,426,556	671,164	$1,135,700	627,311	$1,165,747	698,257	$1,264,948
Coal	587,903	2,694,842	530,590	2,441,605	421,616	1,879,018	512,469	2,001,743
Lime	72,885	746,893	71,705	707,736	67,081	685,427	74,497	669,228
Natural gas ... million cubic feet	2,372	460,000	1,408	268,000	1,394	282,000	3,116	626,000
Sand and gravel	6,956,640	8,136,697	7,379,511	8,919,088	10,097,800	12,171,613	9,694,928	12,210,658
Stone (except limestone for cement and lime, 1952–53)	[8] 3,391,679	[8] 6,330,443	[8] 3,578,250	[8] 6,275,124	5,064,526	8,265,521	[8] 5,342,968	[8] 8,800,044
Value of items that cannot be disclosed: Beryllium concentrate (1954), cement, greensand marl (1954–55), mica (1954), potassium salts, quartz (1952), slate, stone (dimension limestone and crushed marble 1952–53, oystershells 1955), and talc and soapstone. Excludes value of clays used for cement (1952–53)	----------	7,051,145	----------	7,337,486	----------	7,288,888	----------	11,027,986
Total Maryland	----------	26,847,000	----------	27,085,000	----------	[4] 30,743,000	----------	[4] 35,491,000

MASSACHUSETTS

Clays	140,148	$160,371	152,117	$195,837	128,998	$121,049	124,832	$141,654
Lime	132,135	1,999,545	135,383	2,156,205	127,836	1,709,341	134,952	1,957,346
Peat	(3)	(3)	2,061	15,962	(3)	(3)	(3)	(3)
Sand and gravel	7,645,728	6,128,744	7,308,190	5,930,894	9,640,274	8,366,409	9,580,943	8,926,329
Stone (except limestone for lime, 1952–53)	[8] 3,355,819	[8] 9,331,871	3,457,708	8,821,108	2,942,435	9,039,590	4,128,003	11,381,164
Value of items that cannot be disclosed: Mineral fuels and nonmetals	----------	191,752	----------	71,368	----------	12,077	----------	5,933
Total Massachusetts	----------	17,812,000	----------	17,191,000	----------	[12] 18,851,000	----------	[12] 22,109,000

MICHIGAN

Cement ... 376-pound barrels	14,760,783	$36,819,042	15,853,096	$41,860,464	16,711,710	$45,691,867	19,738,400	$58,048,400
Clays	1,775,917	1,810,916	1,645,804	1,686,113	1,870,814	1,919,204	1,937,593	2,019,077
Copper (recoverable content of ores, etc.)	21,699	10,502,316	24,097	13,831,678	23,593	13,919,870	50,066	37,349,236
Gem stones	----------	----------	----------	----------	----------	----------	(5)	250
Gypsum	1,487,642	4,200,418	1,446,973	4,091,002	1,693,279	5,035,550	1,762,105	5,660,587
Iron ore (usable) ... long tons, gross weight	11,779,366	76,088,935	13,312,766	94,691,612	9,709,167	70,004,504	14,143,509	104,258,188
Magnesium compounds from well brine (partly estimated) MgO equivalent	38,449	3,917,138	43,190	4,591,922	37,038	4,103,766	46,336	5,063,621
Manganiferous ore (5 to 35 percent Mn) ... gross weight	22,095	(3)	76,251	(3)	15,361	(3)	----------	----------
Marl, calcareous (except for cement)	164,519	86,529	183,685	72,781	106,668	37,724	119,313	57,176
Natural gas ... million cubic feet	9,052	1,322,000	7,774	1,275,000	6,962	1,239,000	8,300	955,000
Peat	29,304	419,856	25,439	257,176	(3)	(3)	(3)	(3)

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States [1]—Continued

MICHIGAN—Continued

Minera	1952		1953		1954		1955	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
Petroleum (crude)......thousand 42-gallon barrels..	13, 251	$35, 250, 000	12, 285	$35, 870, 000	12, 028	$35, 600, 000	11, 266	$32, 900, 000
Salt (common)......	4, 778, 347	21, 446, 382	5, 127, 387	22, 171, 988	5, 063, 633	29, 396, 812	4, 975, 442	31, 668, 351
Sand and gravel......	29, 193, 763	22, 400, 879	30, 459, 663	23, 170, 802	32, 040, 639	25, 516, 169	37, 214, 459	29, 490, 775
Silver (recoverable content of ores, etc.)......troy ounces..							478, 000	432, 614
Stone (except limestone for cement and lime, 1952–53)......	17, 973, 685	15, 770, 816	21, 615, 686	17, 639, 525	27, 758, 443	21, 904, 517	33, 635, 612	28, 908, 784
Value of items that cannot be disclosed: Bromine, calcium-magnesium chloride, lime, magnesium chloride for magnesium metal, natural-gas liquids, potassium salts, ground sand and sandstone (1952–53), and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)......	......	24, 482, 809	......	25, 276, 772	......	[6] 29, 271, 636	......	31, 849, 463
Total Michigan......	......	254, 518, 000	......	286, 487, 000	......	[4] [6] 279, 940, 000	......	[4] 363, 787, 000

MINNESOTA

Minera	1952		1953		1954		1955	
	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......	113, 492	$160, 408	91, 401	$149, 384	(3)	(3)	(3)	(3)
Gem stones......							(5)	$175
Iron ore (usable)......long tons, gross weight..	63, 906, 069	375, 765, 251	80, 533, 670	517, 850, 509	48, 613, 338	$319, 632, 491	69, 419, 334	465, 169, 412
Manganiferous ore (5 to 35 percent Mn)......gross weight..	912, 118	(3)	1, 091, 491	(3)	504, 057	(3)	864, 628	(3)
Marl, calcareous (except for cement)......	1, 449	722	(3)	(3)	(3)	(3)	(3)	(3)
Sand and gravel......	19, 825, 157	6, 808, 763	19, 774, 411	7, 304, 351	23, 848, 856	16, 318, 520	25, 896, 426	17, 429, 334
Stone (except limestone for cement and lime, 1952–53)......	[8] 2, 394, 178	[8] 5, 498, 177	2, 770, 528	6, 587, 096	[8] 2, 629, 456	[8] 7, 485, 291	[8] 3, 004, 521	[8] 7, 042, 840
Value of items that cannot be disclosed: Abrasive stones, cement, iron oxide pigments, lime, manganese ore (1955), peat (1954–55), stone (crushed basalt 1952, crushed sandstone 1954–55), and values indicated by footnote 3......	......	9, 206, 865	......	10, 653, 888	......	[6] 8, 204, 448	......	11, 739, 266
Total Minnesota......	......	397, 440, 000	......	542, 545, 000	......	[12] 351, 474, 000	......	[12] 501, 151, 000

MISSISSIPPI

Clays	509,099	$2,681,563	560,047	$3,158,385	559,401	$3,103,132	700,615	$3,913,113
Natural gas ... million cubic feet	174,100	10,620,000	154,254	12,340,000	140,448	11,657,000	163,167	15,664,000
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	33,726	2,606,000	32,214	2,295,000	27,804	1,944,000	22,382	1,573,000
LP-gases ... do	19,614	777,000	17,724	713,000	15,288	528,000	12,242	396,000
Petroleum (crude) ... thousand 42-gallon barrels	36,310	80,970,000	35,620	84,060,000	34,240	85,600,000	37,741	92,840,000
Sand and gravel	2,296,577	1,833,306	2,653,646	2,173,871	5,441,837	4,286,871	5,624,878	4,603,032
Stone	90,000	103,500	38,000	43,700	[6] 181,418	181,418	572,816	572,816
Value of items that cannot be disclosed: Certain nonmetals. Excludes value of clays used for cement (1952–53)		2,283,312		3,083,749		3,352,481		3,589,504
Total Mississippi		101,875,000		107,868,000		[12] 110,563,000		[12] 122,620,000

MISSOURI

Barite	304,080	$2,919,795	330,763	$3,338,395	312,791	$3,047,436	363,692	$4,003,842
Cement ... 376-pound barrels	10,086,850	25,523,038	9,860,179	26,238,460	11,379,257	31,425,190	12,255,346	34,912,186
Clays	2,991,019	12,098,420	2,231,596	11,182,096	1,927,285	5,858,756	2,402,401	6,902,323
Coal	2,954,450	12,048,141	2,393,304	9,848,903	2,513,593	10,028,293	3,232,485	12,771,570
Copper (recoverable content of ores, etc.)	2,576	1,246,784	2,374	1,362,676	1,925	1,135,750	1,722	1,284,612
Iron ore (usable) ... long tons, gross weight	268,218	(3)	274,693	(3)	173,394	(3)	260,560	(3)
Lead (recoverable content of ores, etc.)	129,245	41,616,890	125,895	32,984,490	125,250	34,318,500	125,412	37,372,776
Lime	1,130,970	11,326,941	1,212,107	12,084,130	1,125,919	11,165,381	1,464,828	14,408,279
Natural gas ... million cubic feet	16	3,000	15	3,000	16	(3)	15	3,000
Petroleum (crude) ... thousand 42-gallon barrels	21	(3)	39	(3)	(3)	(3)	72	190,000
Sand and gravel	6,790,422	6,122,195	5,792,058	5,233,999	9,891,305	10,203,481	[9] 9,983,624	[9] 9,980,878
Silver (recoverable content of ores, etc.) ... troy ounces	517,432	468,302	359,781	325,620	352,971	319,457	268,620	243,115
Stone (except limestone for cement and lime, 1952–53)	15,106,544	20,676,958	[8] 13,947,834	[8] 20,552,840	18,672,239	24,751,610	[8, 9] 22,368,768	[8, 9] 29,580,414
Zinc (recoverable content of ores, etc.)	13,986	4,643,352	9,981	2,295,630	5,210	1,125,360	4,476	1,101,096
Value of items that cannot be discosed: Native asphalt, masonry cement (1955), cobalt (1955), iron oxide pigment materials (1955), manganese ore (1953–54), nickel (content of ore, 1955), ground sand and sandstone (1952–53), stone (dimension marble 1953, 1955), tripoli (1952–54), and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)		2,283,550		2,756,746		2,908,454		4,833,392
Total Missouri		140,977,000		128,207,000		[4] 131,280,000		[4] 151,626,000

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States [1]—Continued

MONTANA

Minera	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Chromite ....gross weight..	----------	----------	26,089	$869,958	123,096	$4,132,475	118,703	$3,718,882
Clays	51,304	$73,601	36,994	38,312	(3)	(3)	(3)	(3)
Coal:								
Bituminous	2,038,808	5,698,778	1,848,334	4,884,209	1,490,846	4,157,325	1,247,253	3,781,879
Lignite	30,550	112,953	24,803	93,551	(3)	(3)	(17)	(17)
Copper (recoverable content of ores, etc.)	61,948	29,982,832	77,617	44,552,158	59,349	35,015,910	81,542	60,830,332
Fluorspar	16,160	(3)	5,932	(3)	15,102	(3)	25,223	(3)
Gold (recoverable content of ores, etc.) ....troy ounces..	24,161	845,635	24,768	866,880	23,660	828,100	28,123	984,305
Iron ore (usable) ....long tons, gross weight..	----------	----------	6,709	45,083	6,473	(3)	6,631	(3)
Lead (recoverable content of ores, etc.)	21,279	6,851,838	19,949	5,226,638	14,820	4,060,680	17,028	5,074,344
Manganese ore (35 percent or more Mn) ....gross weight..	100,070	(3)	113,429	(3)	58,661	(3)	106,026	(3)
Manganiferous ore (5 to 35 percent Mn) ....do....	9,357	(3)	5,598	(3)	5,266	(3)	6,341	(3)
Natural gas ....million cubic feet..	28,714	1,752,000	27,889	1,645,000	30,252	2,057,000	28,255	1,724,000
Petroleum (crude) ....thousand 42-gallon barrels..	9,606	21,610,000	11,920	26,020,000	14,195	31,230,000	15,654	35,380,000
Pumice	----------	----------	3,000	15,000	175	920	(3)	(3)
Sand and gravel	6,765,955	3,579,932	6,203,480	2,993,575	13,340,544	7,460,260	13,771,609	6,615,326
Silver (recoverable content of ores, etc.) ....troy ounces..	6,138,185	5,555,367	6,689,556	6,054,386	5,177,942	4,686,299	6,080,390	5,503,060
Stone (except limestone for cement and lime, 1952–53)	[8] 690,081	[8] 792,897	[8] 802,735	[8] 1,124,731	1,319,829	1,385,239	1,273,600	1,199,619
Tungsten ore and concentrate ....60-percent WO_3 basis..	----------	----------	14	(3)	678	(3)	1,211	(3)
Zinc (recoverable content of ores, etc.)	82,185	27,285,420	80,271	18,462,330	60,952	13,165,632	68,588	16,872,648
Value of items that cannot be disclosed: Antimony ore and concentrate (1953), barite, cement, gem stones, gypsum, lime, sheet mica (1954), natural-gas liquids, phosphate rock, pyrites, stone (dimension granite 1952–53), talc, vermiculite and values indicated by footnote 3	----------	17,928,016	----------	19,292,629	----------	18,518,856	----------	25,637,201
Total Montana	----------	122,069,000	----------	132,184,000	----------	[12] 126,412,000	----------	[12] 166,993,000

NEBRASKA

Clays	167,228	$167,703	175,856	$186,893	163,831	$163,831	150,835	$150,835
Gem stones							(5)	2,400
Natural gas ... million cubic feet	5,568	740,000	6,748	911,000	6,801	796,000	12,515	2,553,000
Petroleum (crude) ... thousand 42-gallon barrels	2,260	6,490,000	6,344	17,190,000	7,783	21,400,000	11,203	30,810,000
Sand and gravel	5,436,540	3,874,106	5,969,858	4,340,163	8,547,876	6,992,314	8,405,197	6,192,797
Stone (except limestone for cement, 1952–53)	1,245,106	1,946,448	1,407,158	2,069,984	2,660,170	3,511,494	3,081,247	4,177,361
Value of items that cannot be disclosed: Cement, natural-gas liquids, and pumice. Excludes value of clays used for cement (1952–53)		7,378,888		8,582,904		10,637,123		11,143,474
Total Nebraska		20,597,000		33,281,000		[4] 42,393,000		[4] 54,237,000

NEVADA

Antimony ore and concentrate ... antimony content	152	(3)	20	(3)	4	(3)		
Barite	68,062	$391,242	99,525	$614,686	83,833	$517,492	113,694	$708,804
Clays	3,958	36,278	(3)	(3)	5,478	8,787	6,155	13,385
Copper (recoverable content of ores, etc.)	57,537	27,847,908	61,850	35,501,900	70,217	41,428,030	78,925	58,878,050
Gold (recoverable content of ores, etc.) ... troy ounces	117,203	4,102,105	101,799	3,562,965	79,067	2,767,345	72,913	2,551,955
Gypsum	608,284	1,666,938	701,584	1,975,053	654,422	2,217,273	836,744	2,835,922
Iron ore (usable) ... long tons, gross weight	911,657	3,991,970	444,081	2,647,859	351,250	2,024,794	324,602	1,667,098
Lead (recoverable content of ores, etc.)	6,790	2,186,380	4,371	1,145,202	3,041	833,234	3,291	980,718
Manganese ore (35 percent or more Mn) ... gross weight	695	(3)	20,150	1,684,555	(3)	(3)	101,469	(3)
Manganiferous ore (5 to 35 percent Mn) ... do	7,947	(3)	25,064	431,559	12,870	165,075		
Mercury ... 76-pound flasks	3,523	701,429	3,254	628,120	4,974	1,315,076	5,750	1,669,512
Petroleum (crude) ... thousand 42-gallon barrels					33	40,000	64	110,000
Pumice	(3)	(3)	21,269	86,366	(3)	(3)	(3)	(3)
Sand and gravel	2,098,211	2,380,419	2,266,064	2,088,948	3,531,291	2,956,537	3,580,260	3,762,384
Silver (recoverable content of ores, etc.) ... troy ounces	941,195	851,829	697,086	630,898	560,182	506,993	845,397	765,127
Stone (except limestone for lime, 1952–53)	830,712	1,158,608	1,035,568	1,399,529	1,832,781	2,010,592	1,611,942	2,608,900
Talc and soapstone	[10] 7,580	[10] 180,328	[11] 10,906	[11] 72,971	[11] 5,866	[11] 53,582	[11] 10,732	[11] 90,086
Tungsten ore and concentrate ... 60-percent WO_3 basis	2,329	8,820,598	3,683	13,824,238	5,331	20,048,448	6,155	22,750,662
Zinc (recoverable content of ores, etc.)	15,357	5,098,524	5,812	1,336,760	1,035	223,560	2,670	656,820
Value of items that cannot be disclosed: Brucite (1952–54), diatomite, fluorspar, gem stones, lime, magnesite, calcareous marl, molybdenum, perlite, salt, sulfur ore (1952–53 and 1955), and values indicated by footnote 3		4,816,659		5,891,368		12,435,384		13,751,734
Total Nevada		64,231,000		73,523,000		[12] 89,138,000		[12] 113,231,000

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States[1]—Continued

NEW HAMPSHIRE

Minera	1952		1953		1954		1955	
	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	(3)	(3)	57	$32,640	12	$6,960	20	$11,975
Clays	30,135	$30,135	45,198	41,427	35,681	35,681	35,184	35,184
Columbium-tantalum concentrate, pounds, gross weight	----------	----------	770	1,309	255	433	(3)	(3)
Feldspar, long tons	(3)	(3)	28,961	286,069	(3)	(3)	(3)	(3)
Gem stones	----------	----------	----------	----------	----------	----------	(5)	5,000
Mica:								
Sheet, pounds	(3)	(3)	90,716	382,680	42,466	234,450	(3)	(3)
Scrap	(3)	(3)	(3)	(3)	325	11,583	(3)	(3)
Sand and gravel	3,209,232	1,001,591	2,249,001	506,156	2,240,548	1,094,474	2,432,146	1,592,580
Stone	69,850	546,177	76,701	538,897	72,486	473,298	(3)	(3)
Value of items that cannot be disclosed: Abrasive stones, peat, and values indicated by footnote 3	----------	366,597	----------	15,617	----------	255,226	----------	960,197
Total New Hampshire	----------	1,945,000	----------	1,805,000	----------	2,112,000	----------	2,605,000

NEW JERSEY

Minera	1952		1953		1954		1955	
	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	598,775	$1,962,599	532,185	$1,326,297	578,344	$1,246,099	644,192	$1,561,994
Gem stones	----------	----------	----------	----------	----------	----------	(5)	16
Iron ore (usable), long tons, gross weight	685,466	6,760,467	815,905	10,114,970	476,192	6,621,881	759,550	13,633,370
Manganiferous residuum, gross weight	215,255	(3)	293,758	(3)	214,931	(3)	213,370	(3)
Marl (greensand)	4,600	177,847	6,821	193,404	2,101	184,834	(3)	(3)
Peat	21,800	191,664	21,706	(3)	(3)	(3)	(3)	(3)
Sand and gravel	7,060,074	9,473,428	7,361,935	10,835,948	10,005,325	14,704,474	11,152,552	16,424,417
Sand and sandstone (ground)	138,434	1,011,844	127,921	918,534	(13)	(13)	(13)	(13)
Stone (except limestone for lime, 1952–53)	6,102,324	12,307,480	6,036,259	13,307,856	5,772,200	12,109,950	[8] 8,357,599	[8] 17,527,890
Sulfur, recovered elemental, long tons	(3)	(3)	(3)	(3)	(3)	(3)	7,404	243,984
Zinc (recoverable content of ores, etc.)[18]	59,190	21,520,612	45,700	9,922,990	37,416	7,992,058	11,643	2,863,945
Value of items that cannot be disclosed: Lime, magnesium compounds, stone (crushed marble 1955), and values indicated by footnote 3	----------	4,061,840	----------	5,325,148	----------	[12] 4,184,432	----------	[12] 5,239,378
Total, New Jersey	----------	57,468,000	----------	51,945,000	----------	47,044,000	----------	57,495,000

NEW MEXICO

Beryllium concentrate .... gross weight	101	$29,185	89	$52,014	117	$43,771	106	$56,420
Clays	57,668	107,633	49,089	103,931	47,832	83,085	45,351	108,582
Coal	759,437	4,382,286	513,781	3,081,366	123,099	727,372	201,579	1,236,125
Columbium-tantalum concentrate .... pounds, gross weight			(3)	(3)	2,093	3,558	76	129
Copper (recoverable content of ores, etc.)	76,112	36,838,208	72,477	41,601,798	60,558	35,729,220	66,417	49,547,082
Fluorspar	16,443	823,320	11,890	(3)	8,876	(3)	(3)	(3)
Gem stones	(5)	(3)	(5)	(3)	(5)	(3)	(5)	25,000
Gold (recoverable content of ores, etc.) .... troy ounces	2,949	103,215	2,614	91,490	3,539	123,865	1,917	67,095
Gypsum					887	2,661		
Helium .... cubic feet			11,158,000	150,127	41,754,600	735,183	53,721,000	946,447
Iron ore (usable) .... long tons, gross weight	7,793	(3)	7,525	(3)	3,316	(3)	9,218	(3)
Lead (recoverable content of ores, etc.)	7,021	2,260,762	2,943	771,066	887	243,038	3,296	982,208
Manganese ore (35 percent or more Mn) .... gross weight	2,360	(3)					1,390	(3)
Manganiferous ore (5 to 35 percent Mn) .... do	52,934	(3)	(3)	(3)	20,546	82,184	40,320	(3)
Mica:								
Scrap							84	2,475
Sheet .... pounds					2,054	13,845	9,431	64,930
Natural gas .... million cubic feet	359,377	16,414,000	399,086	24,344,000	449,346	35,049,000	540,664	48,119,000
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	163,926	11,660,000	171,654	10,094,000	224,112	11,744,000	261,023	15,425,000
LP-gases .... do	114,408	3,600,000	121,212	4,618,000	225,994	5,704,000	278,403	6,767,000
Perlite	(3)	(3)	84,891	661,698	111,040	885,824	147,805	1,091,250
Petroleum (crude) .... thousand 42-gallon barrels	58,681	144,940,000	70,441	185,260,000	74,820	205,760,000	82,958	227,310,000
Potassium salts .... K_2O equivalent	1,411,125	46,385,452	1,552,831	58,076,435	1,732,240	64,366,641	1,826,118	69,057,754
Pumice	217,482	755,139	528,649	759,840	363,926	1,060,096	393,597	780,339
Salt (common)	(3)	(3)	62,087	216,364	50,669	333,255	49,738	596,780
Sand and gravel	496,921	499,589	1,416,380	1,238,979	6,519,339	8,340,251	4,556,447	6,004,554
Silver (recoverable content of ores, etc.) .... troy ounces	479,318	433,807	205,309	185,815	109,132	98,770	251,072	227,233
Stone	[8] 317,894	[8] 191,642	624,528	510,713	771,630	714,037	1,573,441	1,546,665
Tungsten ore and concentrate .... 60-percent WO_3 basis					(19)	1,414	1	3,036
Zinc (recoverable content of ores, etc.)	50,975	16,923,700	13,373	3,075,790	6	1,296	15,277	3,758,142
Value of items that cannot be disclosed: Barite, carbon dioxide, diatomite (1953–55), molybdenum, magnesium compounds (1954), stone (crushed miscellaneous 1952), recovered elemental sulfur (1953—55), vanadium, and values indicated by footnote 3		[6] 2,125,730		[6] 1,651,604		[6] 1,672,426		2,187,727
Total, New Mexico		[6] 288,474,000		[6] 336,545,000		[6] 373,519,000		435,911,000

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States [1]—Continued

NEW YORK

Mineral	1952		1953		1954		1955	
	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 [15] ......376-pound barrels	14,624,274	$36,679,379	14,965,164	$39,388,183	14,496,876	$38,861,205	17,942,126	$52,150,099
Clays	1,218,850	1,291,736	960,791	1,303,281	1,199,158	1,493,503	1,393,665	1,676,215
Emery	10,352	141,911	10,562	143,974	9,758	132,313	10,735	151,455
Gem stones							(5)	194
Gypsum	1,143,920	3,816,148	987,156	3,507,207	1,133,579	4,005,353	1,249,119	4,403,895
Iron ore (usable) ......long tons, gross weight	2,896,531	34,514,879	3,414,859	36,346,279	2,802,873	31,706,570	3,201,927	38,018,783
Lead (recoverable content of ores, etc.)	1,120	360,640	1,435	375,970	1,187	325,238	1,037	309,026
Lime	(3)	(3)	(3)	(3)	(3)	(3)	82,890	1,365,481
Natural gas ......million cubic feet	3,267	1,059,000	2,347	742,000	2,598	847,000	3,637	1,073,000
Peat	(3)	(3)	3,775	46,307	(3)	(3)	(3)	(3)
Petroleum (crude) ......thousand 42-gallon barrels	4,242	17,940,000	3,800	16,260,000	3,257	11,140,000	2,904	10,310,000
Salt (common)	3,417,443	16,746,462	3,322,659	17,351,111	3,412,636	22,754,118	3,779,547	25,214,191
Sand and gravel	20,270,058	18,287,623	22,530,891	23,493,857	30,082,333	29,756,301	25,561,941	25,542,363
Silver (recoverable content of ores, etc.) ......troy ounces	38,895	35,202	35,398	32,037	34,576	31,293	66,162	59,880
Slate	125,930	1,810,865	113,575	1,733,332	114,929	1,742,048	90,668	1,344,715
Stone (except limestone for cement and lime, 1952–53)	16,234,549	25,244,245	[8] 15,961,657	[8] 25,250,576	19,410,121	31,425,701	22,812,222	37,919,063
Talc	[10] 149,837	[10] 4,069,771	[11] 156,299	[11] 940,541	(3)	(3)	(3)	(3)
Zinc (recoverable content of ores, etc.)	32,636	10,835,152	51,529	11,851,670	53,199	11,490,984	53,106	13,041,936
Value of items that cannot be disclosed: Abrasive stone (1953–54), beryllium concentrate (1954), natural cement, abrasive garnet, iron oxide pigments (1955), calcareous marl (1952–54), pyrites (1952), stone (crushed unclassified 1953), recovered elemental sulfur (1952, 1954), titanium concentrate, wollastonite and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)		7,917,911		8,102,030		[6] 9,882,438		8,772,755
Total New York		180,751,000		186,868,000		[4 6] 192,738,000		[4] 216,907,000

NORTH CAROLINA

Abrasive stones	(9)	$28,992	(9)	$16,150	587	$12,125	[20] 227	$12,104
Clays	1,357,700	2,080,172	1,466,232	2,534,908	1,872,541	2,519,721	2,375,494	1,792,081
Coal	1,600	12,684						
Copper (recoverable content of ores, etc.)					(19)	106	(19)	112
Feldspar ... long tons	240,364	2,416,031	268,042	3,290,495	230,744	2,220,707	242,724	2,184,793
Gem stones							(5)	10
Gold (recoverable content of ores, etc.) ... troy ounces					214	7,490	190	6,650
Lead (recoverable content of ores, etc.)					4	1,049	2	596
Mica:								
Scrap	58,576	1,551,071	56,834	1,428,793	61,049	1,457,122	60,887	1,377,035
Sheet ... pounds	595,331	664,075	619,895	1,308,494	479,221	1,787,197	553,444	2,745,234
Sand and gravel	8,724,748	5,665,169	6,910,982	4,992,991	7,441,200	5,508,284	7,785,741	5,911,223
Silver (recoverable content of ores, etc.) ... troy ounces					438	396	181	164
Stone	[8] 9,647,513	[8] 14,694,698	[6 8] 9,316,823	[8] 14,424,323	10,133,728	15,625,331	10,903,366	16,532,910
Talc and pyrophyllite	[10] 115,481	[10] 1,771,518	[11] 119,341	[11] 578,239	[11] 112,704	[11] 388,428	125,206	571,689
Tin (content of ore and concentrate) ... long tons	4	11,601						
Titanium concentrate (ilmenite) ... gross weight	25,328	177,296						
Tungsten concentrate ... 60-percent WO_3 basis	1,254	(3)	2,074	(3)	2,538	(3)	2,609	(3)
Value of items that cannot be disclosed: Abrasive stone (millstones 1954), asbestos (1953–55), beryllium concentrate (1953–55), columbium-tantalum concentrate (1952–53), lithium minerals, manganiferous ores (1953), olivine, quartz (1952–53), stone (dimension and crushed marble 1952–53), vermiculite and values indicated by footnote 3		5,652,311		9,876,773		12,122,942		10,074,950
Total North Carolina		34,726,000		38,451,000		41,651,000		41,210,000

NORTH DAKOTA

Clays	(3)	(3)	23,084	$47,862	(3)	(3)	(3)	(3)
Coal (lignite)	2,983,752	$7,068,259	2,802,558	6,617,980	(3)	(3)	3,102,087	$7,261,120
Natural gas ... million cubic feet	369	23,000	498	34,000	1,093	$69,000	5,256	405,000
Petroleum (crude) ... thousand 42-gallon barrels	1,549	(3)	5,183	10,370,000	6,025	12,890,000	11,143	32,200,000
Pumice							3,500	10,000
Sand and gravel	6,557,069	1,841,216	6,173,737	2,164,685	7,105,466	2,219,747	11,168,849	2,637,988
Stone	67,064	4,968	35,031	2,595	1,419	3,784	77,366	80,560
Value of items that cannot be disclosed: Certain nonmetals and values indicated by footnote 3		3,119,900				7,040,820		1,528,636
Total North Dakota		12,057,000		19,237,000		22,223,000		44,123,000

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States [1]—Continued

OHIO

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Cement ... 376-pound barrels	11,377,806	$28,488,500	12,532,437	$32,957,308	13,076,921	$35,929,163	14,913,719	$42,965,924
Clays	5,493,830	13,643,742	5,634,596	9,327,706	5,051,478	11,136,478	6,297,413	15,677,389
Coal	36,208,450	138,090,700	34,736,773	131,475,408	32,468,728	117,519,936	37,869,791	133,814,166
Lime	2,205,432	28,393,260	2,945,800	35,310,353	2,549,046	31,444,083	3,038,949	39,393,634
Natural gas ... million cubic feet	30,993	6,725,000	37,542	8,334,000	28,824	6,111,000	33,756	7,595,000
Natural-gas liquids:								
Natural gasoline ... thousand gallons	1,596	114,000	(3)	(3)	(3)	(3)	(3)	(3)
Peat	24,828	290,664	27,696	260,474	29,540	356,970	22,484	249,427
Petroleum (crude) ... thousand 42-gallon barrels	3,350	10,020,000	3,610	9,710,000	3,880	10,710,000	4,353	12,580,000
Salt (common)	2,827,455	5,991,626	3,040,237	7,484,795	2,748,993	12,358,521	2,905,028	14,768,761
Sand and gravel	20,751,493	23,069,458	24,032,388	27,076,276	25,827,220	27,873,469	27,906,047	31,995,215
Stone (except limestone for cement and lime, 1952–53)	[8] 24,693,189	[8] 36,197,485	[8] 25,285,782	[8] 39,041,308	32,626,737	47,802,169	33,272,567	49,841,246
Value of items that cannot be disclosed: Abrasive stones, calcium-magnesium chloride, gypsum, ground sand and sandstone (1952–53), stone (crushed unclassified 1952, dimension unclassified 1952–53), and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)	-----	1,664,191	-----	1,264,540	-----	2,084,098	-----	2,864,455
Total Ohio	-----	292,689,000	-----	302,242,000	-----	[4] 293,659,000	-----	[4] 340,457,000

OKLAHOMA

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Clays	520,050	$577,420	577,557	$637,082	452,050	$1,282,848	[16] 724,156	[16] $726,856
Coal	2,193,409	12,687,855	2,167,594	13,226,881	1,914,834	11,264,692	2,163,536	12,667,563
Lead (recoverable content of ores, etc.)	15,137	4,874,114	9,304	2,437,648	14,204	3,891,896	14,126	4,209,548
Natural gas ... million cubic feet	554,033	29,918,000	599,955	41,397,000	616,355	43,145,000	614,976	45,508,000
Natural-gas liquids:								
Natural gasoline and cycle products ... thousand gallons	405,720	29,459,000	433,650	28,066,000	478,590	24,332,000	504,692	28,770,000
LP-gases ... do	376,026	14,090,000	414,036	14,886,000	453,810	13,506,000	512,320	14,297,000
Petroleum (crude) ... thousand 42-gallon barrels	190,435	487,510,000	202,570	546,940,000	185,851	518,520,000	202,817	563,830,000
Sand and gravel	3,769,663	2,911,845	5,011,366	4,258,585	5,424,131	4,265,031	6,293,798	4,785,786
Stone (except limestone for cement and lime, 1952–53)	[8] 9,636,475	[8] 8,974,334	8,489,994	7,930,737	[8] 9,238,811	[8] 9,146,995	10,933,355	12,295,274

Zinc (recoverable content of ores, etc.)	54,916	18,232,112	33,413	7,684,990	43,171	9,324,936	41,543	10,219,578
Value of items that cannot be disclosed: Native asphalt, bentonite (1955), cement, gypsum, lime, pumice (1952-54), salt, ground sand and sandstone (1952-53), stone (dimension limestone, 1952 and 1954), recovered elemental sulfur (1953-55), and tripoli (1953-55). Excludes value of clays used for cement (1952-53)		12,116,791		11,538,234		12,584,340		15,525,248
Total Oklahoma		621,351,000		679,003,000		[4] 650,205,000		[4] 711,089,000
OREGON								
Chromite ... gross weight	6,591	$507,981	6,216	$484,453	6,655	$537,928	5,341	$463,514
Clays	277,072	569,968	292,445	296,050	(3)	(3)	250,608	275,916
Coal	1,179	8,650						
Copper (recoverable content of ores, etc.)	1	484	9	5,166	5	2,950	4	2,984
Gold (recoverable content of ores, etc.) ... troy ounces	5,509	192,815	8,488	297,080	6,520	228,200	1,708	59,780
Iron ore (usable) ... long tons							1,786	(3)
Lead (recoverable content of ores, etc.)	1	322	5	1,310	5	1,370	3	894
Manganese ore (35 percent or more Mn) ... gross weight			46	(3)				
Manganiferous ore (5 to 35 percent Mn) ... do			271	(3)				
Mercury ... 76-pound flasks	868	172,819	648	125,083	489	129,287	1,056	306,610
Nickel (content of ore and concentrate)					1,993	(3)	4,181	(3)
Pumice	59,578	201,809	73,080	173,822	67,852	177,515	(3)	(3)
Sand and gravel	12,219,486	8,556,218	8,763,078	8,629,632	13,157,239	14,149,380	11,953,878	11,832,344
Silver (recoverable content of ores, etc.) ... troy ounces	4,037	3,654	12,259	11,095	14,335	12,974	8,815	7,978
Stone (except limestone for cement and lime, 1952-53)	6,250,849	8,893,368	[8] 4,939,080	[8] 6,301,639	5,872,353	8,617,795	7,741,937	9,417,834
Tungsten ore and concentrate ... 60-percent WO_3 basis	4	15,960	(19)	(3)	(19)	(3)	1	(3)
Zinc (recoverable content of ores, etc.)	1	332						
Value of items that cannot be disclosed: Carbon dioxide, cement, diatomite, gem stones, iron oxide pigments (1954), lime (1952), perlite (1952-53), quartz (1952-53), stone (crushed granite 1953), and values indicated by footnote 3		7,549,366		8,123,493		[6] 9,634,139		10,500,091
Total Oregon		26,674,000		24,449,000		[4] 32,268,000		[4] 31,736,000
PENNSYLVANIA								
Cement ... 376-pound barrels	40,037,761	$103,388,586	42,093,765	$114,002,846	43,068,234	$117,912,299	48,089,578	$141,969,042
Clays	3,731,130	12,639,864	3,575,287	9,987,928	3,524,398	10,243,485	4,019,909	12,413,093
Coal:								
Anthracite	40,582,558	379,714,076	30,949,152	299,139,687	29,083,477	247,870,023	26,204,554	206,096,662
Bituminous	89,181,232	473,475,646	93,330,871	516,490,411	72,010,101	378,658,531	85,713,456	440,451,700
Cobalt (content of concentrate) ... pounds	639,856	(3)	564,450	(3)	517,124	(3)	478,840	(3)
Copper (recoverable content of ores, etc.)	3,485	1,686,740	3,027	1,737,498	(3)	(3)	(3)	(3)
Gem stones							(5)	60
Gold (recoverable content of ores, etc.) ... troy ounces	1,500	52,500	1,134	39,690	1,317	46,095	1,610	56,350

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States [1]—Continued

PENNSYLVANIA—Continued

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Iron ore (usable)...long tons, gross weight	992,110	(3)	1,020,826	(3)	708,109	(3)	838,349	(3)
Iron oxide pigments (crude)							519	$6,714
Lime (open-market)	1,202,981	$13,842,213	1,335,300	$16,010,114	1,081,583	$13,206,310	1,424,051	17,631,795
Natural gas...million cubic feet	108,684	30,758,000	105,558	30,717,000	145,934	43,634,000	99,172	29,652,000
Natural-gas liquids:								
Natural gasoline...thousand gallons	7,182	548,000	(3)	(3)	4,830	320,000	4,305	281,000
LP-gases...do	798	75,000	1,008	90,000	1,008	89,000	995	90,000
Peat	7,898	43,874	8,232	47,516	15,621	141,352	23,277	219,628
Petroleum (crude)...thousand 42-gallon barrels	11,233	47,740,000	10,649	45,680,000	9,107	31,150,000	8,531	30,200,000
Sand and gravel	14,696,106	19,920,003	14,715,383	20,692,391	14,218,444	20,595,990	13,312,971	20,511,847
Pyrophyllite sericite schist			2,463	[7] 4,926	1,898	8,541	(3)	(3)
Silver (recoverable content of ores, etc.)...troy ounces	9,247	8,369	6,972	6,310	8,415	7,616	10,379	9,394
Slate	214,860	4,487,648	202,386	4,419,612	194,205	4,419,439	186,035	4,421,298
Stone (except limestone for cement and lime, 1952–53)	[8] 25,609,812	[8] 44,676,456	[8] 26,192,607	[8] 48,094,029	40,521,756	61,193,419	44,437,623	70,056,080
Sulfur, recovered elemental...long tons	(3)	(3)	(3)	(3)	(3)	(3)	7,738	263,370
Tripoli	(3)	(3)	(3)	(3)	(3)	(3)	990	21,780
Value of items that cannot be disclosed: Graphite (crystalline 1953), mica, pyrites, ground sand and sandstone (1952–53), stone (dimension basalt 1952–53), and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)		12,575,843		14,461,911		12,548,574		15,819,073
Total Pennsylvania		1,145,633,000		1,121,622,000		[4] 925,545,000		[4] 971,064,000

RHODE ISLAND

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Sand and gravel	589,451	$557,396	898,393	$775,700	1,013,014	$979,470	1,940,738	$1,498,552
Stone	168,993	654,782	161,632	617,096	(3)	(3)	(3)	(3)
Value of items that cannot be disclosed: Certain nonmetals and values indicated by footnote 3		37,500		69,000		481,186		335,932
Total Rhode Island		1,250,000		1,462,000		1,461,000		1,834,000

SOUTH CAROLINA

Clays	947,278	$4,675,261	964,356	$4,801,921	1,136,019	$4,702,027	1,086,492	$5,463,179
Sand and gravel	1,048,099	892,312	2,975,608	2,564,484	2,813,750	2,550,260	3,126,952	2,677,054
Stone	[8] 2,914,839	[8] 3,881,178	[8] 2,913,860	[8] 3,976,370	[8] 2,861,953	[8] 4,233,270	3,455,388	4,920,697
Value of items that cannot be disclosed: Barite, cement, kyanite, mica (1954–55), dimension granite (1952–54), and vermiculite. Excludes value of clays used for cement (1952–53)	----------	5,236,961	----------	6,428,135	----------	6,373,880	----------	7,399,847
Total South Carolina	----------	14,686,000	----------	17,771,000	----------	[12] 17,744,000	----------	[12] 20,197,000

SOUTH DAKOTA

Beryllium concentrate ... gross weight	334	$166,251	392	$157,656	337	$139,663	294	$157,046
Clays	292,791	2,640,640	330,983	2,826,074	(3)	(3)	(3)	(3)
Coal (lignite)	----------	----------	23,671	82,117	(3)	(3)	25,782	90,240
Columbium-tantalum concentrate ... pounds, gross weight	(3)	(3)	4,431	9,002	25,447	43,260	5,638	9,584
Feldspar ... long tons	40,163	220,954	50,601	321,026	(3)	(3)	42,164	267,286
Gem stones	----------	----------	(5)	(3)	(5)	5,000	(5)	7,400
Gold (recoverable content of ores, etc.) ... troy ounces	482,534	16,888,690	534,987	18,724,545	541,445	18,950,575	529,865	18,545,275
Gypsum	(3)	(3)	(3)	(3)	8,518	11,073	12,592	16,369
Iron ore (usable) ... long tons, gross weight	----------	----------	1,060	(3)	2,040	(3)	2,048	(3)
Lead (recoverable content of ores, etc.)	2	644	10	2,620	----------	----------	----------	----------
Mica:								
Scrap	915	24,148	1,687	27,388	1,510	26,943	1,322	26,853
Sheet ... pounds	4,308	32,034	11,174	77,352	16,299	65,222	4,854	21,383
Natural gas ... million cubic feet	6	300	5	[7] 250	7	[7] 350	----------	----------
Sand and gravel	5,846,140	2,478,314	5,402,378	2,817,726	[6] 14,819,228	7,840,393	13,537,801	10,096,828
Silver (recoverable content of ores, etc.) ... troy ounces	132,102	119,559	138,642	125,478	151,407	137,031	154,092	139,461
Stone (except limestone for cement and lime, 1952–53)	1,671,187	4,806,882	[8] 1,189,444	[8] 4,997,497	1,614,818	4,928,855	2,262,246	5,679,444
Tungsten concentrate ... 60-percent WO_3 basis	(19)	335	2	(3)	(19)	500	----------	----------
Value of items that cannot be disclosed: Cement, lime, lithium minerals (1952–54), petroleum (1954–55), stone (dimension miscellaneous 1953), vanadium (1954), and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)	----------	3,076,258	----------	3,654,587	----------	[6] 6,121,186	----------	6,114,433
Total South Dakota	----------	30,455,000	----------	33,823,000	----------	[4 6] 37,874,000	----------	[4] 40,526,000

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States [1]—Continued

TENNESSEE

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Cement ....376-pound barrels	7,428,604	$17,834,060	7,276,964	$18,283,366	7,569,279	$19,734,262	8,811,853	$23,673,112
Clays	1,042,239	3,519,143	1,037,450	3,478,622	1,015,256	3,780,952	1,207,613	4,169,885
Coal	5,264,954	25,559,740	5,466,569	25,151,682	6,428,831	25,477,006	7,052,844	28,746,574
Copper (recoverable content of ores, etc.)	7,620	3,688,080	7,829	4,493,846	9,087	5,361,861	9,911	7,393,569
Fluorspar	348	(3)	426	(3)				
Gold (recoverable content of ores, etc.) ....troy ounces	241	8,435	293	10,255	218	7,630	221	7,735
Iron ore (usable) ....long tons, gross weight	(3)	(3)	12,751	82,499	(3)	(3)	(3)	(3)
Lead (recoverable content of ores, etc.)	18	5,796	9	2,358				
Lime	100,189	1,005,235	114,474	1,177,461	80,372	968,078	103,257	1,102,005
Manganese ore (35 percent or more Mn) ....gross weight	126	(3)	2,625	201,898	11,823	919,949	15,895	1,280,102
Natural gas ....million cubic feet	107	11,000	89	11,000	89	10,000	39	5,000
Petroleum (crude) ....thousand 42-gallon barrels	15	(3)	16	(3)	(3)	(3)	(3)	(3)
Phosphate rock ....long tons	1,444,737	11,306,438	1,518,912	11,305,098	1,633,226	11,743,012	1,465,902	10,526,404
Sand and gravel	5,173,401	5,303,321	5,231,329	5,629,687	5,155,185	6,141,139	5,136,543	5,814,116
Silver (recoverable content of ores, etc.) ....troy ounces	57,569	52,103	68,935	62,390	60,795	54,990	66,619	60,294
Stone (except limestone for cement and lime, 1952–53)	10,377,320	17,652,763	[8] 10,485,351	[8] 16,948,053	14,040,187	22,046,016	[8] 14,381,481	[8] 22,276,037
Zinc (recoverable content of ores, etc.)	38,020	12,622,640	38,465	8,846,950	30,326	6,550,345	40,216	9,893,136
Value of items that cannot be disclosed: Barite, manganiferous ore (1954), pyrites, stone (crushed granite 1953 and crushed sandstone 1954), and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)		2,363,399		2,364,412		5,479,590		6,994,403
Total Tennessee		100,932,000		98,050,000		[4] 105,686,000		[4] 119,316,000

TEXAS

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Abrasive stone: Pebbles (grinding)	510	$3,100	400	$5,500	(3)	(3)	(3)	(3)
Cement ....376-pound barrels	19,849,455	48,042,901	19,140,193	48,497,762	21,928,170	$56,674,124	24,855,680	$67,548,627
Clays	2,069,020	4,470,182	2,370,975	4,678,974	2,400,924	7,002,024	[16] 3,096,959	[16] 5,099,922
Copper (recoverable content of ores, etc.)	18	8,712					1	746
Feldspar ....long tons	2,600	31,200			(3)	(3)	(3)	(3)
Gem stones	(5)	(3)	(5)	(3)	(5)	100,000	(5)	115,000
Gold (recoverable content of ores, etc.) ....troy ounces	39	1,365						
Gypsum	1,021,161	2,682,019	1,067,854	2,860,633	1,218,048	3,773,230	1,349,434	4,219,652
Helium ....cubic feet	107,301,332	1,405,096	103,711,334	1,388,671	110,588,471	1,873,860	139,397,000	2,271,642
Iron ore (usable) ....long tons, gross weight	787,193	(3)	1,014,937	(3)	914,949	(3)	875,443	(3)
Lead (recoverable content of ores, etc.)	56	18,032						

Lime	281,604	2,622,975	475,569	4,380,831	547,436	5,421,732	584,855	5,549,309
Manganese ore (35 percent or more Mn)........gross weight..	56	(3)	------	------	------	------	------	------
Natural gas........million cubic feet..	4,147,805	257,164,000	4,383,158	333,120,000	4,551,232	386,855,000	4,730,798	378,464,000
Natural-gas liquids:								
Natural gasoline and cycle products...thousand gallons..	2,589,594	188,500,000	2,750,370	200,479,000	2,732,100	200,559,000	2,987,808	206,506 000
LP-gases........do....	2,456,874	88,635,000	2,777,880	109,131,000	2,983,962	95,913,000	3,450,430	110,414,000
Peat	1,200	12,000	1,375	(3)	(3)	(3)	------	------
Petroleum (crude)........thousand 42-gallon barrels..	1,022,139	2,641,860,000	1,019,164	2,777,900,000	974,275	2,768,490,000	1,053,297	2,989,330,000
Salt (common)	2,640,209	4,402,032	2,845,190	5,010,624	2,864,312	9,310,339	3,583,242	12,867,094
Sand and gravel	18,661,403	17,275,255	15,101,226	12,845,561	26,315,635	24,840,811	31,518,123	28,480,350
Silver (recoverable content of ores, etc.)........troy ounces..	4,672	4,228	------	------	100	90	126	114
Sodium sulfate (natural)	(3)	(3)	(3)	(3)	(3)	(3)	46,718	1,099,522
Stone (except limestone for cement and lime, 1952–53)	7,604,468	8,664,633	[8] 9,095,109	[8] 8,550,320	[8] 25,840,338	[8] 29,343,684	27,321,444	33,543,782
Sulfur (Frasch-process)........long tons...	3,691,724	78,910,000	3,614,838	97,601,000	3,474,477	92,791,821	3,766,882	105,128,170
Sulfur, recovered elemental........do....	38,344	872,134	84,717	2,202,381	107,232	2,889,100	114,989	3,143,606
Talc and soapstone	[10] 17,800	[10] 216,569	[11] 16,210	[11] 70,658	[11] 19,362	[11] 127,855	[11] 35,064	[11] 213,366
Zinc (recoverable content of ores, etc.)	3	996	------	------	------	------	------	------
Value of items that cannot be disclosed: Native asphalt, bromine, clay (fuller's earth 1955), coal (lignite 1954–55), graphite, magnesium chloride (for metal), magnesium compounds (except for metal), mercury (1955), pumice, stone (crushed basalt 1953, dimension sandstone 1954), and values indicated by footnote 3. Excludes value of clays sold or used for cement (1952–53)	------	34,010,619	------	39,189,833	------	[6] 52,527,152	------	50,069,384
Total Texas	------	3,379,813,000	------	3,647,913,000	------	[4, 6] 3,730,705,000	------	[4] 3,993,310,000

UTAH

Asphalt and related bitumens, native: Gilsonite	60,740	$1,779,815	60,505	$2,184,328	75,943	$2,724,023	82,822	$3,117,310
Carbon dioxide, natural (estimated)....thousand cubic feet..	84,500	10,000	(3)	(3)	(3)	(3)	(3)	(3)
Clays	189,723	1,125,299	188,348	1,447,515	(3)	(3)	(3)	(3)
Coal	6,140,305	32,410,303	6,544,145	37,689,144	5,007,952	29,761,341	6,295,524	40,005,140
Copper (recoverable content of ores, etc.)	282,894	136,920,696	269,496	154,690,704	211,835	124,982,650	232,949	173,779,954
Fluorspar	17,304	438,699	15,527	374,944	4,403	82,353	7,328	151,140
Gem stones	------	------	------	------	------	------	(5)	6,000
Gold (recoverable content of ores, etc.)........troy ounces..	435,507	15,242,745	483,430	16,920,050	403,401	14,119,035	441,206	15,442,210
Iron ore (usable)........long tons, gross weight..	3,990,505	15,025,899	4,617,288	26,496,950	3,040,646	19,277,434	3,847,402	24,687,485
Lead (recoverable content of ores, etc.)	50,210	16,167,620	41,522	10,878,764	44,972	12,322,328	50,452	15,034,696
Lime	(3)	(3)	(3)	(3)	30,428	431,828	38,710	582,760
Manganese ore (35 percent or more Mn)........gross weight..	95	(3)	550	(3)	25	(3)	------	------
Manganiferous ore (5 to 35 percent Mn)........do....	3,397	(3)	5,155	82,316	97	(3)	------	------
Natural gas........million cubic feet..	3,006	225,000	7,075	807,000	16,024	2,259,000	17,163	2,386,000
Petroleum (crude)........thousand 42-gallon barrels..	1,737	(3)	1,807	(3)	1,905	4,480,000	2,227	5,140,000
Pumice	(3)	(3)	3,880	4,385	3,588	3,788	2,041	20,011
Salt (common)	136,125	522,721	154,088	772,035	166,506	1,020,061	195,726	1,339,085
Sand and gravel	3,260,044	2,350,412	4,627,808	3,179,690	5,327,969	3,592,286	5,158,265	3,309,280
Silver (recoverable content of ores, etc.)........troy ounces..	7,194,109	6,511,032	6,725,807	6,087,195	6,179,243	5,592,527	6,250,565	5,657,077
Stone (except limestone for cement and lime, 1952–53)	[8] 852,351	[8] 1,123,108	997,330	1,446,594	1,127,461	1,545,841	1,925,867	2,650,480

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States [1]—Continued

UTAH—Continued

Mineral	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Tungsten ore and concentrate ..... 60-percent WO_3 basis	3	$9,449	35	$123,445	84	$308,634	65	$224,742
Vanadium ..... pounds	194,532	(3)	385,038	(3)	575,884	(3)	995,873	(3)
Zinc (recoverable content of ores, etc.)	32,947	10,938,404	29,184	6,712,320	34,031	7,350,696	43,556	10,714,776
Value of items that cannot be disclosed: Cement, gypsum, molybdenum, natural gasoline, perlite, phosphate rock (1953–55), potassium salts, stone (crushed marble 1952), and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)	.....	[6] 24,874,851	.....	[6] 28,692,061	.....	[6] 26,203,114	.....	28,733,292
Total Utah	.....	[6] 265,676,000	.....	[6] 298,589,000	.....	[6] [12] 255,495,000	.....	[12] 331,929,000

VERMONT

Mineral	1952 Short tons	1952 Value	1953 Short tons	1953 Value	1954 Short tons	1954 Value	1955 Short tons	1955 Value
Clays	(3)	(3)	(3)	(3)	(3)	(3)	14,200	$14,200
Copper (recoverable content of ores, etc.)	3,774	$1,826,616	3,947	$2,265,578	4,352	$2,567,680	4,305	3,211,530
Gem stones	.....	.....	.....	.....	.....	.....	(5)	8
Gold (recoverable content of ores, etc.) ..... troy ounces	162	5,670	171	5,985	185	6,475	181	6,335
Pyrites ..... long tons	17,892	(3)	19,486	(3)	20,713	(3)	(3)	(3)
Sand and gravel	1,264,490	749,835	1,113,607	690,073	1,481,549	1,110,996	1,763,229	1,169,031
Silver (recoverable content of ores, etc.) ..... troy ounces	45,361	41,054	43,128	39,033	48,572	43,960	50,447	45,657
Stone (except limestone for lime, 1952–53)	404,391	6,016,530	527,150	8,859,703	436,870	8,178,389	581,749	11,061,196
Talc	[10] 71,027	[10] 926,646	[11] 80,209	[11] 240,627	[11] 66,195	[11] 198,585	(3)	(3)
Value of items that cannot be disclosed: Asbestos, lime, slate, and values indicated by footnote 3	.....	8,324,329	.....	8,201,333	.....	[6] 8,400,809	.....	8,399,641
Total Vermont	.....	17,891,000	.....	20,302,000	.....	[12] 20,483,000	.....	[12] 23,884,000

VIRGINIA

Mineral	1952 Short tons	1952 Value	1953 Short tons	1953 Value	1954 Short tons	1954 Value	1955 Short tons	1955 Value
Beryllium concentrate ..... gross weight	.....	.....	.....	.....	(19)	$39	(19)	$389
Clays	940,496	$996,351	952,266	$927,571	704,843	723,292	935,941	873,348
Coal	21,579,368	114,861,137	19,119,050	102,022,118	16,387,292	72,901,277	23,507,509	108,173,907
Gem stones	.....	.....	.....	.....	.....	.....	(5)	344
Lead (recoverable content of ores, etc.)	3,792	1,221,024	2,788	730,456	4,320	1,183,680	2,997	893,106
Lime	442,845	4,448,924	477,384	4,947,418	445,158	4,610,645	494,293	5,048,697
Manganese ore (35 percent or more Mn) ..... gross weight	1,011	(3)	8,454	635,926	22,678	1,780,934	32,654	2,779,337
Marl, calcareous (except for cement)	(3)	(3)	(3)	(3)	33,174	21,079	(3)	(3)
Natural gas ..... million cubic feet	1,133	279,000	3,697	954,000	1,401	380,000	968	259,000

Petroleum (crude) thousand 42-gallon barrels	10	(3)	8	(3)	7	(3)	4	(3)
Sand and gravel	7,136,112	5,556,953	5,276,350	5,160,564	7,115,403	8,657,871	6,460,886	8,076,104
Silver (recoverable content of ores, etc.) troy ounces	----	----	1,169	1,058	1,773	1,605	1,850	1,674
Slate	(3)	(3)	(3)	(3)	17,410	468,911	31,536	820,124
Stone (except limestone for cement and lime, 1952–53)	9,670,961	16,969,952	9,091,907	16,258,620	10,893,972	18,137,501	11,965,890	19,869,675
Zinc (recoverable content of ores, etc.)	13,409	4,451,788	16,676	3,835,480	16,738	3,615,408	18,329	4,508,934
Value of items that cannot be disclosed: Aplite, cement, feldspar, gypsum, iron ore (1952–54), iron oxide pigments (1954–55), kyanite, mica, pyrites, salt, ground sand and sandstone (1952–53), talc and soapstone, titanium concentrate and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)	----	15,893,790	----	17,505,609	----	19,403,489	----	24,045,936
Total Virginia	----	164,679,000	----	152,979,000	----	[4] 129,603,000	----	[4] 172,541,000

WASHINGTON

Abrasive stone:								
Pebbles (grinding)	20	$240	(3)	(3)	(3)	(3)	(3)	(3)
Pulpstones	12	908	----	----	----	----	----	----
Antimony ore and concentrate gross weight	100	(3)	----	----	----	----	----	----
Barite	----	----	(3)	(3)	----	----	25	$250
Chromite gross weight	----	----	----	----	----	----	22	1,706
Clays	291,134	352,576	259,421	$312,141	261,328	$318,500	365,331	411,807
Coal	844,197	5,986,129	689,831	5,047,928	619,209	4,478,127	609,790	4,263,030
Copper (recoverable content of ores, etc.)	4,357	2,108,788	3,740	2,146,760	3,636	2,145,240	3,958	2,952,668
Epsomite	(3)	(3)	200	8,000	(3)	(3)	100	5,000
Gold (recoverable content of ores, etc.) troy ounces	54,776	1,917,160	62,560	2,189,600	66,740	2,335,900	74,360	2,602,600
Gypsum	7,900	29,625	3,800	14,250	(3)	(3)	3,500	14,000
Lead (recoverable content of ores, etc.)	11,744	3,781,568	11,064	2,898,768	9,938	2,723,012	10,340	3,081,320
Manganese ore (35 percent or more Mn) gross weight	436	(3)	(3)	(3)	----	----	----	----
Manganiferous ore (5 to 35 percent Mn) do	142	(3)	----	----	----	----	----	----
Peat	42,580	111,386	32,107	104,274	43,134	153,058	37,640	113,254
Pumice	3,604	8,089	(3)	(3)	(3)	(3)	(3)	(3)
Sand and gravel	13,322,279	9,422,117	11,182,835	9,317,793	16,044,687	13,595,014	21,645,161	19,350,682
Silver (recoverable content of ores, etc.) troy ounces	315,645	285,675	321,202	290,704	313,735	283,946	436,348	394,917
Stone (except limestone for cement and lime, 1952–53)	4,523,234	5,491,525	4,438,259	5,890,849	5,366,890	9,526,534	6,593,212	10,579,631
Talc and soapstone	(3)	(3)	5,351	28,833	(3)	(3)	(3)	(3)
Tungsten ore and concentrate 60-percent WO_3 basis	4	14,008	5	19,710	18	65,812	12	45,949
Zinc (recoverable content of ores, etc.)	20,102	6,673,864	32,786	7,540,780	22,304	4,817,664	29,536	7,265,856
Value of items that cannot be disclosed: Carbon dioxide, cement, diatomite, gem stones, iron ore (1955), lime, magnesite, olivine, quartz (1952–53), ground sand and sandstone (1952–53), and values indicated by footnote 3. Excludes value of clays used for cement (1952–53)	----	19,955,089	----	18,766,830	----	16,923,833	----	19,765,194
Total Washington	----	56,139,000	----	54,577,000	----	[4] 53,300,000	----	[4] 67,334,000

See footnotes at end of table.

TABLE 5.—Mineral production in the United States, 1952–55, by States [1]—Continued

WEST VIRGINIA

Minera	1952		1953		1954		1955	
	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	982, 030	$2, 421, 669	968, 838	$2, 488, 938	587, 120	$1, 450, 539	707, 433	$2, 563, 289
Coal	141, 713, 059	741, 421, 131	134, 105, 310	693, 593, 645	115, 996, 041	541, 369, 652	139, 167, 889	653, 388, 287
Natural gas ... million cubic feet	180, 995	35, 475, 000	186, 477	44, 009, 000	191, 601	45, 601, 000	212, 403	49, 915, 000
Natural-gas liquids:								
Natural gasoline ... thousand gallons	43, 302	3, 069, 000	44, 352	3, 245, 000	41, 076	2, 593, 000	35, 756	2, 352, 000
LP-gases ... do	199, 794	6, 187, 000	153, 090	6, 743, 000	142, 884	5, 035, 000	286, 871	6, 376, 000
Petroleum (crude) ... thousand 42-gallon barrels	2, 602	9, 780, 000	3, 038	11, 570, 000	2, 902	8, 500, 000	2, 320	7, 080, 000
Salt (common)	392, 519	1, 438, 490	419, 907	1, 490, 592	471, 516	2, 885, 696	638, 390	3, 476, 352
Sand and gravel	4, 120, 105	7, 275, 370	3, 162, 776	6, 070, 847	4, 073, 991	8, 351, 153	5, 171, 399	9, 779, 288
Stone (except limestone for cement and lime, 1952–53)	[8] 4, 869, 442	[8] 6, 826, 113	[8] 5, 501, 148	[8] 8, 924, 411	7, 314, 934	11, 743, 440	5, 898, 585	9, 714, 168
Value of items that cannot be disclosed: Abrasive stone (1952–53 and 1955), bromine, calcium-magnesium chloride, cement, lime, calcareous marl, ground sand and sandstone (1952–53), stone (dimension limestone, 1952–53), and recovered elemental sulfur. Excludes value of clays used for cement (1952–53)	----------	11, 838, 988	----------	11, 974, 948	----------	10, 504, 113	----------	12, 929, 982
Total West Virginia	----------	825, 733, 000	----------	790, 110, 000	----------	[4] 636, 311, 000	----------	[4] 755, 512, 000

WISCONSIN

Minera	1952 Short tons (unless otherwise stated)	1952 Value	1953 Short tons (unless otherwise stated)	1953 Value	1954 Short tons (unless otherwise stated)	1954 Value	1955 Short tons (unless otherwise stated)	1955 Value
Abrasive stone: Pebbles (grinding)	723	$17, 352	(3)	(3)	(3)	(3)	(3)	(3)
Clays	134, 453	134, 493	175, 311	$175, 276	180, 233	$174, 488	165, 088	$166, 030
Iron ore (usable) ... long tons, gross weight	1, 485, 845	(3)	1, 655, 331	(3)	1, 428, 910	(3)	1, 886, 029	(3)
Lead (recoverable content of ores, etc.)	2, 000	644, 000	2, 094	548, 628	1, 261	345, 514	1, 948	580, 504
Lime	107, 813	1, 368, 556	123, 997	1, 566, 085	115, 397	1, 557, 579	134, 635	1, 767, 563
Marl, calcareous (except for cement)	17, 000	8, 833	15, 871	7, 327	19, 607	9, 817	14, 087	7, 330
Peat	(3)	(3)	366	(3)	(3)	(3)	----------	----------
Sand and gravel	24, 895, 947	16, 938, 228	23, 664, 086	16, 253, 302	23, 978, 722	17, 396, 438	27, 978, 335	19, 958, 450
Stone (except limestone for cement and lime, 1952–53)	8, 578, 882	16, 754, 675	7, 450, 396	15, 979, 756	8, 289, 373	16, 187, 738	[8] 12, 180, 452	[8] 18, 843, 272
Zinc (recoverable content of ores, etc.)	20, 588	6, 835, 216	16, 830	3, 870, 900	15, 534	3, 355, 344	18, 326	4, 508, 196

Value of items that cannot be disclosed: Abrasive stone (tube-mill liners), cement, quartz (1952–53), ground sand and sandstone (1952–53), stone (crushed basalt, 1955), and values indicated by footnote 3	------------	13, 008, 759	------------	16, 810, 752	------------	15, 839, 813	------------	20, 528, 430
Total Wisconsin	------------	55, 710, 000	------------	55, 212, 000	------------	[4] 54, 286, 000	------------	[4] 65, 813, 000
WYOMING								
Clays	706, 748	$9, 176, 507	852, 651	$10, 036, 727	943, 505	$9, 534, 087	1, 035, 560	$10, 923, 521
Coal	6, 088, 421	26, 451, 530	5, 244, 572	23, 743, 996	2, 831, 430	11, 541, 312	2, 926, 593	11, 845, 252
Copper (recoverable content of ores, etc.)	------------	------------	1	574	1	590	------------	------------
Gem stones	(5)	(3)	(5)	(3)	(5)	(3)	(5)	57, 000
Gold (recoverable content of ores, etc.) troy ounces	1	35	1	35	407	14, 245	52	1, 820
Gypsum	(3)	(3)	5, 493	21, 972	7, 403	29, 612	22, 373	89, 493
Iron ore (usable) long tons, gross weight	484, 945	(3)	654, 285	(3)	458, 237	(3)	748, 831	(3)
Natural gas million cubic feet	75, 313	5, 874, 000	76, 262	6, 025, 000	71, 068	5, 970, 000	77, 819	6, 615, 000
Natural-gas liquids:								
Natural gasoline thousand gallons	51, 492	4, 016, 000	(3)	(3)	47, 082	3, 137, 000	40, 290	2, 775, 000
LP-gases do	38, 976	1, 881, 000	(3)	(3)	46, 084	2, 128, 000	46, 106	1, 961, 000
Petroleum (crude) thousand 42-gallon barrels	68, 074	148, 400, 000	82, 618	195, 800, 000	93, 533	229, 160, 000	99, 483	239, 750, 000
Phosphate rock long tons	186, 715	1, 247, 256	(3)	(3)	(3)	(3)	54, 958	345, 451
Pumice	2, 851	10, 918	648	1, 898	(3)	(3)	(3)	(3)
Sand and gravel	2, 426, 999	1, 738, 548	3, 149, 376	2, 001, 197	4, 163, 660	2, 681, 527	3, 952, 119	3, 977, 677
Silver (recoverable content of ores, etc.) troy ounces	------------	------------	11	10	74	67	20	18
Stone (except limestone for cement, 1952–53)	1, 466, 567	1, 688, 890	1, 431, 372	1, 839, 922	1, 616, 015	1, 665, 302	1, 303, 399	2, 033, 800
Sulfur, recovered elemental long tons	(3)	(3)	(3)	(3)	113, 101	2, 977, 954	120, 697	3, 206, 353
Vermiculite	(3)	(3)	403	2, 418	------------	------------	------------	------------
Value of items that cannot be disclosed: Cement, feldspar (1953), manganiferous ore (1953), sodium carbonate and sulfate, sulfur ore (1952–53), vanadium (1954), and values indicated by footnote 3. Excludes value of clays used for cement (1953)	------------	6, 343, 624	------------	16, 432, 721	------------	[6] 12, 827, 165	------------	14, 982, 945
Total Wyoming	------------	206, 828, 000	------------	255, 906, 000	------------	[4 6] 281, 306, 000	------------	[4] 297, 752, 000

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers). Excludes uranium and monazite.
[2] Excludes pozzolan cement, value for which is included with "Value of items that cannot be disclosed."
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Total adjusted to eliminate duplicating the value of clays and stone.
[5] Weight not recorded.
[6] Revised figure.
[7] Estimate.
[8] Excludes certain stone, value included with "Value of items that cannot be disclosed."
[9] Final figure. Supersedes preliminary figure given in commodity chapter.
[10] Sold or used by producers. Quantity and value of ground material included.
[11] Mine production of crude material.
[12] Total has been adjusted to eliminate duplicating the value of raw materials used in the manufacture of cement and/or lime.
[13] Beginning with 1954, sand and sandstone (ground) included with sand and gravel or stone.
[14] Includes value of nonmetals; excludes value of clays used for cement.
[15] Excludes natural cement, value for which is included with "Value of items that cannot be disclosed."
[16] Excludes certain clays, value included with "Value of items that cannot be disclosed."
[17] Included with bituminous coal.
[18] Recoverable zinc valued at the yearly average price of Prime Western slab zinc, East St. Louis market. Represents value established after transportation, smelting, and manufacturing charges have been added to the value of ore at mine.
[19] Less than 1 ton.
[20] Grinding pebbles and tube-mill liners, weight of millstones not recorded.

TABLE 6.—Mineral production in Territories of the United States, 1952–55 by individual minerals [1]

Territory and mineral	1952		1953		1954		1955	
	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	420	(2)						
Chromite .... do					2,953	$208,257	7,082	$625,340
Clays					(2)	(2)	1,112	3,836
Coal	686,218	$5,779,423	861,471	$8,451,542	666,618	6,442,414	639,696	5,759,000
Copper (recoverable content of ores, etc.)					4	2,360	1	746
Gold (recoverable content of ores, etc.) ...... troy ounces	240,557	8,419,495	253,783	8,882,405	248,511	8,697,885	249,294	8,725,290
Lead (recoverable content of ores, etc.)	1	386	9	2,240			1	298
Mercury .... 76-pound flasks	28	5,575	40	7,721	1,046	276,552	(2)	(2)
Sand and gravel	10,781,926	8,650,582	7,689,278	5,079,681	6,639,638	6,301,939	9,793,214	8,242,344
Silver (recoverable content of ores, etc.) .... troy ounces	32,968	29,854	35,387	32,027	33,697	30,497	33,693	30,494
Stone	(2)	(2)	47,086	169,711	283,734	465,423	265,740	289,589
Tin (content of ore and concentrate) .... long tons	82	220,956	49	105,917	199	409,840	86	182,484
Tungsten concentrate .... 60-percent WO_3 basis	8	(2)	3	(2)				
Value of items that cannot be disclosed: Gem stones (1952–54), platinum-group metals, and values indicated by footnote 2		3,195,336		1,520,782		[3] 1,572,150		1,552,427
Total Alaska		26,302,000		24,252,000		[3] 24,407,000		25,412,000
Hawaii:								
Lime	8,894	240,786	7,431	223,575	8,375	251,610	6,453	202,005
Pumice					(2)	(2)	130,306	75,906
Sand and gravel	111,716	143,541	110,558	156,853	119,121	318,754	165,081	425,760
Stone	705,994	1,545,301	[4] 1,299,501	[4] 2,654,358	1,485,427	2,993,032	1,414,304	2,884,354
Value of items that cannot be disclosed: Other nonmetals and values indicated by footnote 2		17,164		297,474		58,778		21,818
Total Hawaii		1,947,000		3,332,000		[5] 3,596,000		[5] 3,592,000

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Revised figure.
[4] Excludes certain stone value for which is included with "Value of items that cannot be disclosed."
[5] Total has been adjusted to eliminate duplicating the value of limestone used in lime.

TABLE 7.—Mineral production in possessions of the United States, 1952–55, by individual minerals [1] [2]

Possession and mineral	1952		1953		1954		1955	
	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value	Short tons (unless otherwise stated)	Value
American Samoa:								
Sand and gravel			[3] 1,320	[3] $425	1,800	$675	1,278	$552
Stone			[3] 74,750	[3] 16,500	57,600	15,000	9,011	3,948
Total American Samoa				[3] 17,000		16,000		5,000
Canal Zone:								
Sand and gravel	56,600	$53,000	85,914	95,500			35,910	47,229
Stone (crushed)	86,000	152,000	171,908	231,752	187,446	245,170	169,485	239,280
Total Canal Zone		205,000		327,000		245,000		287,000
Canton: Stone (crushed)	150	375	4,200	8,750	2,600	5,000	500	1,500
Guam: Stone	948,000	870,000	2,080,650	5,573,169	842,660	2,275,182	1,241,466	3,351,958
Johnston: Stone					98	300	12,090	32,550
Midway: Stone (crushed)	[3] 7,200	[3] 6,000	204	638	490	1,500		
Puerto Rico:								
Cement ... 376-pound barrels	3,994,483	10,517,894	3,641,135	9,335,421	3,682,187	9,663,445	4,116,739	12,506,784
Iron ore (usable) ... long tons, gross weight	138,613	797,025						
Lime (open-market)	8,575	195,000	7,338	157,467	8,384	198,452	10,392	254,121
Salt (common)	12,676	122,158	13,692	131,490	8,758	98,110	10,496	112,399
Sand and gravel	122,730	164,166	226,586	250,202	374,690	833,654	433,017	678,761
Stone (except limestone for cement and lime, 1952–53)	[4] 689,320	[4] 1,807,388	[4] 648,400	[4] 1,237,236	[4] 1,751,996	[4] 2,492,827	1,783,910	2,515,760
Value of items that cannot be disclosed: Other nonmetals		6,328		44,466		154,331		121,753
Total Puerto Rico		13,610,000		11,401,000		[5] 12,381,000		[5] 14,917,000
Virgin Islands: Stone (crushed)	12,900	51,900	10,789	45,853	3,939	17,134	875	4,900
Wake: Stone (crushed)	4,260	8,000	11,980	20,615	780	1,300	1,000	3,000

[1] Production as measured by mine shipments, sales, or marketable production (including consumption by producers).
[2] Production data for Canton and Wake furnished by the U. S. Department of Commerce, Civil Aeronautics Administration; Midway and Johnston, by the U. S. Department of the Navy; Guam, by the Government of Guam; American Samoa, by the Government of American Samoa.
[3] Estimate.
[4] Excludes certain stone value included with "Value of items that cannot be disclosed."
[5] Total has been adjusted to eliminate duplicating the value of stone.

TABLE 8.—Principal minerals imported for consumption in the United States, 1954–55

[Compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce]

Mineral	1954		1955	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
METALLIC				
Aluminum:				
Metal	215,250	[1] 83,573	177,652	[1] 74,695
Scrap	14,845	[1] 4,675	40,779	[1] 16,364
Plates, sheets, bars, etc	13,655	[1] 8,042	20,972	[1] 13,973
Antimony:				
Ore (antimony content)	4,722	1,290	7,470	1,850
Needle or liquated	33	17	46	19
Metal	2,802	1,349	3,667	1,860
Oxide	1,476	645	2,210	926
Arsenic: White	4,848	545	7,222	765
Bauxite:				
Crude ... long tons	[2] 5,258,530	[2] 36,289	5,221,008	36,629
Calcined, when imported for manufacture of fire brick ... long tons	[2] 99,421	[2] 2,361	107,694	2,453
Beryllium ore	5,816	2,574	6,037	2,226
Bismuth ... pounds	628,833	1,235	603,649	1,128
Boron carbide ... do	24,209	50	40,837	75
Cadmium:				
Metal ... do	402,299	654	927,495	1,320
Flue dust (cadmium content) ... do	1,482,565	1,078	1,832,827	1,146
Calcium:				
Metal ... do	685,417	728	699,799	835
Chloride	1,547	51	1,844	58
Chromite:				
Ore and concentrates (Cr_2O_3 content)	[2] 608,578	[2] 34,197	763,401	37,854
Ferrochrome (chromium content)	9,563	3,502	19,397	8,011
Metal	------	------	------	------
Cobalt:				
Alloy (cobalt content) ... pounds	2,360,360	(3)	2,464,336	(3)
Ore (cobalt content) ... do	3,349	6	223	(4)
Metal ... do	14,227,868	35,391	15,535,040	38,585
Oxide (gross weight) ... do	430,400	723	1,072,950	1,792
Salts and compounds (gross weight) ... do	353,094	211	361,600	249
Columbium ore ... do	6,804,076	14,191	9,612,576	19,852
Copper (copper content):				
Ore	6,182	3,399	7,476	4,948
Concentrate	[2] 114,353	[2] 62,675	105,045	68,406
Regulus, black, coarse	5,408	3,089	6,386	4,515
Refined, black, blister	[2] 257,393	[2] 150,791	253,693	182,073
Refined in ingots, etc	[2] 215,118	[2] 127,130	201,640	153,604
Old and scrap	4,752	[1] 2,081	12,597	[1] 9,058
Old brass and clippings	3,657	[1] 1,568	8,284	[1] 5,145
Ferroalloys: Ferrosilicon	3,760	1,244	5,963	[1] 1,993
Gold:				
Ore and base bullion ... troy ounces	822,684	28,721	1,071,270	37,340
Bullion ... do	260,321	9,112	1,858,736	67,080
Iron ore:				
Ore ... long tons	[2] 15,792,450	[1,2] 119,459	23,459,660	177,329
Pyrites cinder ... do	898	4	3,879	[1] 16
Iron and steel:				
Pig iron	290,716	13,315	283,559	14,564
Iron and steel products (major):				
Semimanufactures	[2] 258,084	[1,2] 21,749	394,093	[1] 34,780
Manufactures	[2] 616,483	[1,2] 75,969	675,985	[1] 91,013
Scrap	206,316	[1] 5,116	196,394	[1] 6,199
Tin-plate scrap	[2] 32,719	[1] 832	32,167	839
Lead:				
Ore, flue dust, matte (lead content)	196,054	[1] 47,967	156,433	[1] 28,143
Base bullion (lead content)	41	10	------	------
Pigs and bars (lead content)	274,286	[1] 68,420	263,977	73,032
Reclaimed, scrap, etc. (lead content)	7,217	[1] 1,450	18,944	[1] 3,931
Sheets, pipe, and shot	397	[1] 129	2,048	535
Babbitt metal and solder (lead content)	1,572	[1] 1,946	1,236	[1] 1,819
Type metal and antimonial lead (lead content)	3,367	1,251	13,213	4,379
Manufactures	------	[1] 149	------	[1] 164
Magnesium:				
Metallic and scrap	733	338	1,844	1,034
Alloys (magnesium content)	6	30	9	52
Sheets, tubing, ribbons, wire and other forms (magnesium content)	3	14	4	25

See footnotes at end of table.

TABLE 8.—Principal minerals imported for consumption in the United States, 1954–55—Continued

Mineral	1954 Short tons (unless otherwise stated)	1954 Value (thousand dollars)	1955 Short tons (unless otherwise stated)	1955 Value (thousand dollars)
METALLIC—continued				
Manganese:				
Ore (35 percent or more manganese)—(manganese content)	[2] 1,029,614	[2] 75,787	1,047,151	69,821
Ferromanganese (manganese content)	44,744	10,903	52,650	12,022
Mercury:				
Compounds ... pounds	35,008	[1] 93	20,408	77
Metal ... flasks	64,957	[1] 10,784	20,354	5,149
Minor metals: Selenium and salts ... pounds	209,596	1,154	191,928	[1] 1,468
Molybdenum:				
Ore and concentrates (molybdenum content) ... do	154,288	180	134,395	142
Nickel:				
Ore and matte	14,135	5,358	9,088	3,264
Pigs, ingots, shot, cathodes	97,263	124,179	109,404	148,925
Scrap	444	276	435	597
Oxide	32,264	25,234	32,896	30,124
Platinum group:				
Unrefined materials:				
Ore and concentrates ... troy ounces	2,714	191	407	29
Grain and nuggets, including crude, dust, and residues ... troy ounces	[2] 42,596	[2] 2,666	40,713	2,787
Sponge and scrap ... do	4,230	[1] 367	8,362	[1] 653
Osmiridium ... do	2,988	290	1,471	115
Refined metal:				
Platinum ... do	[2] 345,081	[1,2] 26,560	450,270	34,419
Palladium ... do	188,839	[1] 3,468	487,174	8,185
Iridium ... do	432	55	271	24
Osmium ... do	199	[1] 20	528	38
Rhodium ... do	13,197	1,336	17,783	1,787
Ruthenium ... do	6,168	333	2,961	124
Radium:				
Radium salts ... milligrams	57,879	857	65,545	975
Radioactive substitutes	------------	150	------------	189
Rare earths: Ferrocerium and other cerium alloy ... pounds	5,736	22	6,234	25
Silver:				
Ore and base bullion ... troy ounces	49,008,443	40,404	55,658,175	45,755
Bullion ... do	41,888,631	35,541	28,861,015	25,413
Tantalum: Ore	981,872	1,972	1,907,686	4,634
Tin:				
Ore (tin content) ... long tons	22,140	41,725	20,112	[1] 36,773
Blocks, pigs, grains, etc ... do	[2] 65,599	133,186	64,718	131,397
Dross, skimmings, scrap, residues, and tin alloys, n. s. p. f. ... pounds	[2] 13,165,707	[2] 9,358	13,764,531	[1] 10,435
Tinfoil, powder, flitters, etc ... long tons	------------	[1] 785	------------	559
Titanium:				
Ilmenite	275,005	[1] 4,993	353,351	7,031
Rutile	14,965	1,323	19,526	1,984
Metal ... pounds	385,045	1,371	1,134,098	[1] 3,433
Ferrotitanium ... do	10,000	4	63,400	27
Compounds and mixtures ... do	10,500	7	338,061	83
Tungsten:				
Ore and concentrates (tungsten content) ... do	[2] 24,188,078	[1,2] 76,251	20,699,528	56,155
Metal (tungsten content) ... do	154,096	[1] 343	89,221	[1] 241
Ferrotungsten (tungsten content) ... do	500,204	837	676,988	1,276
Other (tungsten content) ... do	65,650	101	44,861	152
Vanadium:				
Ore (vanadium content) ... do	395,287	238	184,737	104
Salts and compounds ... do	4,000	3	------------	------------
Zinc:				
Ores (zinc content)	[2] 480,918	[1] 52,482	384,648	36,811
Blocks, pigs, and slabs	160,138	[1,2] 33,714	195,059	46,452
Sheets	259	88	431	[1] 148
Old, dross, and skimmings	1,087	103	284	32
Dust	------------	------------	72	[1] 18
Manufactures	------------	[1] 41	------------	[1] 190
Zirconium: Ore, including zirconium sand	18,657	487	29,091	813

See footnotes at end of table.

TABLE 8.—Principal minerals imported for consumption in the United States, 1954–55—Continued

Mineral	1954		1955	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
NONMETALLIC				
Abrasives: Diamonds (industrial) ..... carats	13,991,151	[1] 48,703	15,100,136	66,256
Asbestos	678,390	[1] 55,857	740,423	[1] 60,958
Barite:				
Crude and ground	317,345	[1] 2,284	359,931	[1] 2,191
Witherite	4,415	153	2,363	78
Chemicals	[2] 3,483	[2] 446	4,464	459
Bromine ..... pounds	77,649	121	692	118
Cement ..... 376-pound barrels	450,248	[1] 1,763	5,219,700	[1] 14,354
Clays:				
Raw	163,157	[1] 2,445	189,138	[1] 2,857
Manufactured	1,543	40	3,244	[1] 86
Cryolite ..... long tons	18,876	2,216	19,625	3,190
Feldspar: Crude ..... do	79	3	105	9
Fluorspar	293,320	[1] 8,962	363,420	[1] 8,540
Gem stones:				
Diamonds ..... carats	[2] 1,482,474	[2] 122,182	1,772,791	151,569
Emeralds ..... do	24,460	385	45,235	1,565
Other		[1] 21,022		[1] 22,128
Graphite	40,839	[1] 2,281	48,800	2,387
Gypsum:				
Crude, ground, calcined	3,368,817	[1] 4,903	3,966,786	[1] 6,320
Manufactures		[2] 474		943
Iodine, crude ..... pounds	945,985	1,034	1,231,994	1,513
Jewel bearings ..... number	49,262,027	[1] 2,219	66,067,549	[1] 2,875
Kyanite	4,826	[1] 197	7,581	339
Lime:				
Hydrated	1,259	[1] 17	1,359	[1] 18
Other	30,613	538	30,264	559
Dead-burned dolomite	4,426	345	7,993	558
Magnesium:				
Magnesite	70,650	4,250	106,253	6,873
Compounds	10,092	[1] 308	12,357	[1] 396
Mica:				
Uncut sheet and punch ..... pounds	1,829,457	[1] 3,198	1,747,106	3,334
Scrap	4,647	[1] 63	9,461	121
Manufactures	3,363	[1] 5,449	6,156	[1] 7,814
Mineral-earth pigments:				
Iron oxide pigments:				
Natural	2,546	121	3,702	161
Synthetic	4,997	603	6,394	[1] 850
Ocher, crude and refined	154	9	218	15
Siennas, crude and refined	338	35	840	[1] 80
Umber, crude and refined	2,598	74	2,654	[1] 79
Vandyke brown	89	5	151	9
Nitrogen compounds (major)	1,913,200	[1] 89,321	1,577,099	[1] 75,034
Phosphate, crude ..... long tons	122,016	[1] 3,081	117,256	2,703
Phosphatic fertilizers ..... do	26,316	[1] 1,507	29,239	[1] 1,788
Pigments and salts:				
Lead pigments and salts	712	[1] 169	1,146	267
Zinc pigments and salts	3,178	[1] 582	4,749	904
Potash	225,230	8,387	329,389	11,769
Pumice:				
Crude or unmanufactured	20,951	117	29,938	[1] 165
Whole or partly manufactured	950	[1] 21	1,497	[1] 39
Manufactures, n. s. p. f.		[1] 7		[1] 4
Quartz crystal (Brazilian pebble) ..... pounds	780,556	1,579	227,573	[1] 35
Salt	160,770	[1] 879	185,653	[1] 1,206
Sand and gravel:				
Glass sand	10,329	93	170	172
Other sand	271,364	[1] 298	317,947	[1] 385
Gravel	2,387	[1] 2	1,680	([1] [4])
Sodium sulfate	118,512	2,141	124,474	2,530
Stone		[1] 5,216		[1] 5,579
Strontium: Mineral	3,291	53	6,125	128
Sulfur and pyrites:				
Sulfur:				
Ore ..... long tons	110	2	24,152	595
Other forms, n. e. s. ..... do	1,104	[1] 56	373	17
Pyrites ..... do	[5] 46,649	[1] [5] 292	[5] 80,305	[1] [5] 520
Talc: Unmanufactured	22,157	[1] 678	29,079	[1] 986

See footnotes at end of table.

TABLE 8.—Principal minerals imported for consumption in the United States, 1954–55—Continued

Mineral	1954		1955	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
FUELS				
Asphalt and related bitumen	4,244	102	4,988	116
Carbon black:				
Acetylene black ... pounds	7,715,875	1,282	8,097,358	[1] 1,331
Gas black and carbon black ... do	74,659	9	53,600	11
Coal:				
Anthracite	5,831	105	170	1
Bituminous, slack and culm, lignite	198,799	[1] 1,608	337,145	2,640
Briquets	239	2		
Coke	115,781	1,258	126,342	1,405
Peat:				
Fertilizer grade	220,768	7,911	217,624	8,683
Poultry and stable grade	20,172	925	11,686	[1] 579
Petroleum:				
Crude ... thousands of barrels	[2] 242,645	[1 2] 544,550	294,170	662,038
Gasoline [6] ... do	[2] 1,360	[1] 6,967	5,081	[1] 26,342
Kerosine ... do	(4)	(4)	44	166
Distillate oil [7] ... do	[2] 4,328	[2] 13,211	5,089	[1] 15,550
Residual oil [8] ... do	132,283	240,225	155,301	[1] 305,180
Unfinished oils ... do	8,257	17,107	6,616	15,540
Asphalt (liquid and solid) ... do	3,397	6,508	3,324	7,571
Miscellaneous ... do	4	[1] 100	(4)	[1] 36

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not comparable to other years.
[2] Revised figure.
[3] Data not available.
[4] Less than $1,000.
[5] In addition to data shown an estimated 232,920l ong tons ($627,620) were imported in 1954 and 277,860 long tons ($711,740) in 1955.
[6] Includes naphtha but excludes benzol: 1954—291,000 barrels ([1] $3,968,000); 1955—764,000 barrels ($7,168,000).
[7] Includes quantities imported free of duty for supplies of vessels and aircraft.
[8] Includes quantities imported free for manufacture in bond and export, and for supplies of vessels and aircraft

TABLE 9.—Principal minerals and products exported from the United States, 1954–55

[Compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce]

Mineral	1954		1955	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
METALLIC				
Aluminum:				
Ingots, slabs, crude	4,044	1,691	5,969	2,773
Scrap	39,338	12,985	18,290	6,501
Plates, sheets, bars, etc	6,050	4,803	8,009	7,518
Castings and forgings	619	1,795	1,139	2,425
Antimony: Metals and alloys, crude	44	26	204	71
Arsenic: Calcium arsenate ... pounds	1,975,894	125	1,885,582	115
Bauxite, including bauxite concentrates ... long tons	16,174	666	14,117	528
Aluminum sulfate	14,503	576	19,594	733
Other aluminum compounds	6,390	1,674	8,497	1,974
Beryllium ... pounds	21,151	68	36,124	155
Bismuth:				
Metals and alloys ... do	137,856	186	203,667	363
Salts and compounds ... do	62,581	268	59,638	218
Cadmium ... do	998,959	1,422	1,393,915	1,938
Calcium chloride	10,987	374	20,743	608

See footnotes at end of table.

TABLE 9.—Principal minerals and products exported from the United States, 1954–55—Continued

Mineral	1954		1955	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
METALLIC—continued				
Chrome:				
Ore and concentrates:				
Exports	864	50	1,341	76
Reexports	427	8	2,950	87
Chromic acid	397	216	701	374
Ferrochrome	2,105	996	4,693	2,267
Cobalt...pounds	3,067,386	1,173	3,823,167	1,231
Columbium metals, alloys, and other forms...do	278	15	6,370	10
Copper:				
Ores, concentrates, composition metal, and unrefined copper (copper content)	2,369	1,309	7,648	7,326
Refined copper and semimanufactures	[1] 312,433	[1] 197,051	259,942	207,742
Other copper manufactures	250	308	234	309
Copper sulfate or blue vitriol	29,762	5,781	37,382	8,382
Copper base alloys	----------	57,086	----------	46,976
Ferroalloys:				
Ferrosilicon...pounds	4,160,243	365	3,377,349	308
Ferrophosphorus...do	48,683,806	793	106,109,167	1,346
Gold:				
Ore and base bullion...troy ounces	3,495	122	11,206	392
Bullion, refined...do	490,462	19,230	151,008	6,561
Iron ore...long tons	3,145,714	24,784	4,516,828	36,993
Iron and steel:				
Pig iron	10,247	762	34,989	1,918
Iron and steel products (major):				
Semimanufactures	[1] 1,868,217	[1] 303,905	3,309,011	482,818
Manufactured steel mill products	[1] 1,205,456	[1] 247,654	1,125,291	255,708
Advanced products	----------	[1] 122,746	----------	144,388
Iron and steel scrap: Ferrous scrap, including rerolling materials	[1] 1,695,861	[1] 51,612	5,147,428	177,526
Lead:				
Ore, matte, base bullion (lead content)	102	25	14	5
Pigs, bars, anodes:				
Exports	596	208	403	154
Scrap	3,894	838	2,983	1,340
Magnesium:				
Metal and alloys	3,096	[1] 1,767	7,611	4,384
Semifabricated forms, n. e. c	161	605	236	515
Powder	34	45	14	34
Manganese:				
Ore and concentrates	6,112	592	6,279	612
Ferromanganese	1,732	615	1,789	643
Mercury:				
Exports...flasks	890	183	451	155
Reexports...do	1,436	257	267	78
Molybdenum:				
Ores and concentrates...pounds	13,546,510	13,989	14,580,358	15,783
Metals and alloys, crude and scrap...do	34,358	37	22,564	19
Wire...do	10,563	196	11,482	177
Semifabricated forms, n. e. c...do	26,001	34	3,952	12
Powder...do	15,423	20	21,173	57
Ferromolybdenum...do	247,763	238	349,193	353
Nickel:				
Alloys and scrap (including Monel metal), ingots, bars, sheets, etc	13,759	10,865	19,964	15,610
Nickel-chrome electric resistance wire	150	522	208	773
Semifabricated forms, n. e. c	336	1,069	429	1,481
Platinum:				
Ores and concentrates...troy ounces	29	2	----------	----------
Bars, ingots, sheets, wire, sponge, and other forms including scrap...troy ounces	[1] 16,980	[1] 1,218	[2] 17,073	[2] 1,306
Palladium, rhodium, iridium, osmiridium, ruthenium, and osmium metals and alloys, including scrap...troy ounces	11,443	287	[2] 11,895	[2] 470
Platinum-group manufactures except jewelry	----------	[1] 1,731	----------	[2] 1,307
Radium metal (radium content)...milligrams	419	15	366	14
Rare earths:				
Cerium ores, metal and alloy...pounds	29,461	129	19,296	75
Lighter flints...do	7,954	56	10,772	83

See footnotes at end of table.

TABLE 9.—Principal minerals and products exported from the United States, 1954-55—Continued

Mineral	1954		1955	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
METALLIC—continued				
Silver:				
Ore and base bullion ... troy ounces	29,917	25	71,074	63
Bullion, refined ... do	1,672,618	1,451	4,821,635	4,378
Tantalum:				
Ore, metal, and other forms ... pounds	52,461	93	3,390	107
Powder ... do	110	5	594	25
Tin:				
Ingots, pigs, bars, etc.:				
Exports ... long tons	271	467	254	504
Reexports ... do	551	1,125	853	1,748
Tin scrap and other tin-bearing material except tin-plate scrap ... long tons	8,269	3,341	6,190	2,441
Tin cans finished or unfinished ... do	23,878	11,022	26,490	11,517
Tin compounds ... pounds	342,146	511	311,005	547
Titanium:				
Ores and concentrates	663	86	1,143	194
Metal and alloys in crude form and scrap	48	1,108	45	1,247
Semifabricated forms, n. e. c.	[1] 171	[1] 3,587	------	------
Ferrotitanium	172	40	245	65
Dioxide and pigments	63,802	23,281	54,353	18,333
Tungsten: Ore and concentrates:				
Exports	39	111	34	65
Reexports	149	239	283	527
Vanadium ore and concentrates (vanadium content) ... pounds	[1] 42,935	[1] 120	1,729,103	3,768
Zinc:				
Slabs, pigs or blocks	24,994	5,394	17,904	4,127
Sheets, plates, strips, or other forms, n. e. c.	4,045	2,183	3,657	2,193
Scrap (zinc content)	16,689	2,023	21,612	2,250
Dust	509	151	445	162
Semifabricated forms, n. e. c.	543	257	651	296
Zirconium:				
Ores and concentrates	692	43	779	58
Metals and alloys and other forms ... pounds	39,680	6	106,778	101
NONMETALLIC				
Abrasives:				
Grindstones and pulpstones ... pounds	714,227	47	904,683	85
Diamond dust and powder ... carats	90,665	238	215,787	516
Diamond grinding wheels ... do	129,868	554	180,405	850
Other natural and artificial metallic abrasives and products	------	19,856	------	23,409
Asbestos: Unmanufactured:				
Exports	1,847	276	2,161	236
Reexports	47	15	626	31
Boron: Boric acid, borates, crude and refined ... pounds	411,228,805	12,904	445,176,000	14,533
Bromine, bromides, and bromates ... do	5,082,437	2,308	3,649,861	1,656
Cement ... 376-pound barrels	[1] 1,859,012	[1] 6,652	1,795,448	7,067
Clay:				
Kaolin or china clay	49,199	946	49,830	1,017
Fire clay	77,913	815	109,312	1,358
Other clays	[1] 200,860	[1] 6,588	247,397	8,515
Cryolite ... long tons	[1] 77	24	155	54
Fluorspar	643	50	874	65
Graphite:				
Amorphous	608	67	1,141	130
Crystalline flake, lump or chip	49	19	141	48
Natural, n. e. c.	141	20	112	22
Gypsum:				
Crude, calcined, crushed	22,384	762	22,539	738
Plasterboard, wallboard, and tile ... square feet	20,968,956	689	8,686,854	412
Manufactures, n. e. c.	------	150	------	198
Iodine, iodide, iodates ... pounds	338,258	488	243,686	357
Kyanite and allied minerals	1,147	58	1,716	87
Lime	73,246	1,300	82,461	1,464
Mica:				
Unmanufactured ... pounds	318,518	79	447,491	35
Manufactured:				
Ground or pulverized ... do	6,058,118	343	5,808,347	332
Other ... do	280,415	1,093	372,548	1,340

See footnotes at end of table.

TABLE 9.—Principal minerals and products exported from the United States, 1954–55—Continued

Mineral	1954		1955	
	Short tons (unless otherwise stated)	Value (thousand dollars)	Short tons (unless otherwise stated)	Value (thousand dollars)
NONMETALLIC—continued				
Mineral-earth pigments: Iron oxide, natural and manufactured	3,554	682	4,744	894
Nitrogen compounds (major)	332,655	[1] 19,478	828,117	44,795
Phosphate rock ... long tons	2,385,013	21,169	2,267,741	20,302
Phosphatic fertilizers ... do	[1] 396,077	[1] 11,869	377,629	11,994
Pigments and salts (lead and zinc):				
Lead pigments	[1] 2,601	[1] 895	2,774	998
Zinc pigments	6,124	1,352	4,541	1,073
Lead salts	355	162	540	215
Potash:				
Fertilizer	111,184	4,134	222,499	7,959
Chemical	6,202	1,330	6,804	1,244
Quartz crystal (raw)	(3)	41	(3)	66
Radioactive isotopes, etc	(3)	536	(3)	1,288
Salt:				
Crude and refined	[1] 385,259	[1] 3,086	407,131	3,023
Shipments to noncontiguous Territories	9,650	782	10,019	721
Sodium and sodium compounds:				
Sodium sulfate	24,965	823	24,561	870
Sodium carbonate	163,548	5,527	151,799	4,883
Stone:				
Limestone, crushed, ground, broken	[1] 570,013	703	936,766	1,149
Marble and other building and monumental ... cubic feet	466,177	1,009	437,644	1,024
Stone, crushed, ground, broken	[1] 142,622	2,396	169,074	2,924
Manufactures of stone	----------	406	----------	394
Sulfur:				
Crude ... long tons	[1] 1,645,000	[1] 50,362	1,597,951	48,615
Crushed, ground, flowers of ... do	30,130	2,162	34,701	2,454
Talc:				
Crude and ground	23,348	745	35,230	859
Manufactures, n. e. c.	259	111	135	102
Powders-talcum (face and compact)	----------	1,076	----------	1,246
FUELS				
Asphalt and bitumen, natural:				
Unmanufactured	29,868	1,474	32,723	1,444
Manufactures, n. e. c.	(3)	716	(3)	714
Carbon black ... thousands of pounds	402,777	36,163	454,181	40,735
Coal:				
Anthracite	2,851,239	51,699	3,152,313	48,429
Bituminous	31,040,564	252,621	51,277,256	436,559
Briquets	98,908	1,627	106,294	1,564
Coke	[1] 387,575	[1] 6,302	530,505	8,238
Petroleum:				
Crude ... thousands of barrels	13,599	45,026	11,470	38,366
Gasoline [4] ... do	26,618	184,626	25,992	177,470
Kerosine ... do	[1] 4,049	[1] 16,282	2,497	10,215
Distillate oil ... do	21,931	80,876	21,854	80,068
Residual oil ... do	20,338	39,438	27,507	55,470
Lubricating oil ... do	14,482	[1] 197,867	13,663	188,933
Asphalt ... do	[1] 1,599	[1] 10,025	1,477	8,024
Liquefied petroleum gases ... do	3,912	15,692	4,231	15,649
Wax ... do	1,340	25,983	1,248	24,253
Coke ... do	[1] 3,198	[1] 12,120	4,463	15,647
Petrolatum ... do	293	5,793	330	6,304
Miscellaneous products ... do	1,014	16,152	830	16,310

1 Revised figure.
2 Owing to changes in classifications, data known to be not strictly comparable to earlier years.
3 Weight not recorded
4 Includes naphtha but excludes benzol: 1954—Revised figure 153,000 barrels ($2,071,000); 1955—59,000 barrels ($990,000).

TABLE 10.—Comparison of world and United States [1] production of principal metals and minerals, 1954–55

[Compiled under the supervision of Berenice B. Mitchell of the Division of Foreign Activities, Bureau of Mines]

Mineral	1954			1955		
	World	United States		World	United States	
	Thousand short tons		Percent of world	Thousand short tons		Percent of world
Coal:						
Bituminous	1,459,100	391,706	27	1,613,300	464,663	29
Lignite	546,000		-------	591,000		
Pennsylvania anthracite	153,900	29,083	19	152,700	26,205	17
Coke (excluding breeze):						
Gashouse [3]	47,000	256	(2)	49,000	(4)	(4)
Oven and beehive	233,000	59,662	26	266,000	75,302	28
Fuel briquets and packaged fuel	123,000	1,701	1	125,000	1,699	1
Natural gas ... million cubic feet	(5)	8,742,546	(5)	(5)	9,405,351	(5)
Peat	58,000	244	(2)	66,000	274	(2)
Petroleum (crude) ... thousand barrels	5,006,205	2,314,988	46	5,634,412	2,484,428	44
Nonmetallic minerals:						
Asbestos	1,530	48	3	1,755	45	3
Barite	2,300	926	40	2,600	1,108	43
Cement ... thousand barrels	1,146,200	275,857	24	1,277,500	314,913	25
Corundum	10	---------	---------	8	---------	---------
Diamonds ... thousand carats	20,440	---------	---------	21,540	---------	---------
Feldspar [6] ... thousand long tons	830	411	50	950	465	49
Fluorspar	1,330	246	18	1,400	280	20
Graphite	185	(4)	(4)	290	(4)	(4)
Gypsum	30,200	8,996	30	33,700	10,684	32
Magnesite	4,300	284	6	4,700	486	10
Mica (including scrap) thousand pounds	285,000	162,815	57	330,000	191,506	58
Nitrogen, agricultural [6 7]	5,732	1,515	26	6,173	1,700	28
Phosphate rock ... thousand long tons	29,400	13,821	47	29,900	12,265	41
Potash ... K_2O equivalent	7,000	1,949	28	7,500	2,065	28
Pumice	3,600	1,647	46	3,800	1,804	47
Pyrites ... thousand long tons	14,400	909	6	16,000	994	6
Salt	64,500	20,669	32	68,000	22,704	33
Sulfur, native ... thousand long tons	6,300	5,579	89	7,000	5,800	83
Talc, pyrophyllite, and soapstone	1,600	619	39	1,760	726	41
Vermiculite [6]	243	196	81	264	204	77
Metals, mine basis:						
Antimony (content of ore and concentrate)[6]	45	(8)	2	50	(8)	1
Arsenic [6]	41	13	32	37	11	30
Bauxite ... thousand long tons	15,550	1,995	13	16,750	1,788	11
Beryllium concentrate	7	(9)	9	9	(9)	6
Bismuth ... thousand pounds	3,600	(4)	(4)	3,800	(4)	(4)
Cadmium ... thousand pounds	15,900	9,552	60	17,920	9,944	55
Chromite	3,600	163	5	3,900	153	4
Cobalt (contained)	14	1	7	15	1	7
Columbium-tantalum concentrates thousand pounds	9,590	33	(2)	11,730	13	(2)
Copper (content of ore and concentrate)	3,100	835	27	3,405	999	29
Gold ... thousand fine ounces	35,100	1,859	5	36,400	1,877	5
Iron ore ... thousand long tons	300,700	78,129	26	366,400	102,999	28
Lead (content of ore and concentrate)	2,220	325	15	2,370	338	14
Manganese ore (35 percent or more Mn)	10,250	206	2	10,600	287	3
Mercury ... thousand 76-pound flasks	182	19	10	196	19	10
Molybdenum (content of ore and concentrate) ... thousand pounds	63,900	58,668	92	67,200	61,781	92
Nickel (content of ore and concentrate)	192	(10)	(2)	216	4	2
Platinum group (Pt, Pd, etc.) thousand troy ounces	850	24	3	950	23	2
Silver ... thousand fine ounces	213,000	35,585	17	221,500	36,470	16
Tin (content of ore and concentrate)[6] ... thousand long tons	179	(11)	(2)	180	(11)	(2)
Titanium concentrates:						
Ilmenite	1,232	532	44	1,418	573	40
Rutile	58	7	12	76	9	12
Tungsten concentrate ... 60 percent WO_3	78	14	20	82	16	20
Vanadium (content of ore and concentrate)[6]	4	3	75	4	3	75
Zinc (content of ore and concentrate)	2,960	474	16	3,200	515	16

See footnotes at end of table.

TABLE 10.—Comparison of world and United States[1] production of principal metals and minerals, 1954–55—Continued

Mineral	1954			1955		
	World	United States		World	United States	
	Thousand short tons		Percent of world	Thousand short tons		Percent of world
Metals, smelter basis:						
Aluminum	3,050	1,461	48	3,340	1,566	47
Copper	3,275	946	29	3,640	1,107	30
Iron, pig (incl. ferroalloys)	175,500	59,806	34	211,500	79,264	37
Lead	2,190	487	23	2,220	479	22
Magnesium	140	70	50	140	61	44
Steel ingots and castings	246,900	88,312	36	297,600	117,036	39
Tin thousand long tons	187	27	14	182	22	12
Zinc	2,710	802	30	2,990	964	32

1 Including Alaska and noncontiguous Territories.
2 Less than 1 percent.
3 Includes low- and medium-temperature and gashouse coke.
4 Bureau of Mines not at liberty to publish United States figure separately.
5 Data not available.
6 World total, exclusive of U. S. S. R.
7 Year ended June 30 of year stated (United Nations).
8 In 1954 United States production of antimony was 766 short tons and 633 short tons in 1955.
9 In 1954 United States production of beryl was 669 short tons and 500 short tons in 1955.
10 In 1954 United States production of nickel was 831 short tons.
11 In 1954 United States production of tin was 200 long tons and 100 long tons in 1955

Employment and Injuries in the Metal and Nonmetal Industries

By John C. Machisak [1]

THIS CHAPTER of the Minerals Yearbook relates to the employment and injury experience in the metal, nonmetal, and quarry industries in the United States. Each industry is shown separately, and no attempt has been made to combine data to show an overall picture of the mineral industries. Combined statistical data on the mineral industries as a whole can be found in volume III.

In 1911, owing to the lack of comparable and accurate statistics on injuries in the metal and nonmetal mines and stone quarries, the Bureau of Mines undertook to collect such statistics in an endeavor to call attention to mining and quarrying hazards and thereby help to reduce them. The requests to the operators for information on injuries and related employment at their establishments were made early in 1912. No distinction was made in the size of operations, as workers at small operations were equally exposed to many of the hazards of mining and quarrying that surrounded those at larger operations.

A gratifying response was received to the first request for injury and employment data, as most of the larger companies submitted detailed reports. From the production point of view, the first statistical data on injuries and employment were fairly representative of the industries. Coverage of the industries has grown to the present, and the data that appear in this chapter of the Minerals Yearbook represent approximately full coverage of the mineral industries. No Federal law requires the operators of metal and nonmetal mines and quarries to submit reports to the Bureau; however, the operators who voluntarily furnished reports on injuries and employment have contributed immeasurably to promotion of safety in the mineral industries of the United States.

METAL MINES

The overall injury experience at metal mines was not as favorable in 1955 as in 1954. Although fewer men were killed, the number of nonfatal injuries increased substantially. There were 7 fewer fatal injuries—a decrease of 8 percent, but the number of nonfatal injuries

[1] Acting chief, Branch of Accident Analysis, Division of Safety.

reached 5,795—an increase of 801 (16 percent). The combined (fatal and nonfatal) frequency rate for 1955 was 41.95, compared with the 1954 rate of 38.93 (an increase of 8 percent). This overall increase was caused by the additional number of nonfatal injuries. Fewer fatal injuries were reported in the copper, lead-zinc, and miscellaneous metals industries (with decreases of 19, 16, and 14 percent, respectively). Gold-placer operations reported no fatalities for 1955.

Employment, based on the average number of men working daily, totaled 63,590 during 1955 and was a decline of approximately 5 percent from the previous year. The average employee worked an 8.09-hour shift and accumulated 2,202 hours of worktime during 1955, the latter representing a 12-percent increase over the previous year in the number of hours worked per man.

TABLE 1.—Employment and injury experience at metal mines in the United States, 1931–55 [1]

Year	Men working daily	Average active mine days	Man-days worked (thousand)	Man-hours worked (thousand)	Number of injuries		Injury rates 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	18,266	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	170,343	150	11,996	.88	70.42
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	[2] 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	70,413	289	20,349	163,027	130	8,894	.80	54.56
1945	61,294	288	17,673	141,295	96	6,922	.68	48.99
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	74,626	265	19,770	158,649	117	6,684	.74	42.13
1953	72,529	270	19,559	156,605	92	6,164	.59	39.36
1954	66,610	245	16,294	130,488	86	4,994	.66	38.27
1955 [3]	63,590	272	17,312	140,006	79	5,795	.56	41.39

[1] Man-hours not available before 1931.
[2] Fluorspar mines, previously included with lead-zinc data for the Mississippi Valley States, now included with nonmetal mines.
[3] Preliminary figures.

Copper.—The fatality experience at copper mines improved in 1955. There were 26 fatal injuries—a decrease of 6 (19 percent). The number of nonfatal injuries increased, as did employment, measured by number of men employed and man-hours worked. There were 1,477 nonfatal injuries, compared with 1,115 for the previous year—an increase of 362 (32 percent). The overall frequency rate for 1955 was 37.92 per million man-hours worked, compared with 31.74 in 1954. The average number of men working daily increased 505 (3 percent), resulting in a 10-percent increase in the number of man-days and man-hours worked during the year. Copper mines worked a 7.95-hour shift and provided 2,391 hours of worktime per man; this represents a 6-percent increase in hours worked per man per year over the previous year. Copper mines were active an average of 301 days in 1955—an increase of 20 days when compared with 1954.

Gold Placer.—Employment in gold placer mines dropped considerably in 1955, with a decrease of 749 (37 percent) in the average number of men working daily. Man-hours of work in 1955 declined 33 percent from the previous year. No fatalities were recorded, but the number of nonfatal injuries increased 48 (57 percent) over the previous year. The average employee worked a shift of approximately 8.5 hours per day and accumulated 1,821 hours of work for the year. The overall frequency rate was 55.76 in 1955, compared with 24.15 for 1954.

Gold-Silver Lode.—Fatalities in gold-silver lode mines rose considerably in 1955 over the previous year; there was an increase of 4 (67 percent). Nonfatal injuries in 1955 declined 108 in number (18 percent) from the 593 nonfatal injuries reported in 1954. The overall injury-frequency rate of 80.34 declined 17 percent from the comparable rate of 96.84 in 1954. Each employee worked a total of 2,129 hours during 1955 at an average shift length of 8 hours.

Iron.—Employment in the iron mines dropped 13 percent under the 1954 total, but the number of man-hours worked increased 9 percent over the previous year. There was a slight increase in the overall number of injuries. Fatalities in 1955 were increased by 1 (7 percent), and nonfatal injuries increased 41 in number (6 percent over 1954). There was a slight change in the overall frequency rate—14.32 per million man-hours in 1955, compared with 14.78 in 1954. The length of shift for the current year averaged 8.26 hours and each man worked an average of 2,221 hours.

Lead-zinc.—Employment in the lead-zinc mining industry increased approximately 5 percent to an average daily working force of 11,301 men in 1955 from the 10,755 working in 1954. Sixteen fatalities were reported during the year—a 16-percent decrease from the 19 reported for the previous year. The number of nonfatal injuries totaled 1,568—a 10-percent increase over 1954. The overall frequency rate for 1955 was 68.37, while in 1954 it was 65.34. The average worker accumulated 2,050 hours while working an 8-hour shift per day.

Miscellaneous Metals.—This group includes mines producing antimony, bauxite, chromite, cobalt, manganese, mercury, molybdenum, pyrite, titanium, tungsten, vanadium-uranium, and several minor metals. The average number of men working daily in these mines increased 7 percent over 1954. The number of fatalities decreased 14 percent compared with 1954. There was a 29-percent increase in the number of nonfatal injuries, resulting in a rise in the overall frequency rate from 80.60 in 1954 to 92.92 per million man-hours worked in 1955. The length of shift was approximately 8 hours, and an average of 2,040 hours was worked per man during the year.

TABLE 2.—Employment and injury experience at metal mines in the United States, by industry groups, 1946–50 (average) and 1951–55

Industry and year	Men working daily	Average active mine days	Man-days worked	Man-hours worked	Number of injuries: Fatal	Number of injuries: Nonfatal	Injury rates per million man-hours: Fatal	Injury rates per million man-hours: Nonfatal
Copper:								
1946–50 (average)	15,263	293	4,469,897	35,729,078	23	1,410	0.64	39.46
1951	16,274	305	4,959,135	39,676,673	19	1,304	.48	32.87
1952	14,910	313	4,661,726	37,279,930	26	1,165	.70	31.25
1953	15,894	311	4,941,301	39,488,069	25	1,212	.63	30.69
1954	16,075	281	4,517,342	36,143,133	32	1,115	.89	30.85
1955	16,580	301	4,983,697	39,639,285	26	1,477	.66	37.26
Gold placer:								
1946–50 (average)	3,626	218	789,045	6,630,621	1	200	.15	30.16
1951	2,649	210	557,482	4,475,624	3	198	.67	44.24
1952	2,436	215	524,577	4,200,622	1	151	.24	35.95
1953	2,588	212	549,897	4,397,978	1	188	.23	42.75
1954	2,049	215	440,289	3,519,582	1	84	.28	23.87
1955	1,300	214	278,465	2,367,436	--------	132	--------	55.76
Gold-silver:								
1946–50 (average)	5,277	260	1,373,102	10,715,107	11	1,128	1.03	105.27
1951	4,261	251	1,070,753	8,294,331	15	963	1.81	116.10
1952	3,645	255	931,214	7,400,300	12	763	1.62	103.10
1953	3,214	254	817,573	6,529,816	6	680	.92	104.14
1954	3,011	257	773,283	6,185,439	6	593	.97	95.87
1955	2,894	266	770,659	6,160,793	10	485	1.62	78.72
Iron:								
1946–50 (average)	26,759	261	6,988,627	56,100,576	28	1,267	.50	22.58
1951	30,576	276	8,446,483	67,931,038	33	1,264	.49	18.61
1952	31,802	248	7,879,534	63,307,839	28	1,066	.44	16.84
1953	30,862	270	8,335,343	66,839,538	19	1,131	.28	16.92
1954	27,840	220	6,131,671	49,177,496	14	713	.28	14.50
1955 [1]	24,177	269	6,500,488	53,701,437	15	754	.28	14.04
Lead-zinc:								
1946–50 (average)	15,809	260	4,104,981	32,809,348	27	2,882	.82	87.84
1951	14,520	271	3,937,874	31,488,680	18	2,497	.57	79.30
1952	16,745	272	4,548,345	36,351,719	40	2,837	1.10	78.04
1953	13,503	248	3,341,999	26,727,287	30	2,135	1.12	79.88
1954	10,755	256	2,754,503	22,038,722	19	1,421	.86	64.48
1955	11,301	256	2,894,574	23,167,144	16	1,568	.69	67.68
Miscellaneous: [2]								
1946–50 (average)	2,837	274	777,989	6,231,147	4	478	.64	76.71
1951	3,323	283	941,591	7,550,962	7	598	.93	79.20
1952	5,088	241	1,224,861	10,108,156	10	702	.99	69.45
1953	6,468	243	1,573,139	12,622,249	11	818	.87	64.81
1954	6,880	244	1,676,576	13,424,116	14	1,068	1.04	79.56
1955	7,338	257	1,883,635	14,969,917	12	1,379	.80	92.12
Total:								
1946–50 (average)	69,571	266	18,503,641	148,215,877	94	7,365	.63	49.69
1951	71,603	278	19,913,318	159,417,308	95	6,824	.60	42.81
1952	74,626	265	19,770,257	158,648,566	117	6,684	.74	42.13
1953	72,529	270	19,559,252	156,604,937	92	6,164	.59	39.36
1954	66,610	245	16,293,664	130,488,488	86	4,994	.66	38.27
1955 [1]	63,590	272	17,311,518	140,006,012	79	5,795	.56	41.39

[1] Preliminary figures.
[2] Includes antimony, bauxite, chromite, cobalt, manganese, mercury, molybdenum, pyrite, titanium, tungsten, vanadium-uranium, and several minor metal mines.

NONMETAL MINES (EXCEPT STONE QUARRIES)

This group of mines comprises those producing barite, feldspar, fluorspar, gypsum, magnesite, mica, phosphate rock, rock salt, sulfur, and minor nonmetallic operations. Employment in these mines declined in 1955 to an average total of 10,290 men—a decrease of 20 percent. Man-days and man-hours worked decreased accordingly.

Fatalities increased 2 and nonfatal injuries decreased 48 compared with 1954 totals of 9 and 956, respectively. The overall (fatal and nonfatal) frequency rate was 39.12 per million man-hours worked—an increase of approximately 20 percent over the previous year. The average employee worked approximately an 8-hour shift and accumulated 2,283 hours of worktime during 1955.

TABLE 3.—Employment and injury experience at nonmetal mines (except stone quarries) in the United States, 1931–55 [1]

Year	Men working daily	Average active mine days	Man-days worked (thousand)	Man-hours worked (thousand)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
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	2,086	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	[2] 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	3,173	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	12,447	288	3,588	28,954	14	1,171	.48	40.44
1953	12,765	292	3,727	30,488	22	1,419	.72	46.54
1954	12,810	284	3,638	29,564	9	956	.30	32.34
1955	10,290	282	2,902	23,495	11	908	.47	38.65

[1] Man-hours not available before 1931.
[2] Fluorspar for Illinois and Kentucky previously included with lead-zinc data for Mississippi Valley States, now included with nonmetal mines.

TABLE 4.—Employment and injury experience at nonmetal mines (except stone quarries) in the United States, 1946–50 (average) and 1951–55 [1]

Year	Men working daily	Average active mine days	Man-days worked	Man-hours worked	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
1946–50 (average)	11,898	288	3,427,281	27,774,840	16	1,243	0.58	44.75
1951	12,500	298	3,728,821	30,130,424	17	1,351	.56	44.84
1952	12,447	288	3,588,289	28,954,402	14	1,171	.48	40.44
1953	12,765	292	3,727,298	30,488,130	22	1,419	.72	46.54
1954	12,810	284	3,637,783	29,563,983	9	956	.30	32.34
1955	10,290	282	2,902,297	23,495,293	11	908	.47	38.65

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

TABLE 5.—Employment and injury experience at ore-dressing plants in the United States, by nonmetallic groups, 1955 [1]

Nonmetallic group	Men working daily	Average active mine days	Man-days worked	Man-hours worked	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
Abrasives	706	269	189,791	1,520,730		32		21.04
Asbestos	150	249	37,399	299,190		4		13.37
Asphalt	214	103	21,963	176,727		11		62.24
Barite	477	264	126,095	1,063,041		28		26.34
Feldspar-mica-quartz	406	271	110,176	890,212	1	50	1.12	56.17
Fluorspar	367	276	101,217	808,860	1	27	1.24	33.38
Gypsum	1,188	317	376,188	3,010,936		29		9.63
Magnesite	32	326	10,432	83,456		14		167.75
Phosphate rock	1,698	252	428,202	3,706,889		28		7.55
Potash	763	357	272,296	2,178,375		76		34.89
Salt	454	280	126,902	1,059,745		1		.94
Sulfur	4	20	80	640				
Talc and soapstone	708	268	189,819	1,557,728		95		60.99
Minor nonmetals	857	319	273,012	2,180,631	1	54	.46	24.76
Total	8,024	282	2,263,572	18,537,160	3	449	.16	24.22

[1] Above table not shown previously.

METALLURGICAL PLANTS

The overall safety at metallurgical plants was very promising in 1955. Fatalities for the year were reduced by 6 (38 percent), and there was a decrease of 232 nonfatal injuries (9 percent). There were declines in employment, man-days, and man-hours worked. An approxi-

TABLE 6.—Employment and injury experience at metallurigcal plants in the United States, 1931–55 [1]

Year	Men working daily	Average active plant days	Man-days worked (thousand)	Man-hours worked (thousand)	Number of injuries		Injury rates 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	49,032	319	15,628	124,967	16	2,853	.13	22.83
1953	55,283	318	17,603	138,811	12	2,824	.09	20.34
1954	54,396	307	16,713	133,675	16	2,578	.12	19.29
1955 [2]	49,892	309	15,417	123,524	10	2,346	.08	18.99

[1] Man-hours not available before 1931.
[2] Preliminary figures.

mate 8-hour shift was reported, and the average employee worked 2,476 hours during the year. The overall frequency rate for 1955 was 19.07, compared with 19.41 in 1954.

ORE-DRESSING PLANTS

Ore-dressing plants handle the crushing, screening, washing, jigging, magnetic separation, flotation, and other milling of metallic ores. There was a 10-percent decline in employment, except for gold-silver lode, where a slight increase was recorded. Man-hours of employment in 1955 decreased 7 percent from the 1954 total. Fatalities were lowered by 7 (70 percent fewer than in the previous year). Non-fatal injuries were 35 less in 1955 than in 1954 (4 percent). The

TABLE 7.—Employment and injury experience at ore-dressing plants in the United States, by industry groups, 1946–50 (average) and 1951–55 [1]

Industry and year	Men working daily	Average active mill days	Man-days worked	Man-hours worked	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
Copper:								
1946–50 (average)	6,029	310	1,869,150	14,958,547	2	275	0.13	18.38
1951	6,033	336	2,025,542	16,205,429		226		13.95
1952	6,141	345	2,121,019	16,968,809	1	306	.06	18.03
1953	6,243	345	2,156,732	17,253,852	1	211	.06	12.23
1954	7,096	294	2,087,365	16,698,943	4	273	.24	16.35
1955	6,110	313	1,915,412	15,563,288		209		13.43
Gold-silver:								
1946–50 (average)	949	281	266,383	2,081,267	1	98	.48	47.09
1951	708	287	203,161	1,579,353	2	55	1.27	34.82
1952	676	295	199,571	1,590,554		39		24.52
1953	494	289	142,604	1,140,610		38		33.32
1954	385	301	116,066	925,843	1	34	1.08	36.72
1955	408	298	121,420	971,223		43		44.27
Iron:								
1946–50 (average)	3,398	231	784,578	6,362,779	2	85	.31	13.36
1951	3,756	250	937,338	7,588,231		69		9.09
1952	3,914	222	869,203	7,037,046		54		7.67
1953	4,439	244	1,082,748	8,721,861	2	88	.23	10.09
1954	4,153	226	939,314	7,574,213	3	80	.40	10.56
1955	4,055	258	1,044,212	8,383,134	2	87	.24	10.38
Lead-zinc:								
1946–50 (average)	4,055	261	1,058,525	8,482,653	3	251	.35	29.59
1951	3,441	270	930,091	7,444,528	2	222	.27	29.82
1952	3,648	273	994,480	7,953,964	3	221	.38	27.78
1953	4,181	258	1,080,762	8,650,758	1	220	.12	25.43
1954	3,551	247	875,911	7,023,574	1	132	.14	18.79
1955	3,404	220	748,844	6,068,766		153		25.21
Miscellaneous metals: [2]								
1946–50 (average)	1,331	277	368,164	2,952,210		122		41.32
1951	2,401	331	793,658	6,361,298	2	206	.31	32.38
1952	3,172	308	977,165	7,819,987		232		29.67
1953	4,400	314	1,380,298	11,045,420		269		24.35
1954	3,910	317	1,238,274	9,898,374	1	311	.10	31.42
1955	3,279	305	1,000,798	8,012,937	1	303	.12	37.81
Total:								
1946–50 (average)	15,762	276	4,346,800	34,837,456	8	831	.23	23.85
1951	16,339	299	4,889,790	39,178,839	6	778	.15	19.86
1952	17,551	294	5,161,438	41,370,360	4	852	.10	20.59
1953	19,757	296	5,843,144	46,812,501	4	826	.09	17.64
1954	19,095	275	5,256,930	42,120,947	10	830	.24	19.71
1955	17,256	280	4,830,686	38,999,348	3	795	.08	20.38

[1] Includes crushers, grinders, and washers and 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.

average employee worked 2,260 hours per year on an 8-hour shift basis. The overall frequency rate for 1955 was 20.46 percent per million man-hours compared with 19.95 percent for 1954.

NONFERROUS REDUCTION PLANTS AND REFINERIES

The reduction plants and refineries in this group are engaged in the primary extraction of nonferrous metals from ore and concentrate and the refining of crude primary nonferrous metals, exclusive of iron and steel plants. Fatalities increased in each group except lead and zinc plants, at which none were reported. The entire group, however, reported an increase of 1 fatal injury. Nonfatal injuries decreased by 197—from 1,748 in 1954 to 1,551 in 1955 (11 percent). The overall frequency rate per million man-hours for 1955 was 18.43, compared with 19.16 in 1954. Employment declined nearly 8 percent. Each worker accumulated 2,590 hours of worktime to his credit while working a 7.98-hour shift per day.

TABLE 8.—Employment and injury experience at primary nonferrous reduction and refinery plants in the United States, by industry groups, 1946–50 (average) and 1951–55 [1]

Industry and year	Men working daily	Average active smelter days	Man-days worked	Man-hours worked	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
Copper:								
1946–50 (average)	11,676	314	3,668,327	29,360,768	6	571	0.20	19.45
1951	11,928	325	3,874,388	31,198,141	3	506	.10	16.22
1952	10,629	323	3,438,403	27,507,902	6	367	.22	13.34
1953	11,177	324	3,617,642	28,942,736	1	332	.03	11.47
1954	11,244	303	3,408,422	27,316,287	4	323	.15	11.82
1955	11,691	312	3,651,422	29,211,324	5	401	.17	13.73
Lead:								
1946–50 (average)	3,911	304	1,188,912	9,507,716	2	175	.21	18.41
1951	3,939	302	1,189,986	9,520,909	2	112	.21	11.76
1952	3,639	318	1,158,368	9,266,594	2	105	.22	11.33
1953	3,753	292	1,095,526	8,764,219	1	80	.11	9.13
1954	3,259	314	1,021,980	8,175,841	1	93	.12	11.37
1955 [2]	2,712	291	788,077	6,304,539	--------	135	--------	21.41
Zinc:								
1946–50 (average)	9,785	339	3,314,366	26,235,190	4	864	.15	32.93
1951	9,160	353	3,236,675	25,744,087	2	788	.08	30.61
1952	9,671	356	3,440,024	27,384,308	4	876	.15	31.99
1953	9,709	354	3,436,291	27,354,478	2	808	.07	29.54
1954	8,881	334	2,969,269	23,612,421	1	675	.04	28.59
1955 [2]	7,842	337	2,639,723	20,955,639	--------	600	--------	28.63
Miscellaneous metals: [3]								
1946–50 (average)	6,015	307	1,846,764	14,830,005	1	342	.07	23.06
1951	6,653	309	2,056,024	16,445,647	3	530	.18	32.23
1952	7,542	322	2,429,697	19,438,096	--------	653	--------	33.59
1953	10,887	332	3,609,904	26,937,080	4	778	.15	28.88
1954	11,917	340	4,056,044	32,449,905	--------	657	--------	20.25
1955 [2]	10,391	337	3,506,679	28,053,417	2	415	.07	14.79
Total:								
1946–50 (average)	31,387	319	10,018,369	79,933,679	13	1,952	.16	24.42
1951	31,680	327	10,357,073	82,908,784	10	1,936	.12	23.35
1952	31,481	332	10,466,492	83,596,900	12	2,001	.14	23.94
1953	35,526	331	11,759,363	91,998,513	8	1,998	.09	21.72
1954	35,301	325	11,455,715	91,554,454	6	1,748	.07	19.09
1955 [2]	32,636	324	10,585,901	84,524,919	7	1,551	.08	18.35

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

STONE QUARRIES

The number of injuries in the quarrying industries dropped slightly in 1955. The number of nonfatal injuries declined almost 2 percent—a total of 3,778 reported in 1955, compared with 3,834 in 1954. Fatal injuries increased 56 percent compared with the number reported for the previous year, or from 34 in 1954 to 53 in 1955. Despite the increased number of fatal injuries for 1955, the combined (fatal and nonfatal) injury-frequency rate of 22.43 per million man-hours of worktime was only 2 percent higher than the rate of 22.00 reported in 1954.

Cement.—The cement industry has been foremost in safeguarding its employees from the hazards connected with their daily work and for years has had excellent safety records. In 1955 the number of injuries (fatal and nonfatal) was 12 percent lower than those reported in 1954. The combined (fatal and nonfatal) injury-frequency rate declined 13 percent. Nonfatal injuries were fewer by 41 in 1955—a 13-percent decrease. The record for fatal injuries for 1955 was not as good as in 1954, as they increased 3 (50 percent). The number of days worked was the same as in the previous year; but more men were employed, and more man-hours were worked than in 1954. An 8.01-hour shift was worked by each employee, and each worker accumulated 2,566 hours of worktime—2 hours more than in the previous year.

Granite.—Accidents at granite quarries and outside plants resulted in 4 fatal and 492 nonfatal injuries in 1955. The combined number of fatal and nonfatal injuries increased by 35 (8 percent), and the combined injury-frequency rate showed a 19-percent increase over 1954.

Fewer men were employed, fewer man-hours worked, and the days active were 4 less than in the previous year. Approximately the same length of shift was worked in each year. Each worker accumulated 1,985 hours of worktime—27 hours less than that worked in 1954.

Lime.—Quarries that produced limestone chiefly for the manufacture of lime reported a very good safety record in 1955. Fatal injuries decreased 4 (40 percent) and nonfatal injuries 40 (9 percent) from the number reported in 1954. The combined injury-frequency rate of 21.50 per million man-hours of work was 13 percent lower than the 24.83 reported the preceding year. Two fewer days were worked in 1955, with more men employed and more man-hours worked. The length of shift was 8.06 hours, and each worker accumulated 2,351 hours of worktime—5 hours less than the 2,356 reported in 1954.

Limestone.—The limestone industry's safety record for 1955 was not as favorable as for the preceding year, as reflected by the number of fatal injuries reported. For 1955, 28 fatalities were reported, while only 12 workers lost their lives in 1954. Nonfatal injuries declined 107 (6 percent), but the overall injury rate (fatal and nonfatal) increased 5 percent. The number of men working daily decreased 2,527 or 10 percent less than the number employed in 1954; days active were approximately the same. The number of man-days and man-hours worked was less than in 1954, with the length of shift (8.40 hours) showing little change from the 8.39 hours worked the preceding year. Each employee accumulated 1,987 hours during the year, or 3 hours less than in 1954.

Marble.—Marble quarries and plants for 1955 operated with decreases in the number of men employed and the man-days and man-hours worked. Injuries to workers, however, increased, with 1 fatal injury reported in 1955, and an increase of 51 nonfatal injuries over the number reported in 1954. The overall number of injuries increased 33 percent. During 1955 the workers averaged an 8.38-hour shift, while in 1954 they worked an 8.27-hour shift. Each employee's worktime totaled 2,103 hours during the year—21 more hours than in 1954.

Sandstone.—Accidents in and around sandstone quarries and their associated plants resulted in 2 fatal and 365 nonfatal injuries. This increase (40 percent) in the combined number of (fatal and nonfatal) injuries in 1955 over the number in 1954 is reflected in both fatal and nonfatal data. The average number of workers was reduced 131, with the days' active increasing 19, and a slight rise in man-days and man-hours worked. The average worker had 1,951 hours to his credit—141 more than the number worked during 1954—and worked an 8.12-hour shift.

TABLE 9.—Employment and injury experience at stone quarries in the United States, 1924–55 [1]

Year	Men working daily	Average active mine days	Man-days worked (thousand)	Man-hours worked (thousand)	Number of injuries		Injury rates per million man-hours	
					Fatal	Nonfatal	Fatal	Nonfatal
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	81,879	279	22,844	186,552	74	4,503	.40	24.14
1953	83,641	278	23,248	189,777	43	4,450	.23	23.45
1954	78,910	273	21,506	175,817	34	3,834	.19	21.81
1955	75,980	275	20,864	170,808	53	3,778	.31	22.12

[1] Man-hours not available before 1924.

TABLE 10.—Employment and injury experience at stone quarries in the United States, by industry groups, 1946–50 (average) and 1951–55

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
Cement:[1]								
1946–50 (average)	28,038	321	9,002,649	71,203,965	19	717	0.27	10.07
1951	29,096	329	9,561,969	75,325,959	15	480	.20	6.37
1952	28,384	329	9,338,887	74,193,087	17	481	.23	6.48
1953	28,925	329	9,504,900	75,800,327	16	388	.21	5.12
1954	27,718	320	8,879,804	71,058,012	6	322	.08	4.53
1955	28,097	320	9,000,019	72,097,180	9	281	.12	3.90
Granite:								
1946–50 (average)	6,218	251	1,558,423	12,970,977	4	579	.31	44.64
1951	7,211	247	1,777,947	14,775,534	7	596	.47	40.34
1952	6,646	245	1,630,766	13,585,369	12	565	.88	41.59
1953	6,484	252	1,631,700	13,506,490	2	552	.15	40.87
1954	6,469	243	1,571,232	13,018,657	4	457	.31	35.10
1955	5,944	239	1,421,453	11,800,012	4	492	.34	41.69
Lime:[1]								
1946–50 (average)	9,086	297	2,695,631	21,501,866	7	888	.33	41.30
1951	9,085	296	2,688,965	21,674,253	9	692	.42	31.93
1952	9,231	294	2,716,061	21,877,280	7	528	.32	24.13
1953	9,165	294	2,690,660	21,663,764	3	526	.14	24.28
1954	7,985	294	2,345,142	18,809,131	10	457	.53	24.30
1955	8,366	292	2,441,932	19,672,136	6	417	.30	21.20
Limestone:								
1956–50 (average)	23,732	237	5,622,238	47,380,905	25	1,851	.53	39.07
1951	27,626	236	6,528,367	54,952,659	21	2,055	.38	37.40
1952	26,818	241	6,462,276	54,265,172	27	1,890	.50	34.83
1953	27,764	240	6,651,663	55,839,029	16	2,039	.29	36.52
1954	26,246	237	6,224,718	52,231,092	12	1,748	.23	33.47
1955	23,719	236	5,608,126	47,132,663	28	1,641	.59	34.82
Marble:								
1946–50 (average)	2,739	258	707,401	5,859,164	1	187	.17	31.92
1951	2,584	254	656,579	5,486,709	--------	191	--------	34.81
1952	2,376	254	604,640	5,021,773	1	196	.20	39.03
1953	2,442	248	606,435	4,981,451	1	161	.20	32.32
1954	2,558	252	643,873	5,326,541	--------	159	--------	29.85
1955	2,221	251	557,180	4,669,780	1	210	.21	44.97
Sandstone:								
1946–50 (average)	3,902	243	948,229	7,902,471	3	362	.38	45.81
1951	4,199	240	1,009,415	8,288,499	2	389	.24	46.93
1952	3,890	248	964,804	7,876,133	6	367	.76	46.60
1953	4,167	247	1,027,719	8,369,173	2	368	.24	43.97
1954	3,471	221	768,252	6,283,356	--------	262	--------	41.70
1955	3,340	240	802,432	6,515,963	2	365	.31	56.02
Slate:								
1946–50 (average)	1,773	266	471,302	4,142,264	2	206	.48	49.73
1951	2,093	270	565,624	4,773,785	--------	239	--------	50.07
1952	1,616	271	438,334	3,692,983	--------	226	--------	61.20
1953	1,682	263	442,689	3,615,041	1	186	.28	51.45
1954	1,506	261	393,270	3,276,274	--------	181	--------	55.25
1955	1,571	255	401,299	3,332,462	1	159	.30	47.71
Traprock:								
1946–50 (average)	2,670	235	627,603	5,320,517	3	254	.56	47.74
1951	2,908	234	680,826	5,835,796	3	303	.51	51.92
1952	2,918	236	687,908	6,040,033	4	250	.66	41.39
1953	3,012	230	692,605	6,001,314	2	230	.33	38.32
1954	2,957	230	679,468	5,814,087	2	248	.34	42.66
1955	2,722	232	631,314	5,588,130	2	213	.36	38.12
Total:								
1946–50 (average)	78,158	277	21,633,476	176,282,129	64	5,044	.36	28.61
1951	84,802	277	23,469,692	191,113,194	57	4,945	.30	25.87
1952	81,879	279	22,843,676	186,551,830	74	4,503	.40	24.14
1953	83,641	278	23,248,371	189,776,589	43	4,450	.23	23.45
1954	78,910	273	21,505,759	175,817,150	34	3,834	.19	21.81
1955	75,980	275	20,863,755	170,808,326	53	3,778	.31	22.12

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

Slate.—The overall record for safety of the slate quarries and plants was improved in 1955, despite the fact that 1 worker lost his life and 159 were injured. The 12-percent reduction in the combined (fatal and nonfatal) injuries reported is also demonstrated in the combined injury-frequency rates per million man-hours of worktime by a 13-percent decrease from 1954. Slate quarries operated 255 days during 1955, with an 8.30-hour shift. Each employee's worktime totaled 2,121 hours for the year.

Traprock.—The injury record for traprock quarries and plants was more favorable in 1955 than in the previous year, as far as the nonfatal disabling injuries were concerned. Fatal injuries in 1955 were 2—the same number reported in 1954; however, the 14-percent decrease in the number of combined (fatal and nonfatal) injuries is also evident in the combined injury-frequency rate per million man-hours of worktime. Fewer men were employed and fewer man-days and man-hours worked in 1955 than in 1954. Days active were 232, while in 1954 work averaged 230 days. The 8.85-hour shift was slightly higher than the 8.56 hours per day worked in the preceding year. The average employee accumulated 2,053 hours during the year—87 more than in 1954.

Abrasive Materials

By Henry P. Chandler[1] and Gertrude E. Tucker[2]

SALES in the United States of many abrasive materials increased over 1954 both in tonnage and value during 1955. This corresponded with the increased industrial activity of the country. Sales of bonded grinding wheels and associated products increased 31 percent in value, and sales of surface-coated abrasives increased 24 percent in value and 19 percent in quantity over the previous year. A more comprehensive canvass of the metallic abrasive industry was begun in 1955 to obtain production information on the various types. The reported production of metallic abrasives was 33 percent greater in tonnage and 35 percent higher in value than in 1954. The quantity and value of silicon carbide production in the United States and Canada increased; the quantity and value of aluminum oxide declined. Imports of both corundum and emery increased slightly. Imports of industrial diamond in 1955 reached the record figure of approximately 15 million carats. Exports of abrasive materials during 1955 increased 20 percent and imports 25 percent in value over 1954.

TABLE 1.—Salient statistics of the abrasives industries in the United States, 1954–55

	1954		1955		Percent of change in—	
	Short tons	Value	Short tons	Value	Short tons	Value
Natural abrasives (domestic) sold or used by producers:						
Tripoli	41,625	$1,458,762	[1] 47,362	[1] $631,366	(1)	(1)
Quartz, ground sand, and sandstone [2]	214,152	1,651,335	239,030	1,844,371	+12	+12
Grindstones	2,218	163,995	2,799	195,761	+26	+19
Millstones	(3)	(4)	(3)	(4)	--------	−7
Tube-mill liners	933	59,471	(4)	(4)	(4)	(4)
Grinding pebbles	3,070	99,491	2,130	68,268	−31	−31
Garnet	14,183	971,353	11,835	1,191,456	−17	+23
Emery	9,758	132,313	10,735	151,455	+10	+14
Artificial abrasives:						
Silicon carbide [5]	66,972	8,787,445	74,805	11,027,693	+12	+25
Aluminum oxide [5]	219,308	22,420,833	195,822	22,141,686	−11	−1
Metallic abrasives (various types) shipments	118,096	13,271,832	157,616	17,911,738	+33	+35
Foreign trade (natural and artificial abrasives):						
Imports	----------	72,022,620	----------	89,738,662	--------	+25
Exports	----------	20,693,708	----------	24,859,873	--------	+20

[1] Data not comparable with earlier years.
[2] For abrasive purposes.
[3] Tonnage not recorded.
[4] Figure withheld to avoid disclosure of individual company operations.
[5] Production (U. S. and Canada).

[1] Commodity specialist.
[2] Statistical assistant.

457676—58——9

This chapter includes the statistics for most materials used for abrasive purposes but omits those for certain clays, carbides, oxides, and other substances, discussed in this chapter under the section Miscellaneous Mineral-Abrasive Materials, that have abrasive applications.

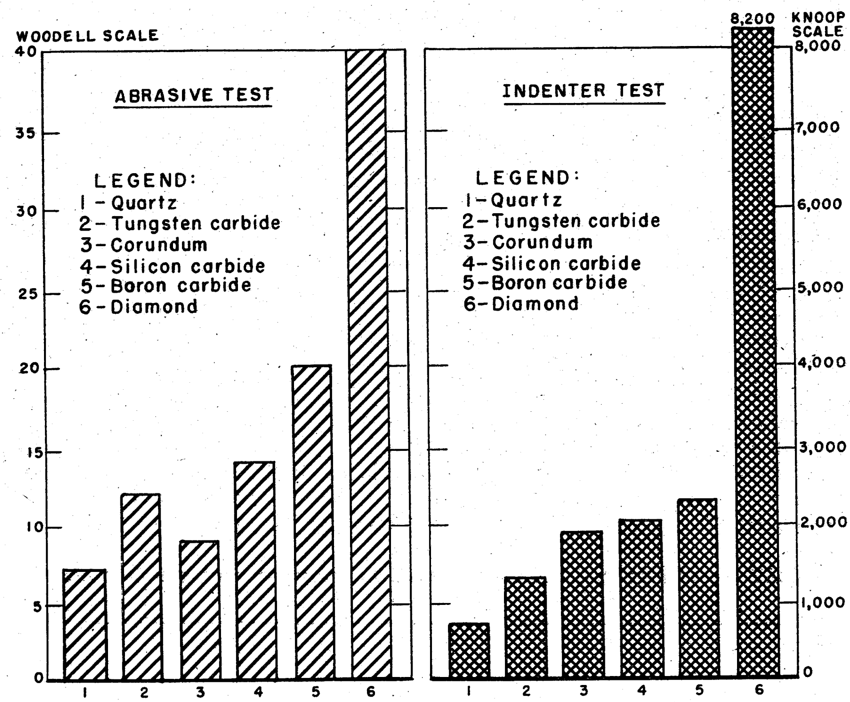

FIGURE 1.—Relative hardness of various abrasive materials.

NATURAL SILICA ABRASIVES

Tripoli.—During 1955 sales of processed tripoli, amorphous silica, and rottenstone were 46,969 short tons, valued at $1,801,935, an increase of 13 percent in tonnage and 24 percent in value over 1954. Illinois, Oklahoma, and Pennsylvania reported mine production of these materials; about 70 percent of the total quantity mined was used for abrasive purposes. A very small quantity was imported.

Companies mining and processing tripoli, amorphous silica, or rottenstone in 1955 were: Ozark Minerals Co., Cairo, Ill. (amorphous silica); Tamms Industries, Inc., Tamms, Ill. (amorphous silica); American Tripoli Corp., Division of Carborundum Co., Seneca, Mo., (processing plant), and Ottawa County, Okla. (tripoli); Penn Paint & Filler Co., Antes Fort, Pa. (rottenstone).

Price quotations on tripoli in E&MJ Metal and Mineral Markets during 1955 were as follows (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; and airfloated through 200-mesh, $35.

TABLE 2.—Processed tripoli[1] sold or used by producers in the United States, 1946–50 (average) and 1951–55, by uses[2]

Year	Abrasives		Filler		Other, including foundry facings		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	25,821	$644,598	3,862	$76,736	2,242	$52,717	31,925	$774,051
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
1953	25,000	852,000	7,000	163,000	4,183	123,635	36,183	1,138,635
1954	31,050	1,181,000	8,719	202,626	1,856	75,136	41,625	1,458,762
1955	32,870	1,376,590	[3] 8,189	[3] 188,748	[4] 5,910	[4] 236,597	46,969	1,801,935

[1] Including amorphous silica and Pennsylvania rottenstone.
[2] Partly estimated.
[3] Includes some tripoli used for abrasive purposes.
[4] Includes some tripoli used for filter block.

Quartz.—Information on production and sale of crude, crushed, and ground quartz and ground sand and sandstone, which formerly appeared in the Abrasive Materials chapter of Minerals Yearbook, is included in the Stone and Sand and Gravel chapters of this volume. However, the quantity of these materials used for abrasive purposes is reported.

The tonnage of graded quartz used by the coated-abrasive industry has shown little change during the past 15 years.

TABLE 3.—Quartz, ground sand, and sandstone used for abrasive purposes, 1953–55

	1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
Ground sand	171,974	$1,328,577	182,046	$1,466,762	209,729	$1,692,064
Sandstone, quartz, and quartzite	16,045	93,105	32,106	184,573	29,301	152,307
Total	188,019	1,421,682	214,152	1,651,335	239,030	1,844,371

Abrasive Sands.—Glass grinding, stove polishing, sand blasting, and similar industries used substantial tonnages of natural sands with a high silica content as abrasive materials. Sales of these sands totaled 1,717,271 short tons valued at $4,611,618 in 1955, compared with 1,343,742 short tons valued at $3,835,780 in 1954. The 1955 figures include 803,962 short tons of blast sand valued at $3,253,098, increases of 36 percent in tonnage and 29 percent in value compared with 1954. The tonnage and value of these sands, by States, are included in the Sand and Gravel chapter of this volume.

SPECIAL SILICA-STONE PRODUCTS

Grindstones and Pulpstones.—Grindstones sales in 1955 increased 26 percent in tonnage and 19 percent in value over 1954. No sales of pulpstones were reported. Ohio and West Virginia were the only States reporting sales.

TABLE 4.—Grindstones and pulpstones sold by producers in the United States, 1946–50 (average) and 1951–55

Year	Grindstones		Pulpstones		
			Quantity		Value
	Short tons	Value	Pieces	Equivalent short tons	
1946–50 (average)	7,812	$371,218	15	48	$3,006
1951	5,549	313,901	6	22	1,970
1952	3,962	246,526	4	12	908
1953	2,499	169,951			
1954	2,218	163,995			
1955	2,799	195,761			

Oilstones and Other Sharpening Stones.—Sales of natural sharpening stones during 1955 increased 41 percent in quantity and 24 percent in value over 1954. In 1955, oilstones and whetstones were produced in Arkansas, whetstones in Indiana and scythestones in New Hampshire.

Millstones.—Rowan County, N. C., was the only area reporting a production of millstones, and no production of chasers were reported.

TABLE 5.—Value of millstones and chasers sold by producers in the United States, 1946–50 (average) and 1951–55 [1]

Year	Number of producers	Value	Year	Number of producers	Value
1946–50 (average)	3	$15,280	1953	2	$18,375
1951	1	6,000	1954	2	(2)
1952	1	9,285	1955	1	(2)

[1] Produced in New York (1946–48 and 1953–54), North Carolina, and Virginia (1946–50 only).
[2] Figure withheld to avoid disclosure of individual company operations.

Grinding Pebbles and Tube-Mill Liners.—Production of grinding pebbles during 1955 decreased 31 percent from the previous year both in tonnage and value. Production was reported from Minnesota, North Carolina, Texas, Washington, and Wisconsin. Tube-mill liners were produced in Minnesota, North Carolina, and Wisconsin.

TABLE 6.—Grinding pebbles and tube-mill liners sold or used by producers in the United States, 1946–50 (average) and 1951–55

Year	Grinding pebbles		Tube-mill liners		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	3,767	$88,711	1,571	$47,146	5,338	$135,857
1951	3,062	84,306	1,408	77,027	4,470	161,333
1952	3,460	95,455	1,083	66,218	4,543	161,673
1953	2,472	81,159	1,219	68,688	3,691	149,847
1954	3,070	99,491	933	59,471	4,003	158,962
1955	2,130	68,268	(1)	(1)	(1)	(1)

1 Figure withheld to avoid disclosure of individual company operations.

NATURAL SILICATE ABRASIVES

Garnet.—The tonnage of garnet sold by producers during 1955 declined 17 percent from 1954, but its value increased 23 percent; this change was due partly to reduced sales of the lower priced garnet used for sandblasting. Garnet producers reporting sales in 1955 were: Otis A. Kittle & Associates, Ltd., Bishop, Calif.; Florida Ore Processing Corp., Melbourne, Fla.; Idaho Garnet Abrasive Co., Fernwood, Idaho; Barton Mines Corp., North Creek, N. Y.; and Cabot Carbon Co., Willsboro, N. Y.

New York was the leading garnet-producing State; Idaho ranked second, California third, and Florida fourth.

Although garnet was produced as a byproduct of the concentration of other minerals, production was mostly from deposits mined primarily for garnet content. Sales of garnet since 1920 are presented graphically in figure 2.

TABLE 7.—Abrasive garnet sold or used by producers in the United States, 1946–50 (average) and 1951–55

Year	Short tons	Value	Year	Short tons	Value
1946–50 (average)	8,077	$614,169	1953	10,520	$988,797
1951	14,050	1,246,947	1954	14,183	971,353
1952	11,390	981,841	1955	11,835	1,191,456

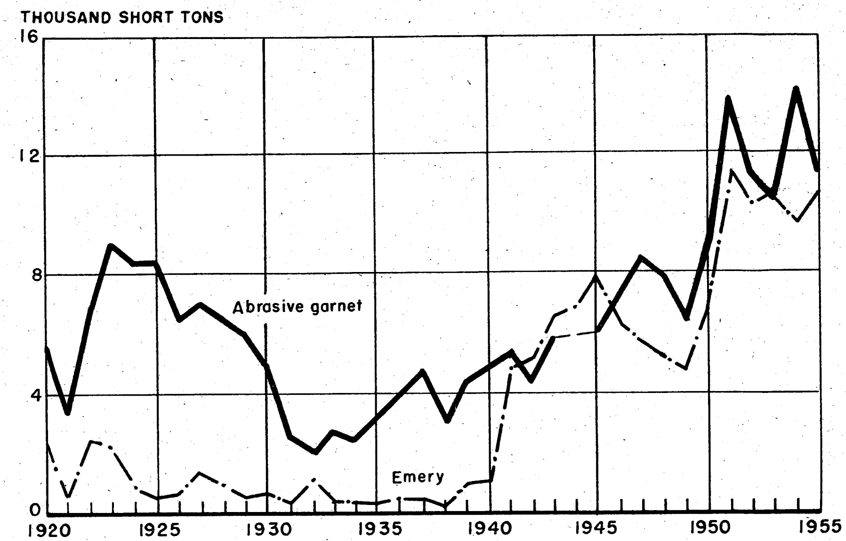

FIGURE 2.—Marketed production of abrasive garnet and emery in the United States, 1920–55.

NATURAL ALUMINA ABRASIVES

Corundum.—During 1955 imports of corundum into the United States increased over 1954 but were still only 42 percent of the 1950–54 average. A decrease in the corundum production of Union of South Africa, which supplies nearly all United States requirements, was the apparent reason for the reduced imports. Southern Rhodesia corundum was not considered suitable for abrasive purposes and was used in South Africa for refractories.[3]

A discovery of corundum was reported in Mozambique;[4] India continued to produce a small tonnage of that mineral.[5]

Canada has not produced corundum commercially since 1946, although many small scattered corundum deposits in the Province of Ontario have been investigated by Canadian geologists. The low corundum content of Canadian deposits has prevented their exploitation.[6]

Prices for crude corundum were quoted in E&MJ Metal and Mineral Markets, c. i. f. United States ports, at $100 to $120 a short ton. No significant changes in the price of the various sizes of graded corundum were noted during 1955.

---

[3] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, p. 36.
[4] Mining World, vol. 17, No. 3, March 1955, p. 71.
Mining Journal (London), Crystal Corundum Discovery in Mozambique: Vol. 245, No. 6262, Aug. 26, 1955, p. 233.
[5] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 39.
[6] Janes, T. H., Natural Abrasives in Canada, 1955: Dept. of Mines and Tech. Surveys, Ottawa, Canada, No. 28, 1955, 6 pp.

TABLE 8.—World production of corundum, by countries,[1] 1946–50 (average) and 1951–55, in short tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
Argentina	33	(3)	(3)	(3)	(3)	(3)
Australia	—	—	61	—	—	10
Brazil	(3)	(3)	(3)	(3)	—	—
Canada	150	—	—	—	—	—
French Equatorial Africa	11	—	—	—	—	—
India	520	621	713	363	527	149
Madagascar	8	—	—	—	—	—
Malaya, Federation of	2	28	—	—	—	—
Mozambique	4	—	—	1	1	9
Rhodesia and Nyasaland, Federation of:						
Nyasaland	150	111	52	—	17	20
Southern Rhodesia	28	—	—	843	2,840	1,168
South-West Africa	2	—	—	—	—	—
Union of South Africa	2,727	5,030	4,179	1,865	1,444	834
World total (estimate) [1]	9,300	11,000	11,000	10,000	10,000	8,000

[1] In addition to countries listed, corundum is produced in 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 Abrasive Materials chapters Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[3] Data not available; estimate by senior author of chapter included in total.

Emery.—Domestic production of emery in 1955 increased over 1954 and approximately equaled the 1951–54 average. The price of crude emery ore at the mine was $14.11 a short ton—a slight advance from the 1954 figure. Imports increased in tonnage but decreased in value per ton. The use of emery as a nonskid component in stair treads, floors, and pavements continued to be its largest application. As in recent years, the only domestic producers of emery ore were Joe DeLuca and DiRubbo & Ellis, both of Peekskill, N. Y. A plant for processing emery ore was operated at Peekskill. Domestic production of emery since 1920 is presented graphically in figure 2.

Nearly all of the 840 short tons of emery imported into the United States came from Turkey, which produced approximately 7,800 short tons in 1955.[7] The emery deposits in Turkey were listed.[8]

TABLE 9.—Emery sold or used by producers in the United States, 1946–50 (average) and 1951–55

Year	Short tons	Value	Year	Short tons	Value
1946–50 (average)	5,650	$66,932	1953	10,562	$143,974
1951	11,634	160,212	1954	9,758	132,313
1952	10,352	141,911	1955	10,735	151,455

[7] United States Embassy, Izmir, Turkey, State Department Dispatch No. 3: July 14, 1955, p. 11. State Department Dispatch No. 35: Nov. 17, 1955, pp. 9–10.
[8] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 3, September 1955, p. 45.

INDUSTRIAL DIAMONDS

The industrial-diamond industry enjoyed a prosperous year in 1955. As the United States consumed most of the world mine output, its imports were a good index of the general prosperity of the industry.[9]

Sales of industrial diamond in London by Industrial Distributors (Sales), Ltd., a sales agency of Diamond Corp., were 19,159,000 carats valued at $67,322,000 in 1955, compared with 15,452,000 carats valued at $46,303,000 in 1954, a 24-percent increase in weight and a 45-percent rise in value.

The United States Government continued to purchase industrial diamonds for the National and Supplementary Stockpiles.[10]

During 1955, new mining regulations that would permit native African miners to dig for diamonds in Sierra Leone were under consideration, thereby ending the diamond-mining monopoly held by one European mining company.[11]

Production.—World production of diamond in 1955 was approximately 21,540,000 metric carats, a 6-percent increase over 1954 and the highest on record. Of the 1955 production, 81 percent was classed as industrial material.

TABLE 10.—World production of industrial diamond, by countries, 1953–55, in thousand carats [1]

Country	1953	1954	1955
Africa:			
Angola	307	300	304
Belgian Congo	12,000	12,060	12,480
French Equatorial Africa	92	100	90
French West Africa	120	140	210
Gold Coast	1,515	1,670	1,770
Sierra Leone [2]	322	260	540
South-West Africa	100	100	80
Tanganyika	73	160	150
Union of South Africa:			
"Pipe" mines:			
Premier	978	1,100	1,050
DeBeers group	564	560	450
Others	59	60	100
"Alluvial" mines	90	90	65
Total Africa	16,220	16,600	17,290
Other areas:			
Brazil [2]	100	100	100
British Guiana	21	18	20
Venezuela	60	68	100
Australia, Borneo, India, and U. S. S. R.[2]	3	3	3
World total	16,400	16,800	17,500

[1] Prepared jointly by Bureau of Mines and Dr. George Switzer, Smithsonian Institution.
[2] Estimate.

[9] Chemical Engineering and Mining Review (Melbourne), Demand for Diamonds Exceeds Supply: Vol. 48, No. 2, Nov. 10, 1955, p. 49.
Industrial Diamond Review (London), Diamond Supply: Vol. 15, No. 176, July 1955, p. 138.
Leveridge, A. D., No Shortage of Industrial Diamonds (But No Abundance Either): Metal Progress, vol. 27, No. 6, June 1955, pp. 124, 170.
Mining and Industrial Magazine (Johannesburg), Prosperity in Diamond Industry: Vol. 45, No. 12, December 1955, pp. 443, 445, 447.
Mining Journal (London), DeBeers Consolidated Mines, Ltd.: Vol. 244, No. 6248, May 20, 1955, p. 568, Diamond Sales Continue at High Levels: Vol. 245, No. 6255, July 8, 1955, p. 51.
South African Mining and Engineering Journal (Johannesburg), Diamond Developments: Vol. 66. part I, No. 3245, Apr. 23, 1955, p. 287.
[10] Ridge, J. D., Stockpiling—One of the Costs of Preparedness: Min. Ind., vol. 25, No. 1, October 1955, p. 11.
[11] Mining Journal (London), "Casts" Diamond Agreement Under Discussion: Vol. 245, No. 6254, July 1, 1955, p. 7.
Mining World, Sierra Leone: Vol. 17, No. 10, September 1955, p. 92.

For the past 25 years Belgian Congo has been the world's largest producer of industrial diamond, and in 1955 its output was 71 percent of the total. Other producing areas in order of magnitude were: Gold Coast, 10 percent; Union of South Africa, 10 percent; Sierra Leone, 3 percent; Angola, 2 percent; all other African fields, 3 percent; other than African, 1 percent.

Diamond fields showing the largest increases in the quantity of industrial diamond produced during 1955 over the preceding year were: Belgian Congo, with an increase of 420,000 carats; Sierra Leone, 280,000 carats; Gold Coast, 100,000 carats; French West Africa, 70,000 carats; and Venezuela, 32,000 carats. Decreases were noted in the output of French Equatorial Africa, south-West Africa, Tanganyika, and Union of South Africa.

Sierra Leone was credited with the production of the industrial diamond exported from Liberia.[12]

Imports.—In addition to the imports shown in table 11, 152,732 carats of diamond dust valued at $435,120 and 2,771 carats of manufactured bort valued at $205,139 were imported in 1955.

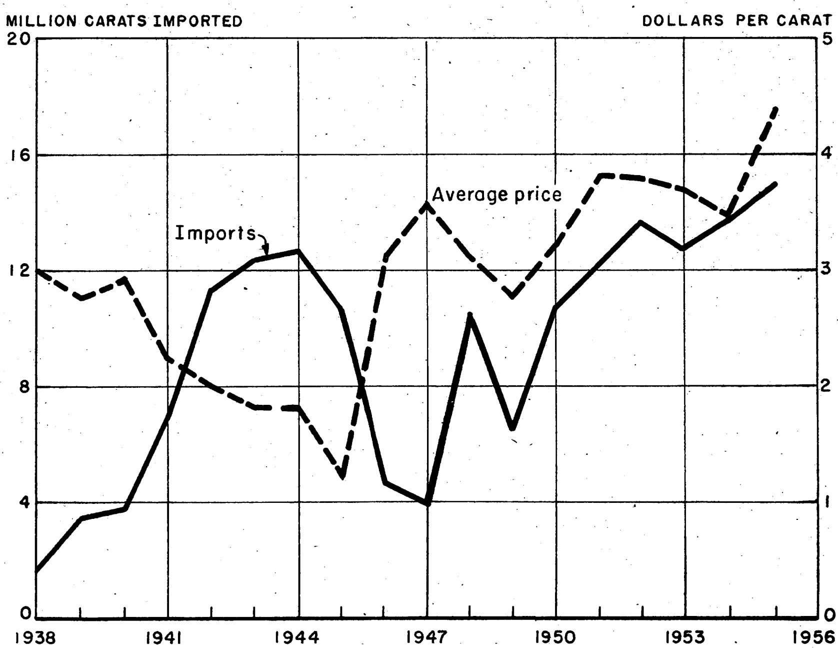

FIGURE 3.—United States imports and average price per carat of industrial diamond, 1938–55.

[12] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, pp. 43–45.
Mining World and Engineering Record (London), Diamond Smuggling in West Africa: Vol. 169, No. 4417, Nov. 26, 1955, p. 300.
United States Embassy, Monrovia, Liberia, State Department Dispatch No. 154: Dec. 23, 1955, 2 pp.

TABLE 11.—Industrial diamond (including diamond dust and manufactured bort) imported for consumption in the United States, 1954–55, by countries

[U. S. Department of Commerce]

Country	Bort manufactured (diamond dies)		Crushing bort (including all types of bort suitable for crushing)		Other industrial diamond (including glaziers' and engravers' diamond unset and miners')		Carbonado and ballas		Dust and powder	
	Carats	Value	Carats	Value	Carats	Value	Carats	Value	Carats	Value
1954										
North America:										
Bermuda	------	------	------	------	97,053	$493,272	------	------	------	------
Canada	------	------	[1] 167,925	[1] $465,491	[1] 661,931	[1] 3,364,859	------	------	11,986	$22,707
Mexico	------	------	571	1,250	1,180	1,921	------	------	------	------
Total	------	------	[1] 168,496	[1] 466,741	[1] 760,164	[1] 3,860,052	------	------	11,986	22,707
South America:										
Brazil	------	------	------	------	19,936	202,415	372	$4,827	------	------
Venezuela	------	------	------	------	5,033	81,531	------	------	------	------
Total	------	------	------	------	24,969	283,946	372	4,827	------	------
Europe:										
Belgium-Luxembourg	10	$254	300	666	350,916	3,415,648	------	------	------	------
France	1,841	153,701	------	------	32,446	314,059	------	------	------	------
Germany, West	83	3,168	------	------	54,216	814,874	------	------	------	------
Netherlands	340	14,675	------	------	311,534	3,511,298	------	------	------	------
Switzerland	5	311	------	------	267	1,247	------	------	------	------
United Kingdom	20	850	1,625,026	3,799,040	2,713,591	12,969,174	2,998	25,706	32,730	99,810
Total	2,299	172,959	1,625,326	3,799,706	3,462,970	21,026,300	2,998	25,706	32,730	99,810
Asia:										
India	------	------	------	------	305	8,820	------	------	------	------
Japan	------	------	------	------	100	600	------	------	------	------
Lebanon	------	------	------	------	954	38,255	------	------	------	------
Malaya	------	------	------	------	598	21,381	------	------	------	------
Total	------	------	------	------	1,957	69,056	------	------	------	------
Africa:										
Belgian Congo	------	------	6,513,054	14,438,529	241,195	844,757	------	------	61,102	168,558
French Equatorial Africa	------	------	------	------	12,877	136,972	------	------	------	------
Liberia	------	------	------	------	5,779	112,964	------	------	------	------
Union of South Africa	90	8,807	714,331	2,006,321	272,856	942,327	------	------	75,600	211,821
Total	90	8,807	7,227,385	16,444,850	532,707	2,037,020	------	------	136,702	380,379
Grand total 1954	2,389	[2] 181,766	[1] 9,021,207	[1] 20,711,297	[1] 4,782,767	[1] 27,276,374	3,370	30,533	181,418	502,896
1955										
North America:										
Bermuda	------	------	------	------	10,573	104,974	------	------	------	------
Canada	132	596	175,193	460,464	585,964	3,355,639	------	------	7,095	13,168
Haiti	------	------	------	------	378	2,546	------	------	------	------
Mexico	------	------	------	------	240	500	------	------	------	------
Total	132	596	175,193	460,464	597,155	3,463,659	------	------	7,095	13,168
South America:										
Brazil	------	------	------	------	27,010	466,955	4,267	87,782	------	------
British Guiana	------	------	------	------	205	2,370	------	------	------	------
Venezuela	------	------	------	------	13,548	273,302	------	------	------	------
Total	------	------	------	------	40,763	742,627	4,267	87,782	------	------
Europe:										
Austria	------	------	------	------	289	3,390	------	------	------	------
Belgium-Luxembourg	24	2,200	------	------	1,018,420	12,091,103	------	------	------	------
France	1,761	147,507	------	------	35,298	318,455	------	------	------	------

See footnotes at end of table.

TABLE 11.—Industrial diamond (including diamond dust and manufactured bort) imported for consumption in the United States, 1954–55, by countries—Con.

[U. S. Department of Commerce]

Country	Bort manufactured (diamond dies)		Crushing bort (including all types of bort suitable for crushing)		Other industrial diamond (including glaziers' and engravers' diamond unset and miners')		Carbonado and ballas		Dust and powder	
	Carats	Value	Carats	Value	Carats	Value	Carats	Value	Carats	Value
1955										
Europe—Con.										
Germany, West	265	$4,672			5,856	$117,315				
Netherlands	184	14,767			317,727	2,973,774				
Sweden	20	502								
Switzerland	5	317	879	$2,198	5,330	37,586			1,074	$2,547
United Kingdom	380	34,578	1,695,603	3,808,399	5,112,296	25,542,053			40,705	132,798
Total	2,639	204,543	1,696,482	3,810,597	6,495,216	41,083,676			41,779	135,345
Asia:										
India					178	3,850				
Israel					1,025	11,109				
Lebanon					516	4,878				
Total					1,719	19,837				
Africa:										
Belgian Congo			4,348,729	9,643,360	567,224	1,661,421			55,570	148,312
French Equatorial Africa					25,657	295,359				
Liberia			330	412	1,243	22,012				
Union of South Africa			286,843	739,155	702,112	3,581,338			48,288	138,295
Total			4,635,902	10,382,927	1,296,236	5,560,130			103,858	286,607
Oceania: Australia					1,700	4,208				
Grand total 1955	2,771	205,139	6,507,577	14,653,988	8,432,789	50,874,137	4,267	$87,782	152,732	435,120

[1] Revised figure.
[2] Owing to changes in tabulating procedures by U. S. Department of Commerce, data known to be not comparable with other years.

TABLE 12.—Industrial diamond (excluding diamond dust and manufactured bort) imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Carats	Value		Year	Carats	Value	
		Total	Average			Total	Average
1946–50 (average)	7,278,219	$22,897,062	$3.15	1953	12,768,595	$46,881,944	$3.67
1951	12,120,647	46,327,622	3.82	1954	13,807,344	48,018,204	3.48
1952	13,469,198	51,117,163	3.80	1955	14,944,633	65,615,907	4.39

Technology.—Recent developments in the diamond-mining industries of Belgian Congo and Angola were described.[13] The operation of diamond-recovery plants in Angola was reported in detail.[14]

The Bakwanga mine in Belgian Congo, where nearly all of the United States supply of crushing bort originates, was described.[15]

Block caving was introduced at the DeBeers mines at Kimberley. This method eliminated much manual handling of the ore.[16]

Mining and recovery of diamond in South-West Africa and other African alluvial diamond fields was described in much detail in the mining press during 1955.[17]

A new treatment plant designed to handle 7,500 tons of diamond-bearing material a day was erected and additional material-handling equipment installed at the Williamson diamond mine in Tanganyika. The water necessary for this new plant was obtained by constructing an artificial lake.[18]

Soviet engineers during 1955 examined diamond mines in the Panna district of India with the view to installing new equipment to increase production.[19] A diamond discovery was reported in China.[20]

Diamond exploration continued at an increased pace in South America.[21] In the United States new interest was shown in the Pike County, Ark., diamond deposits.[22]

New methods for saving the smaller diamonds occurring in alluvial gravels were described.[23]

---

[13] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 2, February 1955, pp. 46–49; vol. 40, No. 5, May 1955, pp. 39–48; vol. 41, No. 4, October 1955, pp. 34–36.

[14] South African Mining and Engineering Journal (Johannesburg), Angola Diamond Company's New Contract: Vol. 65, part II, No. 3232, Jan. 22, 1955, p. 911; Companhia de Diamates de Angola: Vol. 66, part II, No. 3268, Oct. 1, 1955, p. 173.
Weavind, R. G., Diamates de Angola Operates 39 Modern Diamond Recovery Plants, Mining World: Vol. 17, No. 4, April 1955, pp. 44–46, 72.

[15] Murdock, T. G., Beceka's Industrial Diamond Mining Operations at Bakwanga: Bureau of Mines, Mineral Trade Notes, vol. 40, No. 6, June 1955, Special Suppl. 46, 23 pp.

[16] Gallagher, W. S., A New Approach to Diamond Mining at Kimberly: Optima (Johannesburg), vol. 5, No. 2, June 1955, pp. 52–61.
Gallagher, W. S., New Approach to Diamond Mining at Kimberly, South Africa: Min. Jour. (London) vol. 245, No. 6254, July 1, 1955, pp. 9–11.

[17] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 43; vol. 41, No. 3, September 1955, pp. 42–43.
Chemical Age (London), Aid to Diamond Recovery: Vo.l 73, 1891, Oct. 8, 1955, p. 784.
Mine and Quarry Engineering (London), The Consolidated Diamond Mines of South-West Africa, Ltd.: Vol. 21, No. 7, July 1955, pp. 266–277; vol. 21, No. 8, August 1955, pp. 311–317; vol. 21, No. 9, September 1955, pp. 354–361; vol. 21, No. 10, October 1955, pp. 427–433; vol. 21, No. 11, November 1955, pp. 463–471; vol. 21, No. 12, December 1955, pp. 502–507.
Mining Journal (London), Diamond-Bearing Deposits at Bakwanga, Belgian Congo: Vol. 245, No. 6276, Dec. 2, 1955, pp. 648–650. New Screen Aids Diamond Recovery: Vol. 245, No. 6266, Sept. 23, 1955, p. 355.
Mining World and Engineering Record (London), Diamonds in French Africa: Vol. 169, No. 4401, Aug. 6, 1955, pp. 42–43.
South African Mining and Engineering Journal (Johannesburg), Recovery Methods at Consolidated Mines: Vol. 66, part II, No. 3243, Apr. 9, 1955, pp. 220–221. Buckets to Uncover Congo's Diamonds: Vol. 66, No. 3278, Dec. 10, 1955, p. 567. Consolidated African Selection Trust: Vol. 66, part II, No. 3280, Dec. 24, 1955, p. 665.

[18] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 47.
Mining Magazine (London), The Tanganyika Mining Industry, 1954, Diamond: Vol. 92, No. 3, March 1955, p. 150; Notes on East African Mining, vol. 93, No. 3, September 1955, pp. 181–182.
South African Mining and Engineering Journal (Johannesburg), New Plants in East Africa: Vol. 66, part I, No. 3260, Aug. 7, 1955, p. 927.

[19] Mining World, India: Vol. 17, No. 1, January 1955, p. 65.
Mining Journal (London), Russian Aid for Indian Diamond Mining: Vol. 244, No. 6250, June 3, 1955, p. 616.

[20] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 3, September 1955, p. 42.

[21] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 1, January 1955, p. 43; vol. 40, No. 4, April 1955, pp. 41–42; vol. 40, No. 5, May 1955, p. 53.
Mining World, British Guiana: Vol. 17, No. 10, September 1955, p. 90.
Mining World and Engineering Record (London), Diamonds in Brazil: Vol. 169, No. 4409, Oct. 1, 1955, p. 183.

[22] Mining World, Central States: Vol. 17, No. 4, April 1955, p. 81.

[23] Hudson, S. B., Electrostatic Separations: Min. Mag. (London), vol. 93, No. 3, September 1955, pp. 182–186.

The economic importance and the wide variety of uses of industrial diamond have increased its value to modern production and the national defense.[24]

Salvage of the diamond material contained in grinding sludges and worn or broken grinding wheels and tools represented a substantial part of the available diamond supply. Total potential salvage was estimated to be between 1 and 2 million carats yearly. If cost were not the controlling factor, 20 percent of the industrial diamond used might be salvaged.[25]

A number of advantages were claimed for a new method of mounting diamonds on tools,[26] and a patent was issued on a diamond abrasive wheel using similar methods for mounting the diamonds.[27]

Owing to the absence of a diamond supply, the Soviet Union showed much interest in developing methods for grinding cemented carbides without using diamond.[28]

A report on the diamond industry of the world was issued.[29]

On February 15, 1955, the General Electric Research Laboratory at Schenectady, N. Y., announced that it had successfully produced synthetic diamond under conditions of high pressure and temperature. The diamond produced was large enough to meet the size requirements for many industrial uses. The company indicated, however, that

---

[24] Davis, Leon, Economic and Strategic Importance of Industrial Diamond: South African Min. Eng. Jour. (Johannesburg), vol. 66, pt. I, No. 3241, Mar. 26, 1955, pp. 137–139.
Denning, R. M., Directional Grinding Hardness in Diamond: Am. Mineral., vol. 40, No. 3–4, March-April 1955, pp. 186–191.
Fritsch, O., Selection of Industrial Diamonds According to Revised and Partly New Testing Methods: Ind. Diamond Rev. (London), vol. 15, No. 171, February 1955, pp. 25–26.
Grodzinski, P., Diamond Sawing Revolutionizes Production at Portland Stone Quarry: Ind. Diamond Rev. (London), vol. 15, No. 180, November 1955, pp. 205–209.
Jenkinson, J. J., Getting the Most Out of Your Diamond Wheels: Machinery, vol. 61, No. 5, January 1955, pp. 167–170.
Steel, Want to Cut Diamond Wheel Costs?: Vol. 137, No. 8, Aug. 22, 1955, pp. 68–69.
South African Mining and Engineering Journal (Johannesburg), Diamond-Tipped Drills and Grind Wheels for Dentists: Vol. 65, part II, No. 3235, Feb. 12, 1955, p. 1077.

[25] Alexander, H., Got Any Old Diamonds Lying Around?: Baltimore Sunday Sun, Features, sec. A, Mar. 27, 1955, p. 1.
Benfield, D. A., The Recovery of Diamond From Tungsten Carbide Inserts: Ind. Diamond Rev. (London), vol. 15, No. 174, May 1955, pp. 85–87.
Benfield, D. A., and Strachen, K. G. A., Electrolytic Recovery of Diamonds From Used Drill Crowns: Ind. Diamond Rev. (London), vol. 15, No. 178, September 1955, pp. 165–168; vol. 15, No. 179, October 1955, pp. 188–191.
Ducommun, P., and Renaud, J. P., A Technique for the Recovery of Diamond Powder: Ind. Diamond Rev. (London), vol. 15, No. 180, November 1955, pp. 210–212.
Grits and Grinds, Norton Company, Diamond Swarf Collection: Vol. 46, No. 4, April 1955, p. 15; vol. 46, No. 5, May 1955, p. 15.
Tool Engineering, Conservation of Industrial Diamonds: Vol. 34, No. 3, March 1955, pp. 247–248.

[26] Hall, H. T., New Diamond Bonding Method Developed: Ind. Diamond Rev. (London), vol. 15, No. 180, November 1955, p. 218.
Industrial and Mining Standard (Melbourne), Diamond Tools, New Method of Mounting: Vol. 110, No. 2793, Aug. 4, 1955, p. 11.

[27] Hall, H. T. (assigned to General Electric Co.), Diamond Abrasive Wheel: U. S. Patent 2,728,651, Dec. 27, 1955.

[28] Cass, W. G., Diamond Substitutes in the Soviet Union: Ind. Diamond Rev. (London), vol. 15, No. 181, December 1955, pp. 226–227.

[29] Switzer, George, The Diamond Industry, 1955: Jewelers' Circ.-Keystone, 1956, 16 pp.

production costs were relatively high; much additional research and process development would be required before man-made diamond could compete in price with natural diamond. The details of the process were not revealed by the General Electric Co., but many articles of a popular nature were published about this new development, as well as some more technical articles.[30]

ARTIFICIAL ABRASIVES

During 1955 both the total tonnage and value of artificial abrasives produced in the United States and Canada increased.

Silicon carbide production in the United States and Canada increased 12 percent in tonnage and 25 percent in value over 1954. During the same period aluminum oxide manufactured principally from imported bauxite decreased 11 percent in tonnage and 1 percent in value. The aluminum oxide production included 22,773 short tons of "white high-purity" material, valued at $3,482,703. About 42 percent of the silicon carbide and 5 percent of the aluminum oxide were used for nonabrasive purposes.

A more comprehensive canvass of the metallic abrasive industry in the United States was begun in 1955 to obtain production information on the various types. The total reported metallic abrasive production was 33 percent higher in tonnage and 35 percent higher in value than in 1954. Separate statistical information covering four basic types of metallic abrasives was obtained. These were: (1) Chilled iron shot and grit; (2) annealed iron shot and grit; (3) steel shot; and (4) other types, including cut wire shot. These are the principal abrasives used in sandblasting processes for cleaning or preparing surfaces of iron and steel-foundry castings and a wide variety of iron and steel-mill products.

The ratio of production to annual plant capacity for aluminum oxide was 69 percent in 1955, compared with 78 in 1954; for silicon carbide, 63 percent in 1955 and 56 percent in 1954; and for metallic abrasives, 60 percent in 1955 and 46 percent in 1954.

Sales of abrasive grinding wheels during 1955 increased 31 percent in value over 1954, and sales of surface-coated abrasives increased 24 percent in value and 19 percent in quantity during the same period. Sales by the coated-abrasive industry reached a record high in 1955; the value of the abrasive grinding-wheel sales nearly reached that of 1953, a record year.[31]

---

[30] Bridgeman, P.W., Synthetic Diamonds: Sci. Am., vol. 193, No. 5, November 1955, pp. 42–46.
Bundy, F. P., Strong, H. M., and Wentorf, R. W., Man-Made Diamonds: Nature, vol. 176, No. 4471, July 1955, pp. 51–55.
Commercial America, General Electric Laboratory Produces Man-Made Diamonds: Vol. 51, No. 9 March 1955, pp. 10–11.
Davis, L. G., The Manufacture of Synthetic Diamonds: South African Min. Eng. Jour. (Johannesburg), vol. 66, pt. I, No. 3240, Mar. 19, 1955, pp. 91, 93, 95.
General Electric Research Information Services, Schenectady, N. Y., Man-Made Diamonds: March 1955, 25 pp.
Iron Age, Industrial Diamonds: Vol. 176, No. 11, Sept. 15, 1955, p. 106.
Mining Journal (London), Arrival of the Synthetic Diamond: Vol. 244, No. 6236, Feb. 25, 1955, pp. 201–202.
Oil, Paint and Drug Reporter, Diamonds Made Synthetically: Vol. 167, No. 8, Feb. 21, 1955, p. 4.
Pough, F. H., Carbon + Heat + Pressure = Diamond: Natural History, vol. 64, No. 6, June 1955, pp. 238–293, 335–336.
Steel, Diamond Market Sparkles: Vol. 137, No. 5, Aug. 1, 1955, p. 47.

[31] Steel, Abrasive Wheelmakers' Sales Near '53 Peak: Vol. 137, No. 6, Aug. 8, 1955, p. 42.

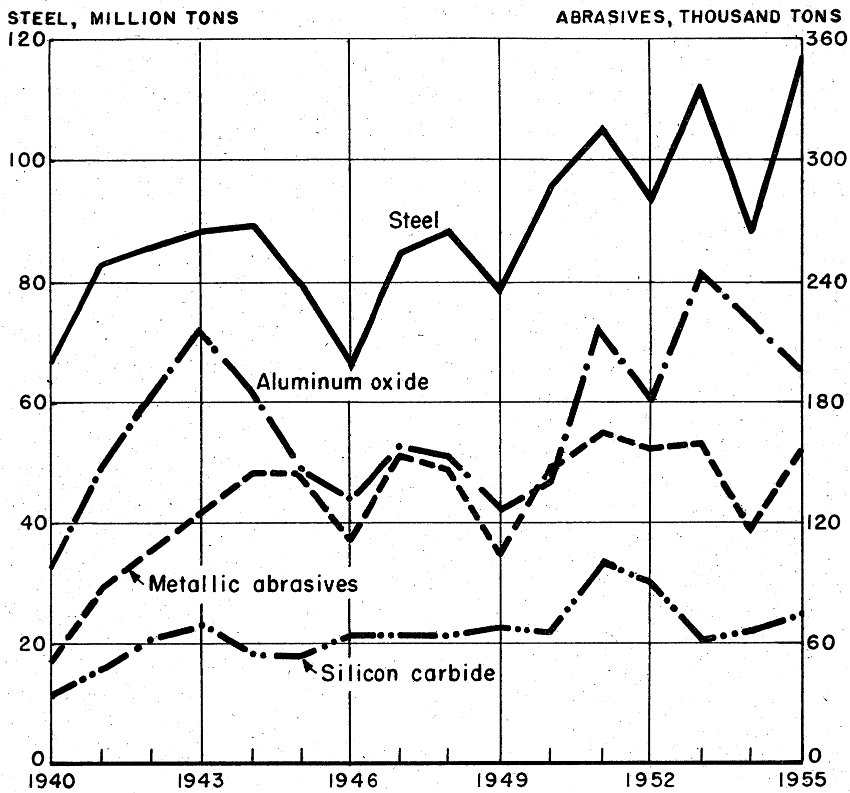

FIGURE 4.—Relationship between ingot-steel and artificial abrasive production, 1940–55.

Developments taking advantage of inherent characteristics of coated abrasives in various forms as machining tools resulted in increased industrial use of coated abrasive belts.[32] The safety features of abrasive-impregnated fabrics expanded their use in industry.[33]

Progress in the use of grinding wheels resulted from better understanding of chemical reactions involved in metal grinding. Future advances in this art probably will be based on further study of these reactions.[34]

Several recommendations for the proper storage of coated abrasives, deemed necessary to keep them at top grinding and finishing efficiency, were made.[35]

[32] Dyer, H. N., Abrasive Belt Grinding of Metals: Ind. Eng. Chem., vol. 47, No. 12, December 1955, pp. 2500–2505.
Vorce, Lee, Abrasive Belt Polishing: Steel, vol. 137, No. 10, Sept. 5, 1955, pp. 86–89.

[33] American Metal Market, Mesh Abrasive Cloths Grow in Favor for Polishing Metal: Vol. 62, No. 153, Aug. 9, 1955, p. 10.
Iron Age, Abrasives, Greater Safety: Vol. 176, No. 2, July 14, 1955, p. 124.
Shanta, P. L., Resin-Bonded Laminated and Reinforced Abrasive Products: Ind. Eng. Chem., vol. 47, No. 12, December 1955, pp. 2495–2499.

[34] Coes, Loring, Jr., Knowledge of the Scientific Principles of Grinding Is Basis of Recent Progress in Abrasives: Ind. Eng. Chem., vol. 47, No. 12, December 1955, pp. 2493–2494.

[35] Steel, Storage Is Key to Abrasive Efficiency: Vol. 137, No. 18, Oct. 31, 1955, p. 71.

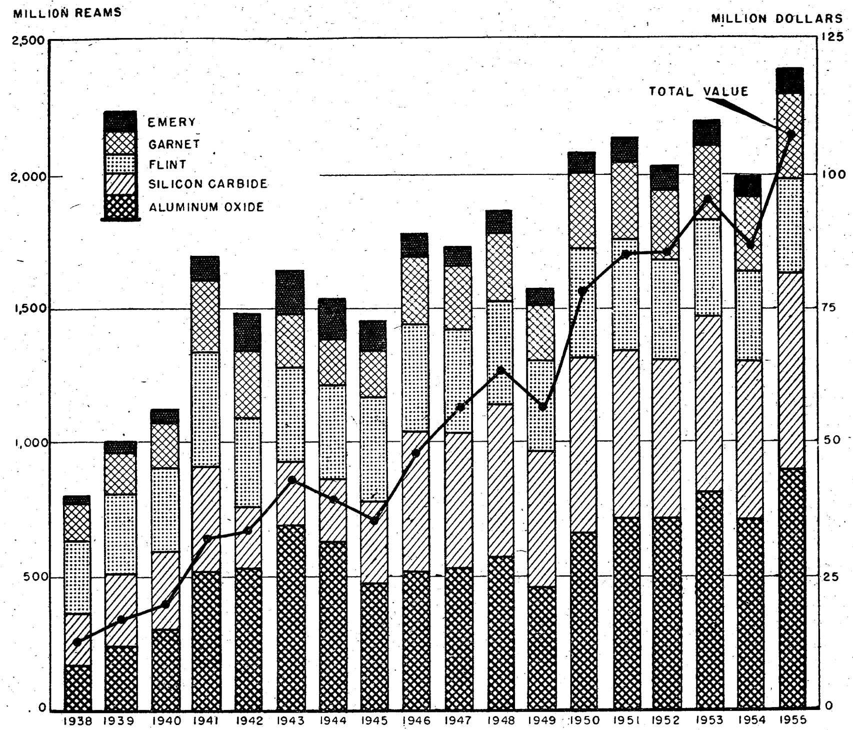

FIGURE 5.—Coated-abrasive industry in the United States, 1938–55.

The importance of selecting the correct type of grinding wheel for each grinding operation was stressed.[36]

Successful tests involving the use of ceramic cutting tools for machining metals have increased the interest in this type of cutting tool.[37]

New grinding-wheel plants were under construction in Ohio and California during 1955.[38]

American and English firms joined with an Indian company to manufacture bonded and coated abrasives at Madras, India.[39]

Reports on the abrasive industries of France,[40] Argentina,[41] Brazil,[42] Switzerland,[43] and the Philippine Islands,[44] appeared during 1955.

---

[36] Mueller, J. A., How to Select the Best Grinding Wheel: Tool Eng., vol. 34, No. 2, February 1955, pp. 91-94.

[37] Rodman Laboratory, U. S. Arsenal, Watertown, Mass., Minutes of Synposium on Ceramic Cutting Tools: February 1955, 127 pp.
Steel, Ceramic Cutting Tools: Vol. 136, No. 9, Feb. 28, 1955, p. 115.

[38] American Ceramic Society Bulletin, Norton Company to Open New Plant: Vol. 34, No. 6, June 1955, p. 43.
Wall Street Journal, Carborundum Plans Abrasive Wheel Plants Near Logan, Ohio: Vol. 146, No. 69, Oct. 7, 1955, p. 7.

[39] Chemical Week, Abrasives, India: Vol. 76, No. 25, June 18, 1955, p. 33.
Chemical Age (London): Vol. 73, No. 1898, Nov. 26, 1955, p. 1155.

[40] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 2, February 1955, pp. 31-37.

[41] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 3, September 1955, pp. 30-33.

[42] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 3, September 1955, pp. 33-38.

[43] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 5, November 1955, pp. 30-40.

[44] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 6, December 1955, p. 27.

TABLE 13.—Crude artificial abrasives produced in the United States and Canada, 1946–50 (average) and 1951–55

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
1946–50 (average)	64,630	$6,065,176	142,647	$9,852,656	132,406	$11,004,916	339,683	$26,922,748
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
1953	62,301	8,190,431	244,136	23,807,806	160,500	18,038,046	466,937	50,036,283
1954	66,972	8,787,445	219,308	22,420,833	118,096	13,271,832	404,376	44,480,110
1955	74,805	11,027,693	195,822	22,141,686	157,616	17,911,738	428,243	51,081,117

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

TABLE 14.—Production, shipments, and stocks of metallic abrasives in the United States, in 1954 and 1955, by product [1]

Product	Manufactured during year		Sold or used during year		Stocks on hand Dec. 31		Average annual capacity
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons
1954							
Total	120,099	$13,516,027	118,096	$13,271,832	[2] 14,414	$1,534,893	254,950
1955							
Chilled iron shot and grit	95,588	8,242,831	96,423	8,267,421	8,949	813,645	168,534
Annealed iron shot and grit	30,195	3,487,544	30,114	3,664,210	2,121	192,475	52,544
Steel shot	31,251	5,974,305	30,018	5,697,257	3,387	691,793	40,194
Other types (including cut wire shot)	884	242,783	1,061	282,850	259	65,135	3,010
Total	157.918	17,947,463	157,616	17,911,738	14,716	1,763,048	264,282

[1] Products were not canvassed before 1955.
[2] Stock adjustment.

TABLE 15.—Stocks of crude artificial abrasives and capacity of manufacturing plants, as reported by producers in the United States and Canada, 1946–50 (average) and 1951–55, 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
1946–50 (average)	8,996	76,560	33,151	235,092	8,771	227.703
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
1953	18,587	110,900	25,165	273,200	11,913	255,624
1954	27,852	120,000	29,924	280,200	[2] 14,414	254,950
1955	10,966	118,820	39,895	282,200	14,716	264,282

[1] Figures pertain to United States plants only.
[2] Stock adjustment.

457676—58——10

TABLE 16.—Abrasive materials (natural and artificial) imported for consumption in the United States, 1954–55, by kinds

[U. S. Department of Commerce]

Kind	1953		1954		1955	
	Quantity	Value	Quantity	Value	Quantity	Value
Burrstones:						
Unmanufactured...short tons..	152	$3,022				
Bound up into millstones short tons..	3	594	(1)	$1,066		
Grindstones, finished or unfinished short tons..	286	12,974				
Hones, oilstones, and whetstones short tons..	22	35,549	(2)	[3] 22,599	(2)	$31,523
Corundum (including emery):						
Corundum ore.............do....	2,675	205,208	1,108	74,072	1,399	96,762
Emery ore................do....			560	12,625	840	10,686
Grains, ground, pulverized, or refined...............short tons..	33	3,269	243	52,643	566	118,163
Paper and cloth coated with emery or corundum...reams..	11,908	173,133	38,024	[3] 358,337	[4] 27,000	319,565
Wheels, files, and other manufactures of emery..short tons..	10	19,153	10	[3] 18,122	34	[3] 61,467
Wheels of corundum or silicon carbide...............short tons..	3	9,962	4	[3] 17,318	4	[3] 10,640
Tripoli, rottenstone, and diatomaceous earth...........short tons..	372	39,451			28	1,029
Diamond:						
Bort, manufactured......carats..	7,891	292,525	2,389	[3] 181,766	2,771	205,139
Crushing bort (including all all types of bort suitable for crushing)...............carats..	8,726,923	20,163,661	[5] 9,021,207	[5] 20,711,297	6,507,577	14,653,988
Other industrial diamond (including glaziers' and engravers' diamond unset and miners')...............carats..	4,039,830	26,702,419	[5] 4,782,767	[5] 27,276,374	8,432,789	50,874,137
Carbonado and ballas....do....	1,842	15,864	3,370	30,533	4,267	87,782
Dust and powder..........do....	749,290	2,107,453	181,418	502,896	152,732	435,120
Flint, flints, and flintstones, unground...............short tons..	9,103	195,055	5,021	116,321	7,809	[3] 169,612
Grit, shot, and sand, of iron and steel...............short tons..	699	244,521	492	[3] 156,085	886	181,658
Artificial abrasives:						
Crude, not separately provided for:						
Carbides of silicon (carborundum, crystalon, carbolon, and electrolon) short tons..	46,294	5,326,018	38,935	4,679,202	67,691	7,914,696
Aluminous abrasives, alundum, aloxite, exolon, and lionite.........short tons..	239,722	21,796,319	184,177	17,603,570	151,720	14,201,390
Other...............do....	549	54,485	1,002	85,081	1,390	109,288
Manufactures:						
Grains, ground, pulverized, refined, or manufactured short tons..	1,287	271,928	521	115,749	1,246	250,168
Wheels, files, and other manufactures, not separately provided for short tons..	7	11,400	5	6,964	3	5,849
Total...................		77,683,963		[3] 72,022,620		[3] 89,738,662

[1] Less than 1 ton.
[2] Beginning January 1, 1954, reported in number (22,740); 1955: 58,903.
[3] Owing to changes in tabulating procedures by U. S. Department of Commerce data known not to be comparable with years before 1954.
[4] Adjusted by Bureau of Mines, U. S. Department of Commerce; shows as 271,012.
[5] Revised figure.

MISCELLANEOUS MINERAL-ABRASIVE MATERIALS

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

FOREIGN TRADE

Imports.[45]—Imports of abrasive materials into the United States increased 25 percent in value over 1954. The principal increase was in industrial diamond, the value of imports was 36 percent higher than during the previous year. A substantial rise in the tonnage and value of silicon carbide imports from Canada was noted, but imports of aluminum oxide declined. Imports of corundum and emery increased slightly. Changes in the value and tonnage of other imported abrasive materials were unimportant.

Exports.—Nearly every item of abrasive material exported from the United States during 1955 rose in value over the preceding year, the total increase being 20 percent.

Abrasive papers and cloths represented 27 percent of the value of these exports; artificial abrasive grain of all types, 22 percent; and grinding wheels, 16 percent.

---

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

TABLE 17.—Abrasive materials exported from the United States, 1953–55

[U. S. Department of Commerce]

	1953		1954		1955	
	Quantity	Value	Quantity	Value	Quantity	Value
Natural abrasives:						
Diamond grinding wheels--carats--	110,847	$545,618	129,868	$553,643	180,405	$850,225
Diamond dust and powder--do----	65,853	182,838	90,665	237,657	215,787	515,555
Grindstones and pulpstones short tons--	432	52,971	357	46,560	452	85,167
Emery powder, grains, and grits (natural)--------pounds--	2,268,056	133,361	2,599,462	169,749	2,800,285	179,810
Corundum (natural)--------do----	476,035	74,682	301,878	49,701	310,975	44,497
Whetstones, sticks, etc., (natural) pounds--	157,923	78,738	130,765	70,764	211,134	95,161
Natural abrasives [1] not elsewhere classified--------pounds--	111,661,593	3,577,630	104,688,654	3,743,691	131,419,734	4,699,379
Manufactured abrasives:						
Aluminum oxide, fused, crude and grains--------pounds--	18,937,931	2,434,239	22,631,036	2,776,940	26,390,434	3,221,190
Silicon carbide, fused, crude and grains--------pounds--	10,536,436	1,640,229	13,185,745	2,188,640	14,141,545	2,288,373
Alumina, unfused--------do----	520,194	41,367	387,180	39,901	235,866	25,370
Manufactured abrasives, not elsewhere classified--------pounds--	49,796	29,913	34,404	14,356	113,247	37,412
Abrasive pastes, except diamond wheels--------pounds--	709,464	145,125	463,267	136,331	744,911	170,608
Grinding wheels, except diamond wheels--------pounds--	3,586,861	3,093,227	4,288,194	3,436,676	4,908,799	4,018,404
Pulpstones of manufactured abrasives--------pounds--	1,625,106	372,930	2,437,279	557,148	2,670,963	617,831
Whetstones, etc., of manufactured abrasives--------pounds--	382,232	437,798	405,861	458,431	419,979	539,141
Abrasive paper and cloth (natural abrasives)--------reams--	67,474	1,188,192	72,607	1,160,692	69,222	1,185,061
Abrasive paper and cloth (artificial abrasives)--------reams--	131,016	3,883,073	133,225	4,478,249	151,706	5,474,299
Metallic abrasives (except steel wool)--------pounds--	8,966,622	623,560	8,202,157	574,579	11,413,127	812,390
Total--------	----------	18,535,491	----------	20,693,708	----------	24,859,873

[1] Includes flint, garnet, tripoli, rottenstone, natural rouge, polishing rouge, pumice, diatomaceous earth, infusorial earth, and kieselguhr.

Aluminum

By R. August Heindl,[1] Arden C. Sullivan,[2] and Mary E. Trought[3]

DURING 1955 the aluminum industry in the United States and throughout the world was characterized by increased production and consumption. Despite a new alltime annual production record in the United States and deferral by the Office of Defense Mobilization (ODM) of scheduled deliveries to the National Stockpile, the metal was in short supply throughout the year. The increased production resulted from expansion of existing facilities and initial production from a new primary producer, the Anaconda Aluminum Co.

TABLE 1.—Salient statistics of the aluminum industry, in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Primary production short tons	585,384	836,881	937,330	1,252,013	1,460,565	1,565,721
Value	$176,895,000	$305,074,000	$344,320,000	$496,315,000	$592,837,000	$684,038,000
Average ingot price per pound cents	16.1	19.0	19.4	20.9	21.8	23.7
Secondary recovery short tons	266,823	292,608	304,522	368,566	[1] 292,041	[1] 335,994
Imports (crude and semicrude) short tons	126,066	161,834	150,738	359,481	243,750	239,403
Exports (crude and semicrude) short tons	39,858	14,817	10,614	15,355	50,096	33,834
World production do	1,310,000	1,980,000	2,260,000	[2] 2,720,000	3,050,000	3,340,000

[1] Not strictly comparable with previous years' data. The 1954 and 1955 data are recoverable aluminum content; previous years' data are recoverable aluminum-alloy content.
[2] Revised figure.

DOMESTIC PRODUCTION

PRIMARY

For the fourth consecutive year the primary aluminum industry set a new production record. The production—nearly 1.6 million tons—was 100,000 tons (7 percent) greater than in 1954 and represented an increase of more than 100 percent above the 718,622 tons produced in 1950.

At the end of 1955 primary aluminum production capacity on an annual basis was 1,609,200 tons; however, as a result of the construction of new facilities or additions to existing facilities, expansion of the industry was expected to continue at least through 1958, when the primary production capacity would exceed 2 million tons.

[1] Assistant chief, Branch of Light Metals.
[2] Statistical clerk.
[3] Statistical assistant.

TABLE 2.—Production of primary aluminum in the United States, 1951–55, by quarters,[1] in short tons

Quarter	1951	1952	1953	1954	1955
First	200,716	226,377	287,004	349,069	374,711
Second	202,875	235,158	311,687	366,330	385,156
Third	215,943	240,425	329,163	371,789	396,826
Fourth	217,347	235,370	324,159	373,377	409,028
Total	836,881	937,330	1,252,013	1,460,565	1,565,721

[1] Quarterly production adjusted to final annual totals.

Tapping of aluminum on August 12 at the Anaconda Aluminum Co. plant at Columbia Falls, Mont., marked the entry of the first new company since 1946 into the primary aluminum field. The plant, which cost $65 million, will have an annual capacity of 60,000 tons of aluminum. Construction of the plant was begun in June 1953, but completion was delayed by labor difficulties. Rated capacity was to be reached by January 1956. The plant layout was such that, if desired, equipment could be readily added to double its capacity. Anaconda, which purchased alumina from the Reynolds Metals Co., differed from the three companies already producing primary aluminum in that its operation was not integrated from ore to metal. Power for the plant was supplied by the Hungry Horse Dam, part of the Bonneville Power System. It was reported that some production would go to two Anaconda fabricating facilities, that Harvey Machine Co. had an option to purchase part of the output, and that a substantial portion would be sold in the open market.

In September the General Services Administration signed a contract with the Harvey Machine Co., Torrance, Calif., which was to result in the addition of 54,000 tons of annual capacity to the Nation's aluminum facilities. Upon completion of the proposed plant at The Dalles, Oreg., Harvey subsidiary, the Harvey Aluminum Co., would become the fifth producer of primary aluminum in the United States. The plant was expected to cost $65 million and to begin production late in 1957. The Government agreed to give Harvey a power contract and a market contract. The agreement also provided for the Government to guarantee payment of loans needed by Harvey and not available from private sources without such a guarantee. Harvey was to pay the cost of the transmission facilities, which were to become the property of the Bonneville Power Administration.

In addition to capacity represented by new producers, the Aluminum Company of America, Reynolds Metals Co., and Kaiser Aluminum & Chemical Corp. announced significant additions to be made to their facilities in the form of additions to existing plants or the construction of new plants. Alcoa announced during 1955 that it planned, or had underway, additions at its Rockdale and Point Comfort, Tex., plants and at its Wenatchee and Vancouver, Wash., plants totaling 86,000 tons annually. Studies were well advanced with respect to construction of an additional smelting plant designed to produce approximately 150,000 tons of aluminum per year. During the year Reynolds announced plans to make additions totaling 45,500 annual tons capacity to 5 of its 6 reduction plants. Additions totaling 6,300 annual tons were to be made to 2 of Kaiser's plants. At the end of the year

Kaiser announced plans to construct a plant at Ravenswood, W. Va., having an ultimate annual capacity of 220,000 tons. Construction of the first 125,000 tons of capacity was to be begun immediately. Construction of the remainder of the plant was to depend upon market conditions. Power for this facility was to be based upon coal-generated electricity.

By the end of the year other plants had been proposed, as follows: Olin Mathieson Chemical Corp., 60,000 tons, in West Virginia; Revere Copper & Brass, Inc., 60,000 tons, in Washington; and St. Joseph Lead Co., 66,000 tons, in Pennsylvania. However, only 1 of these 3 proposals, that of Olin Mathieson, had received a fast tax-amortization allowance.

In July agreement was reached between Alcoa and the Power Authority of the State of New York on terms of a contract to make power available for operation of its smelter at Massena, N. Y. When the St. Lawrence Seaway project is complete, 239,000 kilowatts will be available to Alcoa.

As a result of the expansions underway in the aluminum industry, it became apparent that the Government should reevaluate its position with respect to aluminum. In August the expansion goal for primary aluminum was suspended by the ODM, and in September the goal was closed. This action was taken, according to ODM, because the goal called for an annual capacity of 1,746,000 by 1955; and capacity in place, under construction, and planned was to reach 1,778,000 tons.

To help alleviate the aluminum shortage in 1955, the ODM deferred metal scheduled for delivery to the National Stockpile. Under the expansion contracts the Government could have called for as much as 100,000 tons per quarter; however, during 1955 and the first half of 1956 only 150,000 tons was to be called, with the result that 450,000 tons was made available to industry. It was also announced that 20,000 tons of the metal acquired by the Government was to be made available to United Kingdom in the light of the assistance it gave to this country in 1952 and 1953, when metal was made available out of its Canadian contracts for United States use.

Progress on installation of forging and extrusion presses under the United States Air Force heavy-press program continued through 1955. By the end of the year the 4 forging presses were in operation, and 4 of the 6 extrusion presses were operating. A 35,000-ton and a 50,000-ton forging press were being operated by Alcoa at Cleveland, Ohio. Two other forging presses of the same size were in operation at the end of the year by Wyman-Gordon Co. at Grafton, Mass. During the year two 8,000-ton extrusion presses were put into operation by Kaiser at Halethorpe, Md., and a 12,000-ton extrusion press was started by Curtiss-Wright Corp., at Buffalo, N. Y. Alcoa's 14,000-ton extrusion press at Lafayette, Ind., had been put into operation in 1954. The remaining 2 presses, an 8,000-ton and a 12,000-ton extrusion press, were to be in operation in mid-1956 at Harvey Machine Company plant at Torrance, Calif.

A statistical State-by-State breakdown of the more than 24,000 firms working with or using aluminum in 1955 was published.[4] The

[4] Modern Metals, The Light Metals Industry: Vol. 11, No. 10, November 1955, p. 102.

survey indicated that the number of companies consuming or processing light metals had tripled since 1947.

SECONDARY

Domestic recovery of secondary aluminum from new and old scrap of all types totaled 336,000 short tons in 1955. Recovery from new scrap increased 12 percent to 260,000 tons and recovery from old scrap 27 percent to 76,000 tons. Secondary aluminum was recovered from the 427,000 tons of aluminum scrap consumed in the United States (321,000 tons of new scrap and 106,000 tons of old scrap) and also from the aluminum contained in copper-, zinc-, and magnesium-base alloys produced from scrap. Recovery was calculated from reports to the Bureau of Mines on the consumption of purchased and toll-treated scrap, excluding all home scrap (scrap produced and consumed by the same company). Aluminum-scrap consumption was reported by nonintegrated secondary smelters, primary producers, foundries, fabricators, chemical producers, and other miscellaneous consumers. Secondary-aluminum recovery was 15 percent greater than in 1954. There was a higher level of business activity in 1955, and aluminum scrap became more plentiful. Imports of scrap were 41,000 tons, compared with 15,000 tons in 1954. In 1955, when export quotas were established by the Bureau of Foreign Commerce, exports were 18,000 tons compared with 39,000 in 1954.

For details on secondary aluminum see the chapter in this volume on Secondary Metals—Nonferrous.

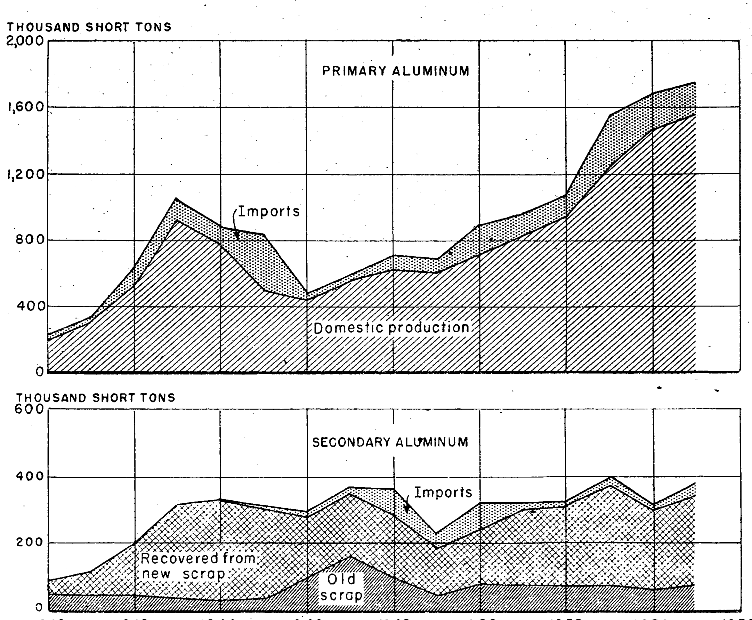

FIGURE 1.—United States production and imports of primary- and secondary-aluminum pig and ingot, 1940–55.

To help conserve the domestic supply of aluminum scrap, the Bureau of Foreign Commerce placed the following quotas on the export licensing of new and old aluminum scrap, including remelt ingots: 9,000 short tons in the second quarter of 1955, 5,000 tons in the third quarter, and 4,000 tons in the fourth quarter. Previously, aluminum-scrap exports had been under the open end licensing policy. Applications covering aluminum scrap under the fourth quarter quantitative quota required evidence of availability to export. Distribution among the exporters was made on an historical licensing basis.

CONSUMPTION AND USES

Continuing the trend that started in 1950, the apparent consumption of primary aluminum increased slightly in 1955 compared with 1954. The apparent consumption of nearly 1.8 million tons, as shown in table 3, was computed by adding primary aluminum sold or used by the producers to net imports of pig, ingot, slab, plate, sheet, bar, and other crude and semifabricated forms. Under this method of calculation, metal delivered to the National Stockpile was part of the apparent consumption figure. The figure did not reflect stock changes by aluminum-metal consumers.

Another important source of aluminum was domestic and imported scrap. Seventy-seven percent of the aluminum recovered was from new scrap and 23 percent from old scrap. There was a net import of scrap in 1955, which represented the reverse of the situation in 1954.

TABLE 3.—Apparent consumption of primary aluminum and ingot equivalent of secondary aluminum in the United States, 1946–50 (average) and 1951–55, in short tons

Year	Primary			Secondary		
				Domestic recovery		
	Sold or used by producers	Imports (net)[1] [2]	Apparent consumption [2]	From old scrap	From new scrap	Imports (net)[3]
1946–50 (average)	590,268	44,822	635,090	94,197	172,626	37,247
1951	845,392	128,468	973,860	76,591	216,017	16,694
1952	938,181	134,153	1,072,334	71,264	233,258	5,374
1953	1,219,968	322,086	1,542,054	78,940	289,626	19,836
1954	1,478,740	218,147	1,696,887	[4] 59,989	[4] 232,052	−22,044
1955	1,571,845	183,080	1,754,925	[4] 76,372	[4] 259,622	20,240

[1] Crude and semifabricated, excluding scrap. May include some secondary.
[2] Figures include mill shapes.
[3] 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.
[4] Not strictly comparable with previous years' data. The 1954 and 1955 data are recoverable aluminum content; previous years' data are recoverable aluminum-alloy content.

The calculated new supply of aluminum in 1955 was the sum of 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 was omitted from this total. Exports of crude forms of aluminum were considered a form of consumption. The new supply figure of 2.1 million tons was

TABLE 4.—Sources of aluminum supply—crude and scrap,[1] 1946–50 (average) and 1951–55, in short tons

Year	Primary production	Recovery from scrap		Imports [2]	Total supply	Exports [2]
		Old	New			
1946–50 (average)	585,384	94,197	172,626	116,675	968,882	5,176
1951	836,881	76,591	216,017	140,430	1,269,919	2,274
1952	937,330	71,264	233,258	134,531	1,376,383	2,312
1953	1,252,013	78,940	289,626	324,888	1,945,467	6,499
1954	1,460,565	[3] 59,989	[3] 232,052	228,611	1,981,217	39,448
1955	1,565,721	[3] 76,372	[3] 259,622	214,353	2,116,068	22,430

[1] Ingot equivalent of scrap.
[2] Crude metal (ingot, pig, slabs, etc.) plus ingot equivalent (wt.×0.9) of scrap.
[3] Not strictly comparable with previous years' data. The 1954 and 1955 data are recoverable aluminum content; previous years' data are recoverable aluminum-alloy content.

an increase of 7 percent over 1954 and the first time the total supply exceeded 2 million tons.

It was reported during 1955 that the consumption of aluminum continued to increase in virtually all civilian uses. Major consuming industries were building, transportation, consumer durable goods, electrical, machinery and equipment, and packaging. The data in table 5 present shipments of wrought products and castings, by types of products. The following distribution for wrought products was also obtained from figures published by the United States Bureau of the Census:

	Percent 1954	Percent 1955 [1]
Plate, sheet and strip:		
Non-heat-treatable	36.8	37.6
Heat-treatable	11.7	10.6
Foil	7.3	7.1
Rolled structural shapes:		
Rod, bar, etc	6.9	3.9
Wire, bare (nonconductor)	2.0	2.1
Cable, bare (including steel-reinforced)	7.0	5.6
Wire and cable, covered or insulated	1.2	1.4
Bare wire conductor	.2	.1
Extruded shapes (including tube blooms):		
Soft alloys	18.5	22.8
Hard alloys	3.1	1.6
Drawn tubing:		
Soft alloys	2.6	2.4 (soft and hard alloys)
Hard alloys	.5	
Welded tubing, non-heat-treatable	----	.9
Powder, flake, and paste:		
Atomized	1.4	.6
Flaked	.2	.2
Paste	.6	.6
Forgings	----	2.5

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not strictly comparable with earlier years.

Increased quantities of aluminum were expected to be used as sheathing materials in the building industry. A new 40-story skyscraper was sheathed with aluminum.[5] In this building aluminum panels, ⅛-inch thick, were bolted to mullions of steel-reinforced concrete. Builders estimated that the weight of the wall was 2.5 million pounds compared with 30.1 million pounds for masonry walls of a

[5] Modern Metals, What Does It Take To Build a Bank?: Vol. 11, No. 1, February 1955, p. 37.

building of comparable size. Aluminum was used extensively throughout the building in such applications as entrance doors, bay divisions, escalator hardware, and venetian blinds.

TABLE 5.—Net shipments[1] of aluminum wrought and cast products by producers, 1951–55, in short tons

[U. S. Department of Commerce]

	1951	1952	1953	1954	1955 [2]
Wrought products:					
Plate, sheet and strip	536,683	542,849	684,083	582,538	771,362
Rolled structural shapes, rod, bar, and wire	172,582	221,773	211,023	180,641	183,976
Extruded shapes, tube blooms, and tubing	156,472	173,771	225,961	256,650	387,546
Powder flake, and paste	12,385	23,982	22,366	23,452	17,840
Forgings					35,172
Total	878,122	962,375	1,143,433	1,043,281	1,395,896
Castings:					
Sand	96,689	97,308	107,277	[3] 78,277	82,741
Permanent mold	80,005	73,442	100,012	107,204	149,174
Die	75,733	84,866	119,665	122,645	177,602
Other	5,139	3,874	2,057	3,401	4,064
Total	257,566	259,490	329,011	[3] 311,527	413,581
Grand total	1,135,688	1,221,865	1,472,444	[3] 1,354,808	1,809,477

[1] Net shipments consist of total shipments less shipments to other metal mills for further fabrication.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not strictly comparable with earlier years.
[3] Revised.

The automotive and truck-manufacturing industries consumed the bulk of the aluminum used by the transportation industry. A survey by Alcoa showed that the average passenger car used 29.6 pounds of aluminum.[6] Applications in engines were pistons, bearings, heads, timing gears, and oil-pump bodies. It was expected that major quantities of aluminum would be used for trim items, wheels and brake drums, and a number of small items. If the research on the use of aluminum in cylinder blocks and radiators were to result in general acceptance of these items by the industry, consumption by the transportation industry would increase markedly. In 1955 one of the luxury cars contained nearly 200 pounds of aluminum, replacing 400 or more pounds of steel.

An automobile using aluminum in all possible applications was described.[7] The 6-passenger model, constructed by a French company, was said to contain 800 pounds of aluminum and to have a dead weight of 1,435 pounds where comparable standard cars would weigh 2,600 pounds or more. Despite its light weight, satisfactory driving and riding characteristics were claimed for the car.

The first national conference on the electrical utilization of aluminum was held in March 1955. Nearly 40 papers were presented, which discussed such electrical applications of aluminum as switch gear, conductors, transformers, small motors, lampbulb bases, and appliances.[8]

[6] American Metal Market, Alcoa Survey Finds Average Automobile Uses 30 Pounds: Vol. 62, No. 107, June 3, 1955, p. 10.
[7] Modern Metals, The All-Aluminum Dynce-Panhard: Vol. 11, No. 4, May 1955, pp. 59–64.
[8] Modern Metals, Aluminum in Electrical Applications: Vol. 11, No. 4, May 1955, pp. 66–80.

Western Electric Co., one of the Nation's largest copper consumers, announced that it had been doing exploratory work during the previous 3 years, aimed at developing methods for producing and utilizing aluminum conductors for certain sizes of telephone cable.[9] The company had already made several billion conductor feet of cable in which aluminum was substituted for copper. The cable had performed satisfactorily, and experience had provided answers to splicing and other problems. It was stated that the change was being made to eliminate the company dependence on one metal and that material savings could be made because of the significant rise in the price of copper compared with aluminum.

The increased use of aluminum pipe for irrigation purposes was indicated by a survey made in 1955.[10] It was estimated that the equivalent of 13,000 miles of pipe with an average diameter of 5 inches would be manufactured. This production represented an increase of 46 percent over the preceding year, and it was estimated that this application consumed 25,000 tons of metal. The pipe ranged from 2 to 8 inches in diameter, with the 4-inch size most common.

Aluminum paint, powder, and paste were discussed in the third edition of a book originally published in 1927.[11] The book discusses the manufacture of powder, properties and testing of powders and paste, and the composition and use of aluminum paint.

STOCKS

Inventories of primary aluminum at reduction plants on January 1, 1955, totaled 21,100 short tons and by September 30 had been reduced 53 percent to 9,900 tons, the smallest quantity held at the plants since January 1953. By the close of the year stocks had reached 15,000 tons, approximately equivalent to 3 days' output based on the December rate of production.

According to reports received by the Bureau of Mines, there was little change in the inventories of aluminum pig and ingot at secondary smelters in 1955. Stocks were lowest during the summer, when they were about 10 percent less than the monthly average (11,400 tons). Year-end stocks were 12,900 short tons, only 100 tons less than those reported at the beginning of the year, and represented about 15 days' production. In addition to the pig-aluminum stocks reported, reduction plants also had inventories of ingot and aluminum in process. Stocks of new and old aluminum-base scrap at consumers increased from 18,500 short tons to 20,000 during 1955.

Information on inventories of primary and secondary ingot at consuming plants, on the quantity of aluminum in the process of fabrication, and on scrap-aluminum stocks at collectors and dealers was not available.

---

9 American Metal Market, Western Electric Co. to Displace Copper With Aluminum: Vol. 62, No. 184, Sept. 22, 1955, p. 1.

10 American Metal Market, Use of Aluminum Pipe Increases: Vol. 62, No. 226, Nov. 24, 1955, p. 9.

11 Edwards, Junius D., and Wray, Robert I., Aluminum Paint and Powder: Reinhold Publishing Corp., New York, N. Y., 1955, 219 pp.

PRICES

There were two changes in the price of primary aluminum during 1955. The first rise of 1.0 cent a pound for both pig and ingot was in effect by the middle of January and was reported by the companies to be the result of rising costs of materials and increased costs for expanding and replacing equipment. The new base price, f. o. b. shipping point, was 21.5 cents a pound for 99-percent average guaranteed aluminum pig and 23.2 cents a pound for 99-plus-percent pure aluminum ingot. In August the second price advance—1.0 cent per pound for pig and 1.2 cents per pound for ingot—was announced, following a labor settlement that provided an average 15-cent hourly wage increase. All producers had increased their prices by August 8. The new price schedules brought the base price for standard 99-percent aluminum pig to 22.5 cents a pound and standard 99-percent-plus aluminum ingot to 24.4 cents a pound.

TABLE 6.—Prices of aluminum, other selected metals, and the Bureau of Labor Statistics' wholesale price index, 1936–55 [1]

Year	Aluminum, primary ingot (cents per pound)	Copper, electrolytic, New York (cents per pound)	Composite finished steel (cents per pound)	Zinc, Prime Western, East St. Louis (cents per pound)	Wholesale price index (1947–49=100)
1936–40 (average)	19.85	11.08	2.66	5.50	52.2
1941–45 (average)	15.30	11.87	2.67	8.10	64.9
1946–50 (average)	16.09	19.62	3.79	11.77	96.4
1951–55 (average)	20.96	28.97	5.12	13.61	111.5
1951	19.00	24.37	4.71	17.99	114.8
1952	19.40	24.37	4.83	16.21	111.6
1953	20.93	28.92	5.12	10.86	110.1
1954	21.78	29.82	5.33	10.69	110.3
1955:					
First quarter	23.14	32.01	5.41	11.50	110.2
Second quarter	23.20	35.87	5.41	12.06	110.2
Third quarter	23.96	38.78	5.79	12.65	111.0
Fourth quarter	24.40	42.87	5.82	13.01	111.4
Average	23.67	37.39	5.61	12.30	110.7
Increase from 1936–40 average to 1955 average (percent)	19.2	237.5	110.9	123.6	112.1

[1] Source: Metal Statistics, 1956 (American Metal Market).

Secondary-aluminum-ingot combined average price for copper silicon alloys 108 and AXS–679 was 28.73 cents a pound. The 1955 average, compiled from quotations published daily in American Metal Market, was 8.12 cents a pound above the average price in 1954 and 2.89 cents a pound above the 1951 average, which had been the previous high. Aluminum-alloy-ingot prices increased early in the year, as secondary smelters reported an increase in the demand from the steel and automobile companies. In February the demand for alloys AXS–679 and 195 was unusually heavy, and prices increased 5.00 to 5.50 cents and 4.25 to 6.50 cents a pound, respectively, for these alloys. Prices declined in the second quarter, possibly influenced by the negotiations for new wage contracts in the steel and automobile industries and reduction in the amount of primary metal to be delivered to the National Stockpile. Secondary-ingot prices advanced again in the second half of 1955, and the December 31, 1955 issue of the American Metal Market listed the following prices: AXS–679 and

Nos. 12, 108, and 319, 31.50 to 32.00 cents a pound and No. 195, 33.00 to 34.00 cents a pound.

In 1955 dealers' buying prices of new aluminum clippings averaged 17.93 cents a pound, a gain of 4.81 cents over the 1954 average. The monthly averages ranged from a low of 14.79 cents in January to a high of 20.36 cents in December. Cast-aluminum-scrap prices averaged 15.34 cents a pound, an increase of 5.20 cents compared with the previous year.

FOREIGN TRADE [12]

Imports.—In 1955 crude and semicrude aluminum imported for consumption in the United States totaled 239,000 short tons, only 2 percent less than in 1954. Pig and ingot imports decreased 17 percent, but total imports of semifabricated shapes and scrap were more than twice those in 1954. Imports of metal and alloys, crude, from Europe, Asia, and North America (Canada) decreased 68, 40, and 13 percent, respectively. Canada maintained its leadership among the suppliers by providing 96 percent of all the crude imports. Of the 41,000 short tons of aluminum-base scrap imported, 72 percent (29,000 tons) came from Canada, 12 percent (4,900 tons) from France, and almost all of the remainder from other European countries. Compared with 1954, scrap imports from Canada doubled, and those from Europe were 10 times as great. The average values per pound of aluminum imported in the United States were as follows: Crude metal, 21.0 cents; semifabricated, 33.3 cents; and scrap, 20.1 cents.

TABLE 7.—Aluminum imported for consumption in the United States, 1953–55, by classes

[U. S. Department of Commerce]

Class	1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
Crude and semicrude:						
Metal and alloys, crude	300,928	$115,761,297	215,250	[1] $83,573,141	177,652	[1] $74,694,865
Scrap	26,621	8,072,379	14,845	[1] 4,674,654	40,779	[1] 16,363,722
Plates, sheets, bars, etc	31,932	18,636,894	13,655	[1] 8,042,188	20,972	[1] 13,972,690
Total	359,481	142,470,570	243,750	[1] 96,289,983	239,403	[1] 105,031,277
Manufactures:						
Bronze powder and powdered foil	16	18,438	11	13,578	25	28,329
Foil less than 0.006 inch thick	909	1,871,863	918	[1] 1,671,880	1,758	[1] 2,963,111
Folding rules					(2)	31
Leaf (5½ by 5½ inches)	(3)	7,122	(3)	[1] 12,315	(3)	7,972
Table, kitchen, hospital utensils, etc	2,271	3,747,379	1,716	[1] 2,908,513	2,720	[1] 4,266,911
Other manufactures	(4)	3,112,512	(4)	[1] 2,617,119	(4)	[1] 1,239,292
Total	(4)	8,757,314	(4)	[1] 7,223,405	(4)	[1] 8,505,646
Grand total	(4)	151,227,884	(4)	[1] 103,513,388	(4)	[1] 113,536,923

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not comparable with years before 1954.
[2] Number: 100; equivalent weight not recorded.
[3] Leaves: 1953, 1,896,436; 1954, 3,748,428; 1955, 2,466,054.
[4] Quantity not recorded.

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

TABLE 8.—Aluminum imported for consumption in the United States, 1954–55, by classes and countries, in short tons

[U. S. Department of Commerce]

Country	1954 Metal and alloys, crude	1954 Plates, sheets, bars, etc.	1954 Scrap	1955 Metal and alloys, crude	1955 Plates, sheets, bars, etc.	1955 Scrap
North America:						
Canada	196,283	6,069	13,735	171,519	5,802	29,477
Other North America			6			36
Total	196,283	6,069	13,741	171,519	5,802	29,513
South America			10			
Europe:						
Austria		77		110	19	56
Belgium-Luxembourg		676			5,141	696
Denmark					22	206
France	1,653	243	614	186	1,074	4,909
Germany, West	9,673	1,967	83	938	1,426	1,488
Italy		349		165	1,179	
Netherlands		191	28	36	583	1,551
Norway	6,594	(1)	102	3,932		220
Switzerland	177	251		574	165	11
United Kingdom	2	3,774	250	27	3,251	1,327
Other Europe	592					359
Total	18,691	7,528	1,077	5,968	12,860	10,823
Asia:						
Japan	276	56		2	2,229	35
Southern and southeastern Asia, n. e. c.						110
Taiwan				163		
Total	276	56		165	2,229	145
Africa						217
Oceania		2	17		81	81
Grand total: Short tons	215,250	13,655	14,845	177,652	20,972	40,779
Value	[2] $83,573,141	[2] $8,042,188	[2] $4,674,654	[2] $74,694,865	[2] $13,972,690	[2] $16,363,722

[1] Less than 1 ton.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not comparable with earlier years.

Exports.—The upward trend that began in 1953 was reversed in 1955, as total exports of crude and semicrude metal decreased 32 percent. Exports of crude and semifabricated aluminum increased 48 and 43 percent, respectively, but scrap exports declined 54 percent—from 39,000 short tons to 18,000. Again in 1955 the chief importer of aluminum-base scrap was West Germany which received 14,000 tons or 78 percent. Italy received 13 percent and India 7 percent. Seventeen countries purchased exports of pig and ingot; 54 percent went to Mexico, 18 percent to the Netherlands, and 11 percent to West Germany. Forty-nine percent of the semifabricated products went to Canada. Cuba and Venezuela each received 10 percent, and the Philippines 8 percent. The average values of the crude and semicrude exports of aluminum increased in 1955 compared with 1954, as follows: Crude rose from 20.9 cents a pound to 23.2; semifabricated, from 49.8 cents to 54.4; and scrap from 16.5 cents to 17.8.

TABLE 9.—Aluminum exported from the United States, 1953–55, by classes

[U. S. Department of Commerce]

Class	1953 Short tons	1953 Value	1954 Short tons	1954 Value	1955 Short tons	1955 Value
Crude and semicrude:						
Ingots, slabs, and crude	2,376	$937,207	4,044	$1,691,059	5,969	$2,773,040
Scrap	4,581	1,475,904	39,338	12,984,970	18,290	6,501,382
Plates, sheets, bars, etc	7,764	6,106,922	6,050	4,803,109	8,009	7,518,319
Castings and forgings	622	1,660,656	619	1,795,482	1,139	2,424,571
Semifabricated forms, n. e. c	12	18,412	45	87,200	427	474,395
Total	15,355	10,199,101	50,096	21,361,820	33,834	19,691,707
Manufactures:						
Foil and leaf	257	464,260	237	432,444	543	957,653
Powders and pastes (aluminum and aluminum bronze) (aluminum content)	195	213,912	403	456,052	297	314,814
Cooking, kitchen, and hospital utensils	1,101	2,274,421	1,190	2,448,110	1,422	2,847,748
Sash sections, frames (door and window)	342	732,892	285	551,836	570	1,034,373
Venetian blinds and parts	721	920,483	853	1,029,397	2,390	2,151,654
Wire and cable	7,158	4,487,954	2,234	1,359,388	6,581	3,700,399
Construction materials, n. e. c	1,446	3,003,840	2,051	3,751,050	3,058	5,301,981
Other manufactures	(1)	97,086	(1)	108,286	(1)	229,444
Total	(2)	12,194,848	(2)	10,136,563	(2)	16,538,066
Grand total	(2)	22,393,949	(2)	31,498,383	(2)	36,229,773

[1] Weight not recorded.
[2] Quantity not recorded.

TABLE 10.—Aluminum exported from the United States, 1954–55, by classes and countries, in short tons

[U. S. Department of Commerce]

Country	1954 Ingots, slabs, and crude	1954 Plates, sheets, bars, etc.[1]	1954 Scrap	1955 Ingots, slabs, and crude	1955 Plates, sheets, bars, etc.[1]	1955 Scrap
North America:						
Canada	111	2,951	193	77	4,723	193
Cuba	40	444	2	109	993	
Mexico	1,841	155	16	3,238	216	17
Other North America		256	82		462	10
Total	1,992	3,806	293	3,424	6,394	220
South America:						
Brazil	601	59			46	
Venezuela	33	1,348		1	929	
Other South America	65	147		20	148	
Total	699	1,554		21	1,123	
Europe:						
Denmark		4		94	20	
Finland				3	3	
Germany, West	77	41	24,694	658	5	14,332
Italy		12	9,191		33	2,436
Netherlands	60	8	523	1,102	59	
United Kingdom	587	16		50	19	30
Other Europe	541	24	108	18	358	
Total	1,265	105	34,516	1,925	497	16,798

See footnote at end of table

TABLE 10.—Aluminum exported from the United States, 1954–55, by classes and countries, in short tons—Continued

[U. S. Department of Commerce]

Country	1954			1955		
	Ingots, slabs, and crude	Plates, sheets, bars, etc.[1]	Scrap	Ingots, slabs, and crude	Plates, sheets, bars, etc.[1]	Scrap
Asia:						
India	26	453	2,391	28	396	1,267
Japan	2	15	2,136		2	
Philippines	38	499		398	800	5
Other Asia		125		30	132	
Total	66	1,092	4,527	456	1,330	1,272
Africa	22	136	2		164	
Oceania		21		143	67	
Grand total: Short tons	4,044	6,714	39,338	5,969	9,575	18,290
Value	$1,691,059	$6,685,791	$12,984,970	$2,773,040	$10,417,285	$6,501,382

[1] Includes plates, sheets, bars, rods, extrusions, castings, forgings, and unclassified "semifabricated forms."

TECHNOLOGY

During 1955 the only process used commercially for the production of aluminum was the electrolytic reduction of alumina. Reduction cells of the Soderberg type in operation at Reynolds plants near Corpus Christi, Tex., and at Arkadelphia, Ark., were described.[13] It was stated that the cells were the largest ever operated in a commercial line producing aluminum. Each cell had a production capacity of approximately 1 ton a day. The current-carrying units were aluminum bars with a cross-sectional area exceeding 500 square inches and capable of carrying over 125,000 amperes of current. A detailed discussion describing the operation of the Kaiser reduction plant at Chalmette, La., appeared in the technical literature.[14] The article was of interest because the Chalmette plant, completed in 1953, was the largest aluminum-reduction plant in the United States, and used natural gas as the prime power source for the generation of electricity. Two potlines were powered with electricity generated by gas engines; the remaining six lines and plant equipment used electricity generated by a gas-fired steam-electric plant.

The new Anaconda plant at Columbia Falls, Mont., was described in several articles.[15] This 60,000-ton-capacity plant was designed in consultation with engineers from Pechiney Co. of France. It incorporated a very effective fume-disposal system; was the only plant in this country with a basement below the pots; and was 1 of 2 plants in the United States with vertical-pin Soderberg electrodes.

The chemistry underlying the aluminum industry, from the ore through the metal, was discussed in a monograph.[16] Not only did the report discuss the Bayer alumina and the Hall-Héroult aluminum

[13] Light Metal Age, Largest Reduction Cell Built by Reynolds: Vol. 7, No. 4, April 1955, pp. 34–35.
[14] Reese, Kenneth M., Garcia, A. F., and Lewis, R. A., Aluminum—Light Metals King: Ind. Eng. Chem., vol. 47, No. 10, October 1955, pp. 2066–2072.
[15] American Metal Market, Anaconda Puts New Aluminum Plant in Service in Montana: Vol. 62, No. 158, Aug. 16, 1955, pp. 1, 9.
Mining World, Anaconda Aluminum Opens $65,000,000 Plant; Full-Capacity Operation Expected by January: Vol. 17, No. 10, September 1955, p. 102.
[16] Pearson, T. G., The Chemical Background of the Aluminum Industry: Royal Inst. Chem. (30 Russell Square, London, W. C. 1), Lectures, Monographs, and Reports, No. 3, July 1955, rev. April 1956, 103 pp.

processes, but considerable attention was devoted to the numerous attempts to replace them. Various alternative processes were critically evaluated.

The use of coal as a future source of power in aluminum production was evaluated.[17] In the article it was stated that, when consideration was given to the total cost of delivering fabricated products to the market center of the United States and when full account was taken of the most efficient methods of mining and utilizing bituminous coal, coal was the economic source of power for new aluminum plants. The announcements at the end of the year by Reynolds and Kaiser of their intentions to build plants in the bituminous-coal area near the Ohio River, in Kentucky, Ohio, or West Virginia, indicated that these companies had reached similar conclusions.

As aluminum was used in more applications, such as architectural and automotive trim, where appearance and color were important considerations, the methods of finishing aluminum to obtain desirable characteristics were important. A published review of various methods of finishing the metal included discussions on anodizing, chemical brightening, electroplating, and chemical filming.[18] A second article described electrical equipment used in anodizing.[19]

Several properties of aluminum make it an important construction material in atomic-energy applications. It has the ability to withstand prolonged radiation and to decontaminate itself within 6 minutes after exposure to radiation. Aluminum has suitable neutron-capture properties and allows gamma rays to pass with little interference.[20] As a result of these properties, combined with aluminum's resistance to corrosion by water, almost all fuel slugs in low-powered atomic reactors were aluminum-clad. It was found that aqueous corrosion at high temperatures (400° to 550° F.) could be prevented by adding alloying elements and by proper water-treatment procedures. Under suitable conditions, commercially pure aluminum could be protected to 530° F.[21] In the swimming-pool nuclear reactor, the suspension frame was fabricated for aluminum.[22]

As a guide in using aluminum in designing and constructing nuclear reactors, the effects of neutron radiation on aluminum alloys were evaluated.[23] It was found that both tensile strength and yield strength of the alloys tested were increased significantly by neutron irradiation. The ductility of the material, strengthened by radiation, was decreased, but it was greater than would have been obtained in an alloy strength-hardened to the same level.

A number of new alloys were announced during the year. Alcoa announced alloy X2219, which was said to have excellent properties at 500° F. It was expected that the metal, which contained copper and small amounts of other elements, would have widespread appli-

[17] Johnson, Arthur F., Coal as a Source of Power for the Production of Aluminum: Min. Eng., vol. 7, No. 4, April 1955, pp. 358–363.
[18] Gardam, G. E., and Jones, G. L., Finishing Aluminum: Metal Ind., vol. 86, No. 22, June 3, 1955, pp. 476–479.
[19] Griffith, D. C., Electric Equipment for Aluminum Anodizing: Elec. Eng., vol. 74, No. 5, May 1955, pp. 384–387.
[20] Modern Metals, Aluminum and the Atom: Vol. 11, No. 9, October 1955, p. 18.
[21] American Metal Market, Some Keys to How Minor Impurities Affect Metal Properties Reported at Geneva: Vol. 62, No. 161, Aug. 19, 1955, pp. 1, 9, 10.
[22] Eldred, Donald, Nuclear Research Reactors: Gen. Elec. Rev., vol. 58, No. 6, November 1955, p. 27.
[23] Steele, R. V. and Wallace, W. P., Effect of Neutron Radiation on Aluminum Alloys: Metal Progress, vol. 68, No. 1, July 1955, pp. 114–115.

cations in supersonic aircraft and in automotive and aircraft engines.[24] A new alloy, No. 5083, was available from Kaiser. It was developed to compete with mild steel in fabrication and welding costs. It was stated that superior-quality welds were obtained at high speeds in all positions. Suggested applications included marine, automotive, and aircraft uses.[25] As a result of a joint research effort between Revere Copper & Brass, Inc., and the Aluminum Company of Canada, a new alloy, No. 6263, was developed specifically to serve the needs of the electrical industry.[26] This magnesium silicide alloy of aluminum was intended to satisfy the need for a lightweight, high-strength conductor, suitable for busway applications. Harvey Aluminum Co. announced alloy 7001, claimed to be the world's strongest commercial aluminum alloy.[27] Use of the alloy was recommended for structural applications in aircraft requiring the highest possible mechanical properties.

Papers presented at the International Congress of Aluminum in Paris in 1954 was issued in a two-volume edition.[28] A total of 80 papers were published under 7 different sections. Papers were included on the chemical and physical-chemical properties of aluminum and its compounds, methods of fabrication, analytical methods, studies of the metal and its alloys, corrosion, techniques of working, and techniques for utilizing the metal.

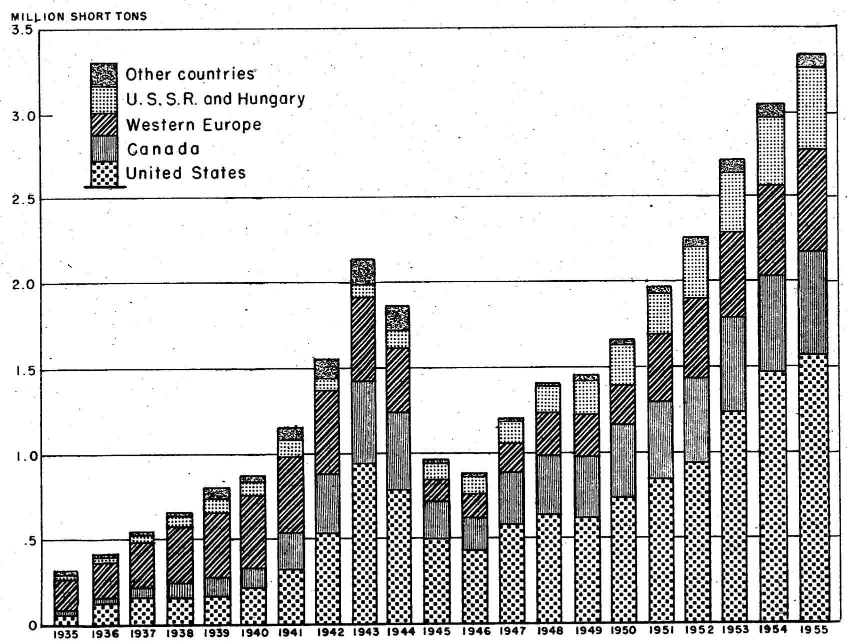

FIGURE 2.—Trends in world production of primary aluminum, 1935–55.

24 Materials and Methods, New Aluminum for Higher Temperature: Vol. 46, No. 6, June 1955, p. 184.
25 Modern Metals, Kaiser's New Alloy 5083 Competes With Mild Steel: Vol. 11, No. 4, May 1955, p. 98.
26 American Metal Market, Revere and Alcan Develop New Alloy for Electrical Industry: Vol. 62, No. 115, June 15, 1955, pp. 1, 5.
27 Modern Metals, Research Results at Harvey Aluminum: Vol. 11, No. 1, February 1955, pp. 54, 56, 58.
28 Congress International de L'Aluminium, Paris 1954, 2 vol., 690 pp.

WORLD REVIEW

Despite power shortages in a number of countries, world aluminum production continued its upward trend and reached an estimated 3.3 million short tons in 1955—an increase of almost 10 percent over that of 1954. Free World countries accounted for 85 percent of the total output and Russia and the satellite countries the remaining 15 percent. All countries showed gains in 1955 except Sweden, United Kingdom, and Formosa. Australia and Rumania reported production for the first time.

A number of new aluminum plants were completed during the year, and aluminum capacity was reported at 3,690,000 short tons.[29] Of this capacity, the Free World total was 3,070,600 tons—the United States, 1,589,200 tons; Canada, 651,500 tons; South America, 13,700 tons; Europe, 721,900 tons; Asia, 86,500 tons; and Australia, 7,800 tons. In the U. S. S. R. and its satellite countries capacity was estimated at 620,000 tons.

A summary of a book written by Dr. F. W. Botzen, entitled, "Some Aspects of the Development of the Aluminum Industry in the First Half-Century of its Existence," was published.[30]

TABLE 11.—World production of aluminum, by countries,[1] 1946–50 (average) and 1951–55, in short tons [2]

[Compiled by Pearl J. Thompson]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
Australia	----	----	----	----	----	1,450
Austria	11,393	29,079	40,468	47,924	52,920	63,051
Brazil	----	444	1,196	1,322	1,612	1,712
Canada	325,320	447,093	499,754	548,441	557,893	584,149
China (Manchuria)	----	----	(3)	(3)	[4] 3,300	[4] 7,700
France	61,648	99,578	116,996	124,581	132,546	142,706
Germany, West	14,107	81,719	110,756	117,881	142,439	151,089
Hungary	10,500	24,000	26,000	[4] 33,000	36,000	41,000
India	3,790	4,311	3,994	4,209	5,439	8,092
Italy	29,124	54,840	58,235	61,136	63,471	67,741
Japan	13,399	40,682	47,025	50,145	58,544	63,387
Korea, North [4]	1,477	----	----	(3)	(3)	(3)
Norway	33,557	55,403	56,330	58,610	67,584	79,527
Rumania	----	----	----	----	----	[4] 6,200
Spain	1,303	4,583	4,532	4,823	4,545	11,508
Sweden (includes alloys)	3,903	7,401	9,089	10,635	11,768	11,063
Switzerland	20,181	29,762	30,203	32,518	28,660	33,069
Taiwan (Formosa)	1,233	3,289	4,251	5,407	7,861	7,717
U. S. S. R.[4]	159,000	225,000	275,000	325,000	375,000	450,000
United Kingdom	33,672	31,052	31,366	34,626	35,395	27,378
United States	585,384	836,881	937,330	1,252,013	1,460,565	1,565,721
Yugoslavia	1,795	3,117	2,825	3,078	3,854	12,675
World total (estimate)[1]	1,310,000	1,980,000	2,260,000	2,720,000	3,050,000	3,340,000

[1] Aluminum was also produced in Czechoslovakia and East Germany, but estimates are not included in the total.
[2] This table incorporates a number of revisions of data published in previous aluminum chapters. Data do not add to totals shown, owing to rounding where estimated figures are included in the detail.
[3] Negligible.
[4] Estimate.

Austria.—Despite a shortage of electric power in the latter part of 1955, the Ranshofen Aluminum Works, produced a record 55,000 short tons of aluminum. A second furnace installed at the plant

[29] American Bureau of Metal Statistics, Yearbook of the American Bureau of Metal Statistics: Thirty-fifth Annual Issue for the Year 1955, 50 Broadway, New York, N. Y., June 1956, pp. 102–103.
[30] American Metal Market, Development of the Aluminum Industry: Vol. 62, No. 32, Feb. 15, 1955, p. 9; and No. 33, Feb. 16, 1955, p. 9.

contributed to the increased output. Salzburger Aluminium Gesellschaft m. b. H, with a capacity of 8,800 short tons, produced the remaining 8,000 tons. Total production in Austria was therefore 63,000 short tons. Further increases in capacity were expected in 1956.

Australia.—The Australian Aluminium Production Commission plant at Bell Bay, Tasmania, began operations in 1955. Production of seed aluminum hydrate was begun in February, calcined alumina in July, and metal in September.[31] About 1,450 short tons of aluminum was produced by the end of the year.

Imports of aluminum increased from 11,672 short tons in 1954 to 16,644 in 1955. Canada was the principal source of aluminum, as it accounted for 7,298 tons in 1954 and 11,891 tons in 1955. Consumption increased to 22,400 tons in 1955, leaving the local market undersupplied. Allocation of Canadian ingot was to be restricted early in 1956 following continued shortage of primary metal overseas. The price of Canadian aluminum was raised from £214 a long ton c.i.f. to £218 in May and to £229 in July.

The Australian Aluminium Co. Pty, Ltd., new 1,000-ton Fielding & Platt horizontal extrusion press began operations in 1955, and arrangements were made to expand the company rolled- and extruded-products capacity further. Southern Aluminium, Ltd., reported increased production of extruded products during the year, but the plant was still not operating at full capacity at the end of the year.

Brazil.—Cia. Brasileira de Aluminio inaugurated its new plant at Aluminio near Sorocaba, Sao Paulo, on June 4, 1955. Installations completed included an alumina plant, a plant to manufacture electrodes, a 11,000-short-ton-capacity aluminum plant, a foundry for all types of alloys, an extrusion mill, one hot- and two cold-rolling mills, a paper lamination section, a wire-drawing mill and electric cable factory, and sections for manufacturing aluminum goods, molds, sulfuric acid, and aluminum sulfate. The company was installing facilities to produce synthetic cryolite, aluminum powder, and vanadium oxide and was building a 40,000-hp. hydroelectric station on the Juquia-Guacu River to supplement the public supply of electricity. Lack of power limited production of the company to 2,200 tons of metal a month. The aluminum plant was to be increased to 55,000 short tons annual capacity as demand increased.

Brazil imported 16,794 short tons of aluminum ingots in 1954 and 7,110 tons in 1955.

Canada.—Although the aluminum industry experienced difficulty in obtaining all the necessary power in 1955, aluminum production reached a new high of 584,149 short tons. Loss of production due to a shortage of power at Arvida and Isle Maligne was estimated at 10,000 tons in the last quarter of 1955. In January 1955 an avalanche damaged four of the towers carrying power to the Kitimat smelter, and the resultant damage to potlines resulted in curtailment of production during the 2 months required for repairs.

Expansion in both Quebec and at Kitimat was well underway and was expected to continue into 1959, when total capacity was to be 912,000 tons. Of this, 582,000 tons was to be in Quebec and 330,000

[31] Department of National Development, Bureau of Mineral Resources, Geology and Geophysics, Australian Mineral Industry, 1955 Review, June 1956, pp. 35–39.

tons at Kitimat. Construction underway and to be completed in 1956 included 22,000 tons at Isle Maligne and 90,000 tons at Kitimat. All future expansion was to be at Kitimat, where 1 line of pots of 30,000 tons capacity would begin operation in 1957, 2 more in 1958, and the final 2 in 1959.

During 1955 contracts covering the sale of substantial quantities of aluminum ingot were entered into with customers in the United States and Europe; some contracts were to extend over a 10-year period. Virtually all of the increased production in 1955 was shipped to United Kingdom, United States, and Canada. Shipments to these countries were:

	1954	1955
United Kingdom	221, 800	267, 100
United States	192, 560	193, 200
Canada	80, 000	85, 000
Other countries	60, 400	64, 300
Total	554, 760	609, 600

Shipments to other countries remained essentially unchanged.

Italy.—Of the 68,000 short tons of aluminum produced in Italy in 1955, Montecatini-Settore Alluminio (SEAL) supplied 39,000 tons, Societa Alluminio Veneto Anonima (SAVA) 25,000 tons, and Societa dell'Alluminio Italiano (SAI) 4,000 tons. Exports of aluminum declined from 11,000 short tons in 1954 to 6,600 in 1955.

An article describing the aluminum industry in Italy was published in a German journal.[32]

Spain.—The 153-percent increase in aluminum output in 1955 was due partly to increased production of the state-owned Empresa Nacional de Aluminio plant at Valladolid, which had been authorized to increase production capacity to 11,000 short tons a year.

Surinam.—Plans to establish an aluminum plant having a capacity of 44,000 tons a year in Surinam were disclosed toward the end of the year. Negotiations were underway between Alcoa, Netherlands Aluminium Co., and the Government of the Netherlands Territory of Surinam.

Switzerland.—Aluminum output of 33,000 short tons almost reached capacity limits in 1955. The reduction plant at Chippis could not operate fully, owing to hydroelectric power shortage, but all four smelters increased output. Studies made by Société Anonyme pour l'Industrie de l'Aluminium to increase capacity included construction of a new aluminum plant at Steg, with an initial capacity of 11,000 short tons, which was to be increased to 22,000 tons later; establishment of an electrode factory at Chippis; new hydroelectric power stations; expansion of bauxite production at Cologne, Germany, or establishment of new works on the coast of the Netherlands; and expansion of facilities for aluminum foil and semimanufactures. The company also was interested in building a reduction plant in French Guinea or the Middle Congo.

Imports of aluminum ingots increased from 9,759 short tons in 1954 to 10,846 in 1955. Most imports were from Canada—4,206 tons; Austria—3,010 tons; Hungary—1,691 tons; and Italy—1,021 tons.

---

[32] Carminia, Von R., Die Aluminiumindustrie in Italien: Aluminium. vol. 32, No. 2, February 1956, pp. 113-115.

Exports of aluminum ingots totaled 5,056 short tons and went mostly to West Germany. Alumina imports during the year totaled 72,450 short tons.

U. S. S. R.—The Sumgait aluminum plant near Baku in Azerbaijan began operations in 1955. Plans called for 4 new aluminum plants, 3 of which were to be built in Siberia and 1 at Pavlodar, and expansion of capacity at the Kandalaksha plant in the Kola Peninsula.

An analysis of the aluminum industry in the Soviet Union was made by the Metal Bulletin, in which it was stated that capacity at the end of 1955 was 570,000 short tons and that projects started or planned would add another 360,000 tons. It was also stated that another 120,000 tons should be allowed for expansion of existing plants and improvement in production techniques, making a total capacity in 1960 of more than 1 million tons.[34] Other articles describing the aluminum industry in the Soviet Union were published.[35]

United Kingdom.—The decline in primary-aluminum output in the United Kingdom from 35,000 short tons in 1954 to 27,000 in 1955 was caused by a power shortage due to low rainfall. The superpurity refinery of British Aluminium Co., Ltd., at Foyers, Scotland, was closed some months, and the Kinlochleven and Lochaber plants in Scotland were forced to reduce operations. Imports of primary aluminum totaled 286,055 short tons compared with 214,778 tons in 1954. The price of aluminum ingot, which remained at £156 throughout 1954, was increased to £163 a long ton on January 1, 1955, and to £171 on July 1, 1955, where it remained the remainder of the year.

The company celebrated its 60th year in the aluminum industry by an exhibition in London. A short history of company activities from 1894 to 1955 was published.[33]

Yugoslavia.—The Boris Kidric aluminum plant at Kidricevo, which began operations late in 1954, accounted for 9,086 short tons of the total output of 12,700 tons in 1955—3 times that of 1954. From an importer of aluminum and rolled-aluminum products, Yugoslavia had become an exporter of these products. In 1955 exports were 2,830 short tons of aluminum.[36]

---

[33] Norfolk House, The History of the British Aluminium Co., Ltd., 1894–1955: St. James's Square, London, S. W. 1, 76 pp.

[34] Metal Bulletin (London), Soviet Russian Aluminium Industry: No. 4083, Apr. 6, 1956, p. 19.
American Metal Market, vol. 63, No. 68, Apr. 11, 1956, p. 10.

[35] Baudart, G. A., [Aluminium Behind the Iron Curtain]: Revue de l'Aluminium, vol. 32, No. 220, June 1955, pp. 579–581.
Light Metals, The Industry in the World Today: Vol. 19, No. 216, March 1956, pp. 74–75.

[36] Commercial Information, The "Boris Kidric" Alumina and Aluminum Factory at Kidricevo: Vol. 9, No. 4, April 1956, pp. 28–31.

Antimony

By Abbott Renick[1] and E. Virginia Wright[2]

TOTAL world production of antimony in 1955 was about 5,000 short tons greater than in 1954. The Free World supply of primary antimony was furnished chiefly by the Union of South Africa, Bolivia, Mexico, Turkey, and Yugoslavia.

Domestic mine production (antimony content) was 630 tons in 1955 compared with 770 tons in 1954. The Sunshine Mining Co. was the only domestic producer, recovering impure cathode metal from complex silver-lead-copper ore in Shoshone County, Idaho. United States smelter production totaled 8,200 tons, a 3-percent increase over the 1954 production.

The price of antimony metal, RMM brand, 99½ percent, f. o. b. Laredo, Tex., averaged 30.18 cents per pound and ranged from a low of 28.50 cents at the beginning of the year to a high of 33.00 cents at the end of the year. The New York price for antimony metal, RMM brand, in cases, averaged 32.15 cents per pound in 1955 compared with 30.47 cents in 1954.

The United States "new supply" of primary antimony in 1955, in terms of recoverable metal,[3] was 15,000 short tons compared with 11,000 tons in 1954. A breakdown of this supply shows that domestic ore and concentrate contributed 4 percent (580 tons), domestic and foreign silver-lead ore 13 percent (2,000 tons), and imports 83 percent (12,400 tons). The types of antimony materials imported for consumption arrived as follows: Ore and concentrate, 6,900 short tons; metal, 3,700 tons; oxide, 1,800 tons; and a small quantity of antimony sulfide. The supply from secondary sources was 23,700 short tons.

Total consumption of antimony in the United States during 1955 was 38,200 short tons and comprised 12,500 tons of primary antimony, 2,000 tons of antimony contained in foreign and domestic lead-silver ores consumed in the manufacture of antimonial lead by primary lead refineries, and 23,700 tons of secondary antimony.

---

1 Commodity specialist.
2 Statistical assistant.
3 Calculated at 92 percent of gross metal content.

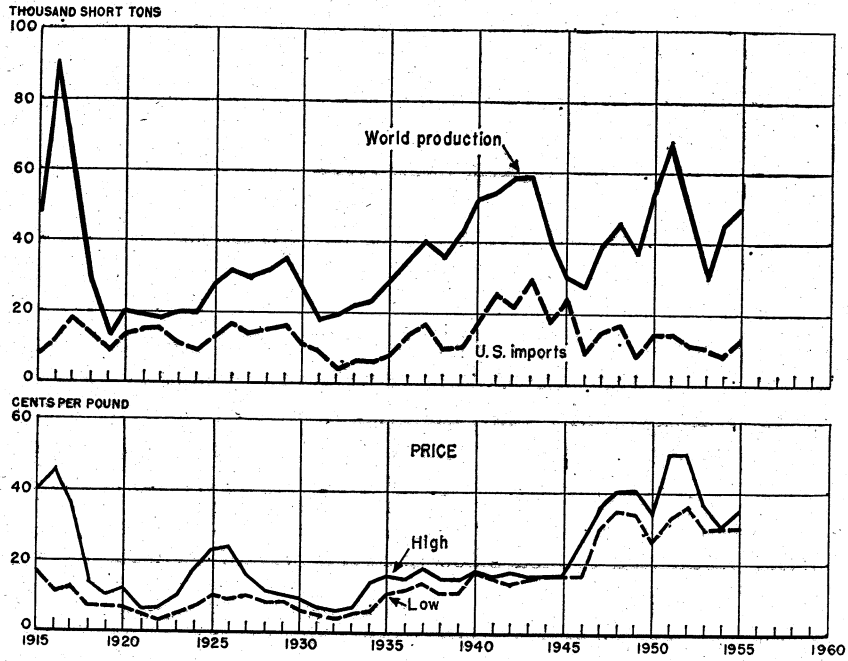

FIGURE 1.—Trends in world production, United States imports for consumption, and New York price for antimony, 1915–55.

TABLE 1.—Salient statistics of antimony in the United States, 1946–50 (average) and 1951–55, in short tons

	1946–50 (average)	1951	1952	1953	1954	1955
Production:						
Primary:						
Mine	3,689	3,472	2,160	372	766	633
Smelter	11,616	13,800	11,860	7,100	7,912	8,169
Secondary	20,723	23,943	23,089	22,360	22,358	23,702
Antimony content of antimonial lead produced by primary lead refineries from domestic and foreign ores	2,234	2,356	2,777	2,790	1,956	2,032
Imports for consumption	13,094	15,673	12,789	11,478	8,772	13,003
Ore and concentrate	9,169	11,746	7,945	7,778	4,722	7,470
Metal	3,632	2,231	3,354	2,612	2,802	3,667
Oxide	202	1,692	1,466	1,076	1,225	1,834
Sulfide	91	4	24	12	23	32
Exports of ore, metal, and alloys [1]	447	168	161	24	44	212
Consumption of primary antimony [2]	15,210	17,370	14,988	14,300	12,180	12,472
Average price of antimony at New York [3] (cents per pound)	31.11	44.17	44.02	35.90	30.47	32.15
World production [4]	40,000	65,000	50,000	40,000	45,000	50,000

[1] Gross weight.
[2] Does not include antimony contained in domestic and foreign silver and lead ores, recovered at primary lead refineries and marketed in antimonial lead.
[3] American Metal Market.
[4] Exclusive of U. S. S. R.

DOMESTIC PRODUCTION

MINE PRODUCTION

During 1955, domestic mine production totaled 630 tons of antimony, of which 580 tons was estimated as recoverable. Production was confined entirely to the Sunshine Mining Co., Shoshone County, Idaho, where impure antimony metal was recovered as a byproduct of processing silver-lead ore. The antimony was leached from silver-copper-antimony concentrate and recovered in an electrolytic plant. Virtually the entire output by Sunshine was added to the company stockpile.

In addition, 2,000 tons of antimony contained in domestic and foreign silver-lead ore was recovered by primary lead refineries in the production of antimonial lead.

TABLE 2.—Antimony-bearing ore and concentrate produced (shipped) in the United States,[1] 1946–50 (average) and 1951–55, in short tons

Year	Gross weight	Antimony content		Year	Gross weight	Antimony content	
		Quantity	Average percent			Quantity	Average percent
1946–50 (average)	12,474	3,689	30.0	1953	2,161	372	17.2
1951	9,401	3,472	37.0	1954	4,686	766	16.3
1952	4,854	2,160	44.5	1955	3,967	633	16.0

[1] Includes Alaska.

SMELTER PRODUCTION

Primary.—United States smelter production of antimony in 1955 was 8,200 tons, 3 percent above the 7,900 tons produced in 1954. Of the total output, 66 percent was oxide, 26 percent metal, 7 percent primary residues and slags, and 1 percent sulfide.

During 1955, 2,000 tons of antimony was recovered as antimonial lead by primary lead refineries from domestic and foreign silver and lead ores. Recovery increased 4 percent over that in 1954. A detailed discussion of antimonial lead production is given in the Lead chapter of this volume.

Secondary.—Total output of secondary antimony in 1955 was 23,700 short tons, comprising 22,200 tons from secondary metal plants and 1,500 tons recovered from scrap at primary lead refineries. Production for the year increased 6 percent from the 1954 output. A detailed review appears in the Secondary Metals—Nonferrous chapter of this volume.

TABLE 3.—Smelter production of antimony, 1946–50 (average) and 1951–55, by type of material, in short tons, antimony content

Year	Metal	Oxide	Sulfide[1]	Residues	Total
1946–50 (average)	5,512	6,006	98	(2)	11,616
1951	3,870	7,475	100	2,355	13,800
1952	2,533	6,805	108	2,414	11,860
1953	2,000	4,600	100	400	7,100
1954	2,178	4,925	124	685	7,912
1955	2,138	5,390	92	549	8,169

[1] Also includes ground high-grade sulfide ore.
[2] Not reported separately.

TABLE 4.—Antimony metal, alloys, and compounds produced in the United States, 1946–50 (average) and 1951–55, in short tons

Year	Primary metal, oxide, sulfide, and residues (antimony content)	Antimonial lead produced at primary lead refineries						Total secondary antimony (content of alloys) [3]
		Gross weight	Antimony content					
			From domestic ores [1]	From foreign ores [2]	From scrap	Total		
						Quantity	Percent	
1946–50 (average)	11,616	68,127	1,670	564	2,140	4,374	6.4	20,723
1951	13,800	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
1953	7,100	62,373	1,684	1,106	1,747	4,537	7.3	22,360
1954	7,912	59,873	1,299	657	1,565	3,521	5.9	22,358
1955	8,169	64,044	1,307	725	1,523	3,555	5.6	23,702

[1] Includes primary residues and small amount of antimony ore.
[2] Includes foreign base bullion and small quantities of foreign antimony ore.
[3] Includes antimony content of antimonial lead produced at lead refineries from scrap.

CONSUMPTION AND USES

The total consumption of antimony was 38,200 tons, 6 percent higher than the 36,200 tons in 1954. Primary antimony used totaled 12,500 tons (12,200 in 1954); the antimony content of lead-silver ore consumed by primary lead refineries in manufacturing antimonial lead was 2,000 tons (2,000 in 1954); and secondary antimony totaled 23,700 tons (22,000 in 1954).

Consumption of primary antimony in manufacturing finished products increased 2 percent above 1954; of the total, 63 percent was in the form of nonmetal products and 37 percent in the form of metal products. Antimony consumed in nonmetallic products increased 14 percent, with larger quantities entering frits and ceramic enamels, flameproof compounds, and glass industries. Consumption of antimony in metal products decreased 13 percent; antimonial lead and battery metal showed the largest decreases for the second consecutive year.

Consumption of secondary antimony, chiefly in metallic products, increased 6 percent.

TABLE 5.—Industrial consumption of primary antimony, 1946–50 (average) and 1951–55, by type of material, in short tons, antimony content

Year	Ore and concentrate	Metal	Oxide	Sulfide	Residues	Total
1946–50 (average)[1]						15,210
1951	3,007	4,645	8,872	162	684	17,370
1952	1,776	4,321	7,465	117	1,309	14,988
1953[2]	2,100	5,400	5,800	100	900	14,300
1954	768	4,609	5,885	94	824	12,180
1955	491	4,041	7,051	127	762	12,472

[1] Breakdown by type of material not available.
[2] Estimated 100 percent coverage based on reports from respondents that consumed 89 percent of the grand total antimony in 1952.

TABLE 6.—Industrial consumption of primary antimony, 1946–50 (average) and 1951–55, in short tons, antimony content

Product	1946–50 (average)[1]	1951	1952	1953[2]	1954	1955
Metal products:						
Ammunition	18	4	3	3	5	5
Antimonial lead	5,781	2,282	2,196	2,300	1,531	1,305
Battery metal	(3)	2,774	2,253	3,000	1,583	1,214
Bearing metal and bearings	1,827	1,308	1,119	1,000	816	831
Cable covering	89	95	43	60	156	146
Castings	124	79	80	80	70	67
Collapsible tubes and foil	53	18	32	60	47	24
Sheet and pipe	249	180	70	170	238	157
Solder	175	123	145	200	148	131
Type metal	1,098	709	624	700	613	598
Other	(3)	52	61	127	118	161
Total metal products	9,414	7,624	6,626	7,700	5,325	4,639
Nonmetal products:						
Ammunition primers	11	18	24	30	22	20
Antimony sulfide (precipitated)	(4)	68	67	50	37	44
Fireworks	(5)	20	36	50	27	32
Flameproofed coatings and compounds	(5)	463	980	450	316	626
Flameproofed textiles	266	2,590	2,059	780	950	592
Frits and ceramic enamels	1,549	1,476	959	1,000	706	1,020
Glass and pottery	400	570	579	700	763	1,028
Matches	34	31	22	20	15	17
Paints and lacquers	1,083	962	853	340	681	414
Pigments	(5)	705	766	780	700	825
Plastics	324	747	632	560	620	767
Rubber products	48	19	66	20	49	78
Other [6]	2,081	2,077	1,319	1,820	1,969	2,370
Total nonmetal products	5,796	9,746	8,362	6,600	6,855	7,833
Grand total	15,210	17,370	14,988	14,300	12,180	12,472

[1] Data for 1946–49 exclude certain intermediate smelting losses, which are included for subsequent years.
[2] Estimated 100 percent coverage based on reports from respondents that consumed 89 percent of the grand total antimony in 1952.
[3] Included with "Antimonial lead."
[4] Not reported as an end-use product.
[5] Included with "Other nonmetal products."
[6] Antimony trichloride and sodium antimonate included to avoid disclosure of individual company operations.

STOCKS

At the end of 1955 industry stocks, including 1,700 tons of cathode metal held by the Sunshine Mining Co. totaled 8,600 short tons, an increase of 16 percent from the 7,400 tons reported on hand December 31, 1954. Mine stocks, which are included in industry stocks, increased to 230 short tons.

TABLE 7.—Industry stocks of primary antimony in the United States at end of year 1954–55, in short tons, antimony content

Raw material	December 31, 1954			December 31, 1955		
	Mine [1]	Other	Total	Mine [1]	Other	Total
Ore and concentrate	200	2,221	2,421	227	3,366	3,593
Metal		1,577	1,577		1,267	1,267
Oxide		2,751	2,751		3,234	3,234
Sulfide		135	135		94	94
Residues and slag		522	522		445	445
Total	200	7,206	7,406	227	8,406	8,633

[1] Includes Alaska.

PRICES

The price of antimony metal RMM brand, 99½ percent, f. o. b. Laredo, Tex., averaged 30.18 cents per pound, ranging from a low of 28.50 cents at the beginning of the year to a high of 33.00 at the end of the year. The corresponding New York price averaged 32.15 cents per pound in 1955 compared with 30.47 in 1954, according to the American Metal Market.

The domestic price of antimony was increased by 4½ cents per pound to 33.00 cents for RMM brand, f. o. b. Laredo, carlots in bulk, effective August 17, 1955. This was the first change in the domestic price since November 27, 1953.

TABLE 8.—E&MJ Metal and Mineral Markets openings and subsequent changes in nominal quotations for antimony ore, 1955, antimony content, per unit (20 pounds)

Date	50-55 percent	55-60 percent	60-65 percent
Jan. 1	\$2.80-\$3.00	\$3.00-\$3.20	\$4.00-\$4.20
Jan. 6	3.25- 3.50	3.80- 4.00	4.25- 4.35
Mar. 24		3.90- 4.10	4.35- 4.50
Apr. 14	3.50- 3.60	4.10- 4.25	4.45- 4.55
Apr. 28	3.60- 3.70	4.20- 4.30	4.50- 4.60
July 14		4.20- 4.30	4.45- 4.55
Nov. 17	3.20- 3.35	3.90- 4.00	4.10- 4.25
Nov. 24		3.90- 4.00	4.05- 4.25

TABLE 9.—Foreign metal prices, New York, 1955, antimony content, cents per pound

[E&MJ Metal and Mineral Markets]

Date	99.6 percent	99.5 percent	99 percent
Jan. 1	28.00-28.50	27.00-28.00	26.00-27.00
Aug. 26	28.50-29.00	27.50-28.50	26.50-27.50
Sept. 8	29.00-29.50	28.00-29.00	27.00-28.00
Nov. 29	28.00-28.50	27.00-28.00	26.00-27.00

TABLE 10.—Antimony oxide prices, New York, 1955, cents per pound

[Oil, Paint & Drug Reporter]

Date	Carlots, in bags	Less than carlots, in bags
Jan. 1	29.00	30.50
May 17	27.00	28.50
Oct. 20	29.00	30.50

FOREIGN TRADE [4]

Imports.—During 1955 imports of contained antimony for consumption totaled 13,000 tons, the highest since 1951. In terms of recoverable metal, total imports were estimated to be 12,400 short tons, comprising 6,900 tons in ore and concentrate, 3,700 tons of metal, 1,800 tons of oxide and a small quantity of sulfide.

Imports of ore and concentrate, principally from Mexico, Bolivia, and Union of South Africa, increased 58 percent from the preceding year; the average grade was 46 percent antimony, an increase of 9 percent. Imports of metal, chiefly from Belgium-Luxembourg, Mexico, and Yugoslavia, increased 31 percent. Imports of oxide, 87 percent of which came from United Kingdom, increased 50 percent, and imports of sulfide, chiefly from United Kingdom and West Germany, increased 39 percent.

Exports.—In 1955 exports (gross weight) of ore and concentrate were 8 tons valued at $5,000; metal and alloys 204 tons valued at $71,000; and salts and compounds 189 tons valued at $126,000. By comparison, exports of metal and alloys in 1954 totaled 44 tons valued at $25,600 and of salts and compounds 330 tons valued at $203,000. No exports of ore and concentrate were reported in 1954.

Reexports of salts and compounds in 1955 were 19 tons valued at $8,100; no reexport of metal and alloys was reported.

TABLE 11.—Antimony imported for consumption in the United States, 1946–50 (average) and 1951–55 [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							
1946–50 (average)	25,997	9,169	$2,529,403	130	$74,831	3,632	$1,956,235	918	243	$91,135
1951	26,698	11,746	4,571,974	6	5,936	2,231	1,780,576	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
1953	17,242	7,778	2,035,125	17	8,678	2,612	1,402,226	1,350	1,296	579,600
1954	12,870	4,722	1,289,782	33	17,101	2,802	1,349,179	771	1,476	645,057
1955	16,209	7,470	1,849,981	46	18,628	3,667	1,859,906	1,366	2,210	926,312

[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.

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

TABLE 12.—Antimony imported into the United States, 1946–50 (average), 1951–53 (totals), and 1954–55, 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						
1946–50 (average)	26,357	9,294	$2,551,169	130	$74,831	3,672	$1,980,070	243	$91,135
1951	26,320	11,507	4,559,702	8	7,032	2,231	1,780,388	2,039	1,525,016
1952	18,246	7,945	3,200,889	34	20,719	3,389	2,359,525	1,766	1,056,286
1953	17,242	7,778	2,035,125	15	7,582	2,627	1,407,424	1,296	579,600
1954									
North America:									
Canada	112	56	15,892						
Mexico	7,889	1,651	305,925			818	445,625		
Total	8,001	1,707	321,817			818	445,625		
South America:									
Bolivia [2]	3,493	2,244	719,702						
Chile [2]	230	139	52,383						
Peru [2]	1,003	547	164,364						
Total	4,726	2,930	936,449						
Europe:									
Belgium-Luxembourg				28	13,797	787	358,027	412	187,816
France	5	2	436			27	11,130		
Germany, West						[3] 208	[3] 80,277	27	11,925
Netherlands						[3] 29	[3] 11,816		
United Kingdom	24	17	11,053	5	3,304	355	178,015	1,037	445,316
Yugoslavia						601	274,607		
Total	29	19	11,489	33	17,101	2,007	913,872	1,476	645,057
Africa: Union of South Africa	114	66	20,027						
Grand total	12,870	4,722	1,289,782	33	17,101	2,825	1,359,497	1,476	645,057
1955									
North America:									
Canada	262	126	22,418	9	1,422				
Mexico	7,558	2,296	422,787			981	590,089		
Total	7,820	2,422	445,205	9	1,422	981	590,089		
South America:									
Bolivia [2]	3,097	1,996	528,706						
Chile [2]	298	218	81,422						
Peru [2]	279	179	63,724						
Total	3,674	2,393	673,852						
Europe:									
Austria	6	3	1,328						
Belgium-Luxembourg				6	2,661	1,087	528,798	190	92,850
Czechoslovakia						30	12,342	6	2,398
France	32	11	2,255	5	2,562	159	72,519		
Germany, West	28	17	6,230	10	4,283	187	78,123	99	40,757
Netherlands				5	2,212				
United Kingdom	23	19	11,070	11	5,488	501	244,376	1,915	790,307
Yugoslavia						726	334,225		
Total	89	50	20,883	37	17,206	2,690	1,270,383	2,210	926,312
Africa:									
Algeria	1,047	460	55,552						
Mozambique	563	344	104,932						
Union of South Africa	3,016	1,801	549,557						
Total	4,626	2,605	710,041						
Grand total	16,209	7,470	1,849,981	46	18,628	3,671	1,860,472	2,210	926,312

[1] Data are general imports, that is, include antimony imported for immediate consumption, plus material entering country under bond. Table does not include antimony contained in lead-silver ores.
[2] Imports shown from Chile probably were mined in Bolivia or Peru and shipped from a port in Chile.
[3] Revised figure.

TECHNOLOGY

The recovery of byproduct antimony in Peru was described in a paper.[5]

Antimony metal is recovered from the converter dusts of the anode slimes treatment. Arsenic in the dust is volatilized by roasting with sulphuric acid which fixes the antimony and prevents its fuming. The resulting calcine is mixed with soda ash together with a limited amount of coal and melted in a small furnace; the product is a bullion carrying high concentrations of silver, bismuth, and lead, while the antimony is unreduced and remains as a soda slag. This slag is transferred to a second furnace to which additional coal is added for a total reducti n to crude antimony containing 95% Sb. This is blended with refined lead to produce antimonial lead for sale.

A Government report on the refining of antimony by electrodeposition and by distillation, was abstracted by its authors as follows:[6]

Antimony was refined on a large laboratory scale by distillation, electrodeposition, and a combination of these two methods. The degree of refinement varied with the types and amounts of impurities present in the crude material, and the refining methods used.

The best grade of material produced contained 99.894 percent antimony, which was purer than the refined products of ten large producers, as reported in the literature. In addition, a considerable amount of new information regarding the metallurgy of antimony was obtained during these experiments.

Developments on the production of antimony by the Sunshine Mining Co. were described.[7]

A technical paper on lead-tin-antimony plating was presented.[8] The paper concluded:

A solution has been developed from which an alloy with a nominal composition of 11 percent tin, 7 percent antimony, and remainder lead can be simultaneously electrodeposited. The effects of variation of individual constituents of the solution on the plated alloy composition have been investigated and determined. The effects of variations of current density, temperature and agitation have also been investigated and determined. Equipment and a procedure have been developed for plating bearings and have been shown adaptable for production use with excellent control of the plated alloy.

An article describing the gallium-antimony system was abstracted as follows:[9]

The binary system Ga-Sb has been investigated by thermal, X-ray, and metallographic methods. The intermetallic compound Ga-Sb melts at 705.9° C. and forms a eutectic with antimony at 11.8 atomic pct Ga. This eutectic melts at 598.8° C. but it is too close to the composition of pure gallium to be detected.

The Federal Geological Survey, United States Department of the Interior, issued a press release stating:[10]

Release to open file by the Geological Survey of a report on the successful application of geochemical prospecting techniques in locating additional mineralized areas in the vicinity of an antimony deposit in southeastern Alaska was announced today by Acting Secretary of the Interior Clarence Davis.

---

[5] Barker, I. L., Complex Metallurgy by Cerro de Pasco: AIME Tech. Paper, Annual Meeting, New York, N. Y., Feb. 20 23, 1956, p. 9.

[6] Rogers, R. R., and Campbell, R. A., Refining Antimony by Electrodeposition and by Distillation: Canada Dept. of Mines and Tech. Surveys, Tech. Paper 11, Ottawa, Canada, 14 pp.

[7] Gould, Wayne D., Sunshine's Tetrahedrite Ores Yield Electrolytic Antimony: Eng. and Min. Jour., vol. 156, No. 6, June 1955, pp. 91–94.

[8] Putnam, R. T., and Roser, E. J., Lead-Tin-Antimony Plating: AES Tech. Proc., 1955 of the 42d Ann. Convention, Cleveland, Ohio, July 20–23, 1955, pp. 38–41.

[9] Greenfield, I. G., and Smith, R. L., Gallium-Antimony System: Jour. Metals, vol. 7, No. 2, February 1955, pp. 351–353.

[10] Geological Survey, Geochemical Prospecting Discloses Alaskan Antimony Deposits Extension. Press Release, June 29, 1955, p. 1.

457676—58——12

The report gives details on the application of a relatively new technique, largely developed by the Geological Survey, to the finding of hidden bodies of stibnite (sulfide of antimony) at a prospect near Caamano Point, about 15 miles northwest of Ketchikan in southeastern Alaska. The work, probably the first of its kind in a typical Alaskan muskeg area, was undertaken to aid a prospecting project of the Defense Minerals Administration.

Detailed sampling of soil and decomposed limestone-and-schist bedrock at depths of from 18 to 60 inches showed abnormal concentrations of antimony. Subsequent drilling, trenching, and underground mining operations showed that disseminated stibnite ore to a depth of 60 feet lay beneath the areas which seemed to be the most promising from the surface-sampling program. Data are also given in the report which may help establish values of soil content of antimony that may be considered normal in geologic terrain such as that near Caamano Point.

The principles of operation of the magnetorestive element and the physical characteristics of a new compound—indium antimonide—was the subject of an article. It stated:[11]

The most striking characteristic of indium antimonide is its extremely high electron mobility. By mobility is meant the drift velocity of a charge carrier per unit electric field. Since the Hall voltage is proportional to the product of the mobility and the magnetic field, it can be shown that the Corbino magneto-resistance is approximately proportional to the square of the mobility. The electron mobilities of a number of semiconductors at room temperature are given in the accompanying table.

Electron mobilities in semiconductors

Semiconductor:	*Mobility, cm./sec. per volt/cm.*
Germanium	4,000
Silicon	1,500
Lead sulfide	700
Indium antimonide	75,000
Indium arsenide	40,000

Since indium antimonide has an electron mobility over 15 times that of germanium, the Corbino magneto-resistance of indium antimonide can be greater by a factor of several hundred.

An abstract of a technical report on the mechanical properties of antimonial bronze bearing metal follows:[12]

This is the second report on the evaluation of "Berry Metal," a tin-free antimonial bronze, as a substitute for high-leaded tin bronze in journal bearing applications. The first report compared the friction and wear behavior of the two bronzes. In this report, the tensile and compressive properties of Berry metal and high-leaded tin bronze are compared at 80°, 212°, and 300° F. Also, variations in the microstructure caused by the addition of nickel and/or phosphorus to the antimonial bronze are presented and discussed. A few sea water corrosion-erosion tests were conducted but the results were inconclusive. The discussion of the report includes service and laboratory test information furnished by the exhibitor.

Antimony oxide glass was the subject of an article [13] which stated as follows:

Glass that transmits a greater range of infrared rays than was possible heretofore has been developed at Battelle. Ordinarily, glasses are based on silicon, but such glasses do not transmit the longer infrared rays. The new glass is based on oxides of antimony.

The research on uses for antimony oxides as a glass-forming material was sponsored by the Bradley Mining Company, San Francisco.

[11] Willardson, R. K., and Beer, A. C., Magnetoresistance—New Tool for Electrical Control Circuits: Elec. Mfg.; vol. 57, No. 1, January 1956, pp. 79-84.

[12] U. S. Naval Engineering Experiment Station, Evaluation Report 040037F(4)-NS-013-118: Feb. 14, 1955, 17 pp.

[13] Battelle Tech. Review: Vol. 4, No. 7, July 1955, p. 90.

Three United States patents were issued during 1955 relative to antimony.[14]

WORLD REVIEW

Bolivia.—In 1955, Bolivia was the second largest antimony producer in the Free World, having a production (gross weight) of 9,471 short tons. Exports of antimony contained in concentrates (net weight) totaled 5,907 short tons valued at $2,109,444.

Canada.—A Government report [15] stated:

> The Consolidated Mining and Smelting Company of Canada Limited (Cominco) produced metallic antimony from 1939 to 1944 at its lead-zinc smelter and refineries at Trail, British Columbia. Since 1944, the output has been in the form of a lead alloy containing from 1 to 35 percent antimony; normally it contains 25 percent antimony and 75 percent lead.
>
> * * * The principal source of the antimony produced at Trail is the silver-lead-zinc ore of Cominco's Sullivan mine at Kimberley, British Columbia. Lead concentrate from the Sullivan, together with concentrates containing small amounts of antimony from a number of other mines, are treated at the Trail smelter, the lead bullion produced containing about one percent antimony, most of which is recovered as antimonial lead in the course of making electrolytically refined lead. In the smelting process, slags and flue dust containing a high percentage of antimony are accumulated and, as the Trail plant is not equipped to treat them, are sold to foreign smelters.

Preliminary data for 1955 report that Canada's production of antimony was 985 short tons valued at Can$536,537 compared with 651 short tons valued at Can$349,249 in 1954. Exports of antimony contained in antimonial lead totaling 787 short tons, increased 126 percent over the preceding year.

China.—In 1955, Chinese production of antimony was estimated at 13,000 tons, compared with 12,000 tons in the previous year.

Japan.—A recent dispatch reported as follows the Japanese production of antimony in 1955:[16]

	Short tons
Antimony content of concentrates	333
Antimony metal	1,082
Antimony oxide	742

Mexico.—Production of antimony decreased from 4,610 short tons in 1954 to 4,209 tons in 1955. The total 1955 production by type of material follows:

	Short tons
Antimony contained in ore and concentrates	2,630
Antimony contained in impure antimony bars	955
Antimony contained in antimonial lead bars	604
Antimony contained in other smelter products	20
Total	4,209

Exports decreased and totaled 2,919 short tons, 99 percent of which went to the United States and the remainder to West Germany and Belgium.

---

[14] Neely, John F., Electrolytic Refining of Antimony: U. S. Patent 2,713,555, July 19, 1955.
Burnside, Don G. (assigned to Radio Corp. of America), Antimony Plating: U. S. Patent 2,715,096, Aug. 9, 1955.
DuRose, Arthur H. (assigned to the Harshaw Chemical Co.), Electrodeposition of Antimony: U. S. Patent 2,721,836, Oct. 25, 1955.

[15] Canada Department of Mines and Tech. Surveys, Antimony in Canada, 1955 (Preliminary): Ottawa, 3 pp.

[16] State Department Dispatch 910, Tokyo, Japan, Apr. 6, 1956, p. 1.

TABLE 13.—World production of antimony (content of ore),[1] by countries,[2] 1946–50 (average) and 1951–55, in short tons [3]

(Compiled by Augusta W. Jann)

Country [2]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada [4]	290	3,351	1,165	744	651	985
Honduras	6	(5)				
Mexico [4]	7,165	7,522	6,097	4,063	4,610	4,209
United States	3,689	3,472	2,160	372	766	633
Total	11,150	14,345	9,422	5,179	6,027	5,827
South America:						
Argentina	[6] 30	[6] 45	(7)	(7)	(7)	7
Bolivia (exports)	10,832	13,025	10,809	6,376	5,751	5,907
Peru	1,290	1,220	567	1,062	933	960
Total	[6] 12,152	[6] 14,290	[6] 11,430	[6] 7,490	[6] 6,740	6,874
Europe:						
Austria	[6] 300	549	429	543	429	441
Czechoslovakia [6]	3,290	1,800	1,800	1,800	1,800	(7)
France	319	674	518	331		(7)
Germany, West	(7)	53	52	55	(7)	(7)
Greece	88	551	386	[6] 600	[6] 60	
Italy	583	799	692	465	317	358
Portugal	23	21	155	1	6	(7)
Spain	215	184	288	254	121	[6] 200
Yugoslavia (metal)	1,666	1,355	1,465	1,554	1,711	1,769
Total [2] [6]	6,630	6,500	6,200	5,900	4,700	5,100
Asia:						
British Borneo: Sarawak	1					
Burma [6]	55	220	100	130	55	60
China [6]	3,400	7,700	8,800	11,000	12,000	13,000
Iran [8]	89	176	265	110	50	(7)
Japan	136	247	230	354	291	333
Thailand (Siam)	122	72	77	50	78	28
Turkey	637	2,984	1,274	951	1,080	1,841
Total [6]	4,440	11,400	10,700	12,600	13,500	15,400
Africa:						
Algeria	750	1,391	1,456	1,995	2,535	1,124
French Morocco	582	1,055	925	64	429	349
Rhodesia and Nyasaland, Fed. of:						
Southern Rhodesia	40	68	110	26	72	223
Spanish Morocco	228	235	475	341	330	397
Union of South Africa	5,006	17,480	7,949	3,009	9,528	15,641
Total	6,606	20,229	10,915	5,435	12,894	17,734
Oceania:						
Australia	292	463	268	251	131	371
New Zealand	2		7	12		
Total	294	463	275	263	131	371
World total (estimate) [2]	40,000	65,000	50,000	40,000	45,000	50,000

[1] Approximate metal content of ore produced, exclusive of antimonial lead ores.
[2] Antimony is also produced in Hungary and U. S. S. R.; an estimate for Hungary by senior author of chapter included in total, but there is too little information to include an estimate for U. S. S. R.
[3] This table incorporates a number of revisions of data published in previous Antimony chapters. Data do not add to totals shown due to rounding where estimated figures are included in detail.
[4] Includes antimony content of antimonial lead.
[5] Negligible.
[6] Estimate.
[7] Data not available; estimate by senior author of chapter included in total.
[8] Year ended Mar. 20 of year following that stated.

Pakistan.—The stibnite deposits of Chitral were reopened during 1955 and began producing at the rate of about 150 short tons of antimony ore monthly. Messrs. Pakistan Industries, Ltd., Karachi, erected a pilot plant for treating the ore. The experimental pilot plant was expected to treat about 1 ton of ore per day. The main feature of this plant, due to the difficulties of transport and scarcity of fuel in the area, is that it is completely electrically operated.[17]

Peru.—Production of antimony in Peru totaled 960 short tons. This represented a 3-percent increase over the 933 tons in 1954. Of the total output, 60 percent was contained in ore and concentrate (577 tons); 30 percent refined metal (290 tons); and 10 percent as the antimony content of antimonial lead bars (93 tons).

Turkey.—A report [18] stated:

Some 30 antimony deposits are known, but most are far from transportation. In Demirkapi and Ivrindi, the average grade is said to be 63%. Principal known deposits are the hydrothermal Turhal mine and the Goynuk mine, a contact deposit.

Antimony is known in sizeable amounts in Turhal County. In years 1949 to 1952, mines in area yielded 12,000 tons ore and sold 3,962 tons concentrate. Reserves of the three mines aggregate to 90,000 tons 13% Sb.

Union of South Africa.—The Consolidated Murchison (Transvaal) Goldfields & Development Co., Ltd., continued during 1955 in its position as the world's largest antimony producer. Production in 1955 totaled 15,640 short tons of contained antimony, representing a 64 percent increase from the preceding year.

The company 1955 Annual Report to Stockholders stated:

The ore reserves at 31st December, 1955, which were deemed to be payable on account of the combined Gold and Antimony content, amounted to 380,000 tons; an increase of 60,000 tons over the figure at the previous year end.

United Kingdom.—In 1955, consumption of primary antimony in the United Kingdom was 6,043 short tons. This represented an increase of about 400 tons, or 4 percent over the previous year. Consumption of antimony in scrap was 5,027 short tons, representing a decrease of 3 percent under 1954.[19]

Yugoslavia.—Smelter production of antimony metal totaled 1,769 short tons. This represented an increase of about 3 percent over the 1954 output.

---

17 Mining World, vol. 18, No. 5, Apr. 16, 1956, p. 117.
18 Engineering and Mining Journal, Turkey's Mineral Potential Expands: Vol. 157, No. 1, January 1956, pp. 88–90.
19 British Bureau of Nonferrous Statistics, Bulletin Statistics: Vol. 8, No. 12, December 1955, p. 50.

Arsenic

By Abbott Renick[1] and E. Virginia Wright[2]

ESTIMATED world production of 37,000 short tons of white arsenic in 1955 was 4,000 tons less than in 1954 and a decrease of 27 percent from the 1946–50 average (51,000 tons).

Domestic production in 1955—10,800 tons of white arsenic—represented an 18-percent decrease from the preceding year and was the lowest since 1946. Shipments exceeded production and reduced producers' stocks on hand at the end of 1955 to 11,600 tons, nearly 900 tons lower than at the 1954 year end. Producers' stocks at the end of 1954 were at a historical high of 12,500 tons.

Of the total white arsenic available for United States consumption in 1955, domestic refinery production (from domestic and foreign ores) constituted 60 percent and imports 40 percent. Apparent consumption was 900 short tons larger than supply.

TABLE 1.—Salient statistics of the white arsenic industry in the United States, 1946–50 (average) and 1951–55, in short tons

Year	Production	Shipments	Imports	Exports [1]	Apparent consumption [2]	Producers' stocks end of year	Price per pound [3]
1946–50 (average)	14,734	14,541	11,313	[4] 400	25,454	3,205	\$0.05¼–\$0.06
1951	16,190	14,351	14,518	----------	28,869	4,834	.06½
1952	15,673	9,244	4,483	----------	13,727	11,263	.06½– .05½
1953	10,873	11,315	4,717	----------	16,032	10,820	.05½
1954	13,167	11,523	4,848	----------	16,371	12,464	.05½
1955	10,780	11,673	7,222	----------	18,895	11,571	.05½

[1] Reported by producers.
[2] Producers' shipments, plus imports, minus exports.
[3] Refined white arsenic, carlots, as quoted by E&MJ Metal and Mineral Markets.
[4] Estimated by the Bureau of Mines.

DOMESTIC PRODUCTION

Domestic white arsenic is produced principally as a byproduct in smelting complex copper and lead ores, and the quantity of white arsenic produced is directly related to the outputs of these metals. Of the 3 smelters that recovered byproduct white arsenic in 1955, 1 was closed by a labor strike for about 6 weeks beginning July 1, which contributed to the 18-percent decline in the 1955 output as compared with 1954.

White arsenic was produced in 1955 by Anaconda Copper Mining Co. at Anaconda, Mont. (copper smelter); United States Smelting, Refining & Mining Co. at Midvale, Utah (lead smelter); and American

[1] Commodity specialist.
[2] Statistical assistant.

Smelting & Refining Co. at Tacoma, Wash. (copper smelter). Arsenic metal was not produced during 1955.

TABLE 2.—Production and shipments of white arsenic by United States producers, 1946–50 (average) and 1951–55

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
1946-50 (average)	13,604	13,338	$958,648	1,130	1,203	$97,870	14,734	14,541	$1,056,518
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
1953	10,345	10,816	495,673	528	499	43,383	10,873	11,315	539,056
1954	12,630	10,921	492,562	537	602	48,516	13,167	11,523	541,078
1955	9,968	10,986	501,104	812	687	53,557	10,780	11,673	554,661

[1] Excludes crude consumed in making refined.

CONSUMPTION AND USES

The major portion of white arsenic was employed in manufacturing calcium and lead arsenate insecticides. The apparent consumption of white arsenic was 18,900 tons in 1955—15 percent above the 16,400 tons consumed in 1954. In recent years the trend has been for organic insecticides to replace arsenic compounds. However, in some cotton-producing areas the arsenicals regained preference.

Arsenic was also consumed in glass manufacture, cattle and sheep dips, poisoned bait, pharmaceuticals, acid-resistant copper, and some antimonial lead alloys. Sodium arsenite was used as a weed killer and a grasshopper bait. Wolman salts (25 percent sodium arsenate) is used as a wood preservative.

STOCKS

Producers' stocks of white arsenic at the end of 1955 were 11,600 short tons, a decrease of nearly 1,000 tons from the historical high of 12,500 tons at the end of 1954. Data are not available on stocks of calcium and lead arsenate held by producers.

TABLE 3.—Production of arsenical insecticides and consumption of arsenic wood preservatives in the United States, 1946–50 (average) and 1951–55

Year	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)
1946-50 (average)	16,779	17,117	1,262,929
1951	12,708	20,450	1,544,181
1952	7,143	3,817	1,658,426
1953	7,098	3,630	1,900,692
1954	7,810	1,379	1,966,790
1955 [3]	7,388	2,116	2,133,215

[1] U. S. Department of Commerce.
[2] Forest Service, U. S. Department of Agriculture.
[3] Preliminary figures.

PRICES

White arsenic was quoted at 5½ cents per pound (powdered, in barrels, carlots) throughout 1955. According to the Oil, Paint, and Drug Reporter, calcium arsenate, in carlots, warehouse, was steady at 9–10 cents per pound. Likewise the quoted price for lead arsenate, carlots (3-pound bags), remained unchanged throughout the year at 27½ cents per pound. Paris green, carlots, was quoted at 36–40 cents per pound in January, and this price held until the end of 1955. The domestic price for arsenic metal remained throughout the year at 54 cents per pound. The London price for white arsenic, per long ton, 98–100 percent, was steady throughout the year at £45–£50 nominal (equivalent to 5.63 to 6.25 cents per pound). The London price for arsenic metal, per long ton, opened in January at £475 (equivalent to 59.38 cents per pound) and in the latter part of December was quoted at £410 (equivalent to 51.25 cents per pound).

FOREIGN TRADE[3]

Imports.—White arsenic imports for 1955 totaled 7,200 short tons and were 49 percent above 1954 receipts but 17 percent below the 5-year average, 1950–54.

TABLE 4.—White arsenic (As_2O_3 content) imported for consumption in the United States, 1946–50 (average) and 1951–55, by countries

[U. S. Department of Commerce]

Country	1946–50 (average)		1951		1952		1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:												
Canada	149	$13,755	742	$69,036	121	$14,470	292	$26,018	592	$48,690	683	$43,048
Mexico	9,064	755,843	10,899	1,147,395	4,252	520,112	4,378	543,443	4,212	493,681	6,431	713,911
Total	9,213	769,598	11,641	1,216,431	4,373	534,582	4,670	569,461	4,804	542,371	7,114	756,959
South America:												
Bolivia	2	208	------	------	------	------	------	------	------	------	------	------
Peru	518	25,189	61	6,468	------	------	------	------	------	------	------	------
Total	520	25,397	61	6,468	------	------	------	------	------	------	------	------
Europe:												
Belgium-Luxembourg	198	9,300	------	------	------	------	------	------	------	------	------	------
France	110	9,125	1,919	247,443	110	12,992	47	4,605	44	2,597	75	5,880
Germany	2	151	------	------	------	------	------	------	------	------	------	------
Italy	67	11,496	------	------	------	------	------	------	------	------	------	------
Poland-Danzig	53	6,548	------	------	------	------	------	------	------	------	------	------
Portugal	27	3,164	------	------	------	------	------	------	------	------	------	------
Sweden	694	78,907	621	72,317	------	------	------	------	------	------	33	2,413
U. S. S. R.	429	44,922	------	------	------	------	------	------	------	------	------	------
United Kingdom	------	------	------	------	------	------	(1)	3	------	------	------	------
Total	1,580	163,613	2,540	319,760	110	12,992	47	4,608	44	2,597	108	8,293
Asia: Japan	------	------	276	39,180	------	------	------	------	------	------	------	------
Grand total	11,313	958,608	14,518	1,581,839	4,483	547,574	4,717	574,069	4,848	544,968	7,222	765,252

[1] Less than 1 ton.

[3] Figures on imports and exports compiled by Mac B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

Mexico continued to be the principal supplier of white arsenic imports and accounted for 89 percent of the total; Canada supplied 9 percent, France and Sweden supplied the balance (2 percent). In 1955, 47 tons of arsenic sulfide was received; arsenical sheep dips came exclusively from the United Kingdom.

Imports of metallic arsenic totaled 114 short tons; Sweden supplied 86 percent and the United Kingdom 14 percent.

TABLE 5.—Arsenicals imported into and exported from the United States by classes, 1946–50 (average) and 1951–55, in pounds

[U. S. Department of Commerce]

Class	1946–50 (average)	1951	1952	1953	1954	'1955
Imports for consumption:						
White arsenic (As_2O_3 content)	22,626,690	29,036,555	8,966,906	9,434,212	9,695,722	14,443,828
Metallic arsenic	66,096	220,668	60,220	141,472	117,085	228,960
Sulfide	82,406	148,299	-	20,018	-	93,717
Sheep dip	51,288	62,050	102,415	52,436	55,700	40,960
Lead arsenate	24,110	13,669	161,316	-	-	-
Arsenic acid	440	5,600	-	-	-	-
Calcium arsenate	45,600	1,554,207	192,205	-	42,544	-
Sodium arsenate	22,030	180,040	65,221	79,520	173,565	172,175
Paris green	17,728	-	41,255	-	-	-
Exports:						
Calcium arsenate	4,863,691	5,356,867	5,606,613	3,890,246	1,975,894	1,885,582
Lead arsenate	1,967,469	626,184	255,268	303,030	709,752	1,080,498

Exports.—Producers of white arsenic reported no direct foreign sales in 1955. Exports of calcium arsenate totaled 943 short tons. This represented a decrease of 45 tons (5 percent) from the previous year; however, exports of lead arsenate increased 52 percent. Peru was the principal recipient of calcium arsenate; Canada, Mexico, Nicaragua, and Cuba followed, in that order. Peru was the principal recipient of lead arsenate; Colombia, Canada, Cuba, and the Philippines followed in that order.

Tariff.—White arsenic, arsenic sulfide, paris green, and sheep dip (certain varieties of which contain arsenic) were all free of duty. Arsenic acid was dutiable at 3 cents per pound, lead arsenate at 1½ cents per pound, and metallic arsenic at 3 cents per pound. Compounds of arsenic not specified in the tariff act were dutiable at 12½ percent of their foreign market value.

TECHNOLOGY

The production of white arsenic in Peru was described in a paper.[4]

Calcium arsenate, an insecticide especially effective against the boll weevil, is prepared in Oroya to meet the needs of the Peruvian cotton growers. A slurry of burned lime and arsenic trioxide is converted by the novel means of an oxidizing roast to calcium pyroarsenate. This crude material is treated with dilute sulphuric acid, and calcium sulphate and impurities are filtered off, and the pure solution of arsenic acid retained. A second precipitation of calcium arsenate is made by the addition of milk of lime under carefully controlled conditions to produce a chemical which, when dried, will meet stringent specifications for active ingredients, protection against burning of foliage, fineness, and apparent density.

[4] Barker, I. L., Complex Metallurgy by Cerro de Pasco: A. I. M. E. Tech. Paper, Annual Meeting, New York, N. Y., Feb. 20–23, 1956, p. 9.

A United States patent was issued in 1955 relative to arsenic.[5]

WORLD REVIEW

Canada.—The Northern Miner reported as follows: [6]

> There is only one producer of refined white arsenic in Canada—Deloro Smelting & Refining Co. at Deloro, Ontario.
>
> The company recovers arsenic as a byproduct in the treatment of silver-cobalt ores from the Cobalt-Gowganda area mines, Northern Ontario, and from the treatment of residues produced by Eldorado Mining and Refining Ltd. at its refinery at Port Hope, Ontario.
>
> Roasting capacity of the Deloro refinery is about 100 tons of refined white arsenic a month. * * *

Rhodesia and Nyasaland Federation of.—According to a recent report,[7] the output of white arsenic (all from Southern Rhodesia) increased from 417 short tons in 1953 to 459 tons in 1954. No exports of arsenic were reported during the year.

TABLE 6.—World production of white arsenic, by countries,[1] 1946–50 (average) and 1951–55, in short tons [2]

(Compiled by Augusta W. Jann)

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	402	1,177	854	702	590	325
Mexico	8,701	14,072	3,159	2,204	2,675	3,255
United States	14,735	16,190	15,673	10,873	13,167	10,780
South America:						
Brazil	1,075	1,456	1,062	411	1,275	(3)
Peru	522	----------	17	----------	105	(3)
Europe:						
Belgium (exports)	[4] 900	358	1,106	1,903	1,979	2,281
France	3,266	5,844	6,934	6,217	812	(3)
Germany: West (exports)	[4] 1,020	3,862	122	675	239	635
Greece	21	62	97	68	55	42
Italy	797	1,754	2,209	1,179	(3)	(3)
Portugal	961	618	1,452	1,301	1,631	[4] 660
Spain	392	332	173	60	22	(3)
Sweden	14,695	20,427	17,189	(3)	10,762	13,803
United Kingdom	[4 5] 120	(3)	(3)	(3)	(3)	(3)
Asia:						
Iran [6]	[4] 40	----------	----------	----------	(3)	(3)
Japan	1,506	1,515	1,545	1,576	1,583	1,248
Africa: Rhodesia and Nyasaland, Fed. of:						
Southern Rhodesia	259	84	568	417	459	508
Union of South Africa	7	----------	----------	----------	----------	----------
Oceania:						
Australia	838	134	134	----------	----------	----------
New Zealand	14	----------	----------	----------	----------	----------
Total (estimate)[1]	51,000	69,000	54,000	45,000	41,000	37,000

[1] Arsenic was also produced in Argentina, Austria, and East Germany, and estimates by senior author of the chapter are included in total. There is too little information to estimate production in China, Czechoslovakia, Finland, Hungary, and U. S. S. R.

[2] This table incorporates a number of revisions of data published in previous Arsenic chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.

[3] Date not available; estimate by senior author of chapter included in total.

[4] Estimate.

[5] White arsenic, including arsenic soot.

[6] Year ended March 20 of year following that stated.

---

[5] Freund, Walter J., Process of Preparing Organic Arsenical Compounds, and Products Obtained Thereby: U. S. Patent 2,710,874, June 14, 1955.

[6] Northern Miner, Annual Review Number: Sec. 5, Dec. 8, 1955, p. 59.

[7] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, p. 7.

Sweden.—The Boliden Mining Co., largest individual producer of white arsenic in the world, increased output 28 percent in 1955 above the 1954 production.

United Kingdom.—The Metal Bulletin (London) reported as follows: [8]

We understand that a major Scandinavian supplier of white arsenic which has been effectively out of the market for some time is now more or less back to normal shipments—from the works at least. There is now, however, something of a problem on shipping space, where the after effects of the dock strike are still being felt, as a large amount of cargo space is being taken up to work off backlogs on timber. Prices are now on an even keel, and, on the whole, there appears to have been practically no disruption to the general level during the period of comparative shortage.

[8] Metal Bulletin (London), Arsenic-Easier Supplies: No. 4023, Sept. 2, 1955, p. 23.

Asbestos

By D. O. Kennedy[1] and Annie L. Marks[2]

WORLD output of asbestos increased in 1955 to 1.75 million tons after 4 years of nearly identical production of 1.5 million tons. Greater output in Canada was responsible for most of the 1955 world increase. Within the United States, production declined for the second consecutive year and amounted to less than 3 percent of the world output. Imports and consumption in the United States rose to nearly the record high of 1951. Imports of low-iron chrysotile of spinning grade from Southern Rhodesia declined to less than 60 percent of the 1954 imports, but imports of low-iron chrysotile from British Columbia continued to increase and have almost entirely replaced Southern Rhodesia fibers in the low-iron field. Imports of Canadian spinning-grade fibers increased 14 percent compared with 1954.

Prices of Canadian chrysotile were advanced in December 1955, but other prices remained unchanged from 1954.

TABLE 1.—Salient statistics of the asbestos industry in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Domestic asbestos:						
Produced short tons	32,216	51,730	53,888	57,950	45,813	44,752
Sold or used do	32,205	51,645	53,864	54,456	47,621	44,580
Value	$1,753,810	$3,912,500	$4,713,032	$4,857,359	$4,697,962	$4,487,428
Imports (unmanufactured) short tons	582,642	761,873	709,469	692,245	678,390	740,423
Value	$33,558,043	$58,521,046	$61,604,601	$59,753,583	[1]$55,856,606	[1]$60,957,578
Exports (unmanufactured)[2] short tons	12,816	16,526	10,724	3,076	1,894	2,787
Value	$2,374,601	$3,662,270	$2,670,970	$592,222	$291,157	$267,776
Apparent consumption short tons	602,075	796,992	752,609	743,625	724,117	782,216
Exports of asbestos products [2] [3]	$9,291,608	$14,321,278	$13,028,857	$10,627,293	$11,484,735	$12,858,504

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be strictly comparable to earlier years.
[2] Includes material that has been imported and subsequently exported without change.
[3] 1945 figures include value of "Magnesia and manufactures."

DOMESTIC PRODUCTION

During 1955, production of chrysotile increased 41 percent in Arizona owing chiefly to increased sales of short fibers. Production in Vermont decreased nearly 5 percent compared with 1954. The

[1] Assistant chief, Branch of Construction and Chemical Materials.
[2] Statistical assistant.

small production and sale of low-grade chrysotile fibers in California and increased Arizona production almost offset declining Vermont output; the result was a decrease of only 1 percent in domestic production of chrysotile asbestos. Output of amphibole asbestos, suspended in Georgia and greatly reduced in North Carolina, was nearly 90 percent less than in 1954. So few companies outside of Arizona produced amphibole and chrysotile that separate statistics for each type and production by States cannot be published.

Of 13 companies in Arizona, 6 produced and sold less than 10 tons each during 1955. Greatly expanded shipments of short fibers resulted in a 40-percent increase in the total quantity of asbestos shipped; the total sales value was 3 percent less than the 1954 shipments. The following firms and individuals produced chrysotile in the Globe district of Arizona during 1955: American Asbestos Cement Corp., American Fiber Corp., Arizona Asbestos Mining Co., Crown Asbestos Mines, Inc., Barry De Rose, Jaquays Mining Corp., Kyle Asbestos Mines of Arizona, Metate Asbestos Corp., Arthur Enders, Phillips Asbestos Mines, Via Development Co., Clarence Via, and Western Chemical Co.

At the end of 1954, bids for leasing a 200-acre asbestos-mining property on the Fort Apache Indian Reservation in Arizona were invited.[3] Jack L. Neal and associates acquired the Bear Canyon asbestos property on the San Carlos Indian Reservation in Arizona under a 10-year leasing agreement.[4]

The Materials Branch, Emergency Procurement Service, General Services Administration, continued to purchase domestic low-iron chrysotile at its depot in Globe, Ariz. Reports of purchases of crudes Nos. 1, 2, and 3 showed that 87 percent of the total production of these grades was sold to the Government. The Government was paying $1,500 a ton for crude No. 1, $900 a ton for crude No. 2, and $400 a ton for crude No. 3. The program was scheduled to run until October 1, 1957, or until 1,500 tons of crudes Nos. 1 and 2 combined had been purchased.

The Tabor Mining Co. produced a small quantity of short chrysotile from the Phoenix mine, Napa County, Calif. Tremolite was produced in Placer County by W. Zimdars and J. Delmue from the Noon Day mine in the Iowa Hill district. Amphibole asbestos was produced by Huntley Industrial Minerals, Inc., in the Ubehebe district of Inyo County, and by the Calasbestos Corp., from the Katherine C mine in the Santa Rosa district of Riverside County.

A new discovery of amphibole asbestos near the Zenia area in Trinity County, Calif., was announced.[5]

The Powhatan Mining Co., Baltimore, Md., continued to produce amphibole asbestos from the Kilpatrick mine in Transylvania County, N. C.

The Vermont Asbestos Mines Division of Ruberoid Co. remained the chief producer of asbestos in the United States. Production from the Vermont quarry was less in 1955 than in 1954.

---

[3] Mining Congress Journal, Lease Apache Asbestos Land: Vol. 41, No. 3, March 1955, p. 77.
[4] Mining World, vol. 17, No. 9, August 1955, p. 100.
[5] California Mining Journal, Trinity County: Vol. 25, No. 1, September 1955, p. 20.

The Asbestos Corp., Ltd., took an option to purchase 27 claims on Ibex Mountains near Hyder, Alaska. High-grade chrysotile asbestos was found on these claims.[6] This area lies southwest of the Cassiar mine, which is producing low-iron chrysotile asbestos of strategic importance.

CONSUMPTION

Chrysotile asbestos represented 96 percent of the total consumption of asbestos in the United States in 1955, and the increase of 8 percent in the consumption of chrysotile in 1955 compared with 1954 was reflected in the same increase in all types of asbestos.

TABLE 2.—Apparent consumption of raw asbestos in the United States, 1946–50 (average) and 1951–55

Year	Short tons	Value	Year	Short tons	Value
1946–50 (average)	602,075	$32,937,252	1953	743,625	$64,018,720
1951	796,992	58,771,276	1954	724,117	60,263,411
1952	752,609	63,646,663	1955	782,216	65,177,230

Consumption of spinning grades of chrysotile increased 11 percent and that of short fibers increased 8 percent. Consumption of amosite declined 20 percent owing to a shortage in supply from the Union of South Africa.

Consumption of crocidolite (blue asbestos) increased 29 percent. As asbestos was employed extensively in building construction and in many industries, trends in asbestos consumption, industrial production, and volume of new construction are compared graphically in figure 1.

PRICES

Canadian Johns-Manville Co., Ltd., announced increases in prices for all grades of asbestos, effective December 15, 1955. This rise, about 10 percent for all long-fiber grades and about 5 percent for all short fibers, was the first adjustment in Canadian prices since January 1952.[7] These increases were not reflected in trade-journal quotations until over a month later and did not appear as 1955 price changes. Trade-journal quotations follow:

	Price per ton
Crude No. 1	US$1,100–US$1,500
Crude No. 2	500– 1,000
No. 3—Spinning fiber	300– 525
No. 4—Shingle fiber	150– 200
No. 5—Paper fiber	100– 140
No. 6—Plaster fiber	77
No. 7—Shorts	35– 70

[6] Western Mining and Industrial News, Alaska Asbestos Properties to Be Mined Near Hyder: Vol. 23, No. 5, May 1955, p. 4.

[7] Northern Miner, Johns-Manville Raises Prices for Asbestos: Vol. 41, No. 40, Dec. 15, 1955, p. 11.

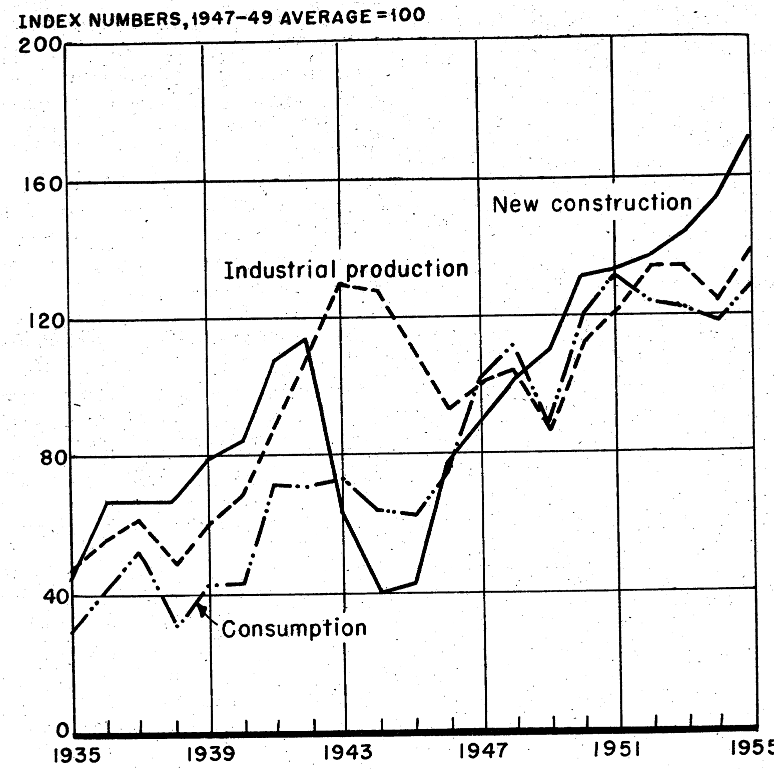

FIGURE 1.—Consumption of asbestos compared with total new construction and industrial production, 1935–55. Statistics on value of construction from Bureau of Foreign and Domestic Commerce and on industrial production from Federal Reserve Board.

The Arizona quotations were unchanged during 1955 and were as follows:

	Per ton f. o. b. Globe, Ariz.
No. 1 crude	$1, 500–$1, 750
No. 2 crude	900– 1, 050
No. 3 crude	400– 450
Filter fiber	250– 450

African asbestos was sold by negotiation with individual purchasers. There were no market quotations. Department of Commerce reports show the following average figures for imports in 1954 and 1955, per short ton:

	1954	1955
Amosite: South Africa	$132. 73	$125. 38
Crocidolite:		
Bolivia	450. 21	-------
Australia	316. 83	229. 00
South Africa	209. 61	206. 06

FOREIGN TRADE [8]

Imports.—During 1955 less than 6 percent of the asbestos consumed in the United States was produced in domestic mines. Nearly half the world production of asbestos was imported to meet United States requirements, an increase of nearly 10 percent in 1955. Imports of amosite dropped about 20 percent, and shortages in this type of asbestos began to develop in some industries. As in 1954, 94 percent of the 1955 imports originated in Canada; nearly 4 percent came from the Union of South Africa, Southern British Africa, and British East Africa; a little over 1 percent came from Southern Rhodesia. The value of the imports from these three areas represented 87, 8, and 3 percent, respectively, of the total value of all imports of asbestos into the United States in 1955.

TABLE 3.—Asbestos (unmanufactured) imported for consumption in the United States, 1946–50 (average) and 1951–53 (totals) and 1954–55, by countries and classes

[U. S. Department of Commerce]

	Crude (including blue fiber)		Mill fibers		Short fibers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	30,998	$4,921,338	159,601	$15,646,889	392,043	$12,989,816	582,642	$33,558,043
1951	35,289	6,618,140	[1]225,284	[1]28,844,485	501,300	23,058,421	761,873	58,521,046
1952	38,636	8,048,835	212,684	31,292,506	458,149	22,263,260	709,469	61,604,601
1953	39,201	9,052,007	170,692	27,521,438	482,352	23,180,138	692,245	59,753,583
1954								
North America: Canada	1,107	338,268	148,026	24,242,023	491,149	23,549,156	640,282	48,129,447
South America:								
Bolivia	166	74,736					166	74,736
Venezuela			47	7,943			47	7,943
Total	166	74,736	47	7,943			213	82,679
Europe:								
Finland					168	9,759	168	9,759
Germany, West	4	6,000	2	275			6	6,275
Italy			1	1,340	1	2,498	2	3,838
Malta, Gozo and Cyprus					120	3,166	120	3,166
U. S. S. R.			292	32,442			292	32,442
United Kingdom	[2]28	[2]9,985	119	39,216	2	1,891	149	51,092
Total	32	15,985	414	73,273	291	17,314	737	106,572
Africa:								
British East Africa	(3)	(3)			53	5,394	[4]53	[4]5,394
Federation of Rhodesia and Nyasaland [5]	6,699	1,832,596	156	94,626	364	199,824	7,219	2,127,046
Southern British Africa	[4]1,105	[4]241,308	125	31,688			[4]1,230	[4]272,996
Union of South Africa	[4]27,096	[4]4,601,514	194	107,400	110	25,607	[4]27,400	[4]4,734,521
Total	34,900	6,675,418	475	233,714	527	230,825	35,902	7,139,957
Oceania: Australia	1,256	397,951					1,256	397,951
Grand total	37,461	[6]7,502,358	148,962	[6]24,556,953	491,967	[6]23,797,295	678,390	[6]55,856,606

See footnotes at end of table.

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

TABLE 3.—Asbestos (unmanufactured) imported for consumption in the United States, 1946–50 (average) 1951–53 (totals) and 1954–55, by countries and classes—Continued

[U. S. Department of Commerce]

	Crude (including blue fiber)		Mill fibers		Short fibers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1955								
North America: Canada	873	$471, 279	167, 191	$27, 388, 074	531, 023	$25, 215, 464	699, 087	$53, 074, 817
South America: Venezuela			1	435			1	435
Europe:								
France					7	589	7	589
Germany, West			2	278			2	278
Italy			8	9, 310			8	9, 310
Portugal	4	538					4	538
United Kingdom	1	336	72	20, 642	9	9, 627	82	30, 605
Yugoslavia	558	23, 276	6	575			564	23, 851
Total	563	24, 150	88	30, 805	16	10, 216	667	65, 171
Africa:								
British East Africa					12	1, 358	12	1, 358
Federation of Rhodesia and Nyasaland [5]	8, 168	1, 999, 787	237	73, 041	15	4, 312	8, 420	2, 077, 140
Southern British Africa	189	42, 458					189	42, 458
Union of South Africa	27, 507	4, 745, 152	635	105, 172	557	79, 168	28, 699	4, 929, 492
Total	35, 864	6, 787, 397	872	178, 213	584	84, 838	37, 320	7, 050, 448
Oceania: Australia	3, 348	766, 707					3, 348	766, 707
Grand total	40, 648	8, 049, 533	168, 152	[6] 27, 597, 527	531, 623	[6] 25, 310, 518	740, 423	[6] 60, 957, 578

[1] Includes 11 tons ($1,632) classified by the U. S. Department of Commerce as "amosite, crude"; reclassified by Federal Bureau of Mines as "mill fibers."
[2] Data includes less than 1 ton, valued at $501 in 1954, believed to have originated in the Union of South Africa or Australia, and processed in the United Kingdom.
[3] Revised to none.
[4] Revised figure.
[5] Believed to be all from Southern Rhodesia.
[6] Owing to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to years before 1954.

TABLE 4.—Asbestos (chrysotile) imported for consumption in the United States from Canada, by grades, 1946–50 (average) and 1951–55, in short tons

[U. S. Department of Commerce]

Grades	1946–50 (average)	1951	1952	1953	1954	1955
Crude No. 1	251	126	144	168	82	65
Crude No. 2	268	226	332	207	181	164
Other crudes	341	384	79	467	844	644
Spinning and textile fiber	19, 093	22, 463	24, 112	19, 417	18, 319	21, 339
Shingle fiber	73, 437	104, 419	98, 577	86, 540	72, 242	83, 898
Paper fiber	65, 184	97, 888	87, 644	63, 139	57, 465	61, 954
Short fiber	392, 035	501, 264	458, 012	482, 179	491, 149	531, 023
Total	550, 609	726, 770	668, 900	652, 117	640, 282	699, 087

As the longer spinning-grade fibers of chrysotile were of strategic interest, tables 4 and 5 were prepared to show the imports of chrysotile from Canada and Southern Rhodesia by grades. Although not shown separately in table 4, imports of low-iron chrysotile from British Columbia increased from 2,323 tons in 1954 to 5,742 tons in 1955. Imports from Southern Rhodesia increased about 17 percent in 1955 compared with 1954 owing to larger shipments of short fibers. Imports of the strategic spinning grades (low-iron) continued to decline.

TABLE 5.—Asbestos (chrysotile) imported for consumption in the United States from Southern Rhodesia [1] by grades, 1946–50 (average) and 1951–55, in short tons

[U. S. Department of Commerce]

Grades	1946–50 (average)	1951	1952	1953	1954	1955
Crude No. 1	1,375	678	462	1,039	181	105
Crude No. 2	3,049	1,239	1,363	814	275	162
Other crude	[2] 4,575	5,783	8,296	7,304	6,243	7,901
Spinning and textile fiber	151	25	177	730	156	76
Shingle fiber	45		245	103		161
Short fiber	6				364	15
Total	9,201	7,725	10,543	9,990	7,219	8,420

[1] Effective July 1, 1954, reported by the U. S. Department of Commerce as Federation of Rhodesia and Nyasaland. Believed to be all from Southern Rhodesia.
[2] Includes small amounts credited by U. S. Department of Commerce to Mozambique.

Imports from the Union of South Africa increased again in 1955. Imports of crocidolite (blue asbestos) more than doubled since 1952, but imports of amosite decreased to about 59 percent of the 1952 figure.

TABLE 6.—Imports of amosite, crocidolite, and chrysotile into the United States from Union of South Africa, 1951–55, in short tons

[U. S. Department of Commerce]

	1951	1952	1953	1954	1955
Amosite	[1] 15,131	[2] 18,323	15,261	14,634	11,745
Crocidolite	[3] 5,473	6,885	7,781	10,911	14,591
Chrysotile	2,979	1,694	3,388	1,855	2,363
Total	23,583	26,902	26,430	27,400	28,699

[1] Includes 100 tons credited by U. S. Department of Commerce to French West Africa; 512 tons credited to Mozambique and 140 tons credited to Southern Rhodesia.
[2] Includes 105 tons credited to Mozambique.
[3] Includes 6 tons blue (crocidolite) crudes credited to United Kingdom.

Exports.—Exports of raw asbestos increased nearly 50 percent in 1955 compared with 1954 but represented less than 6 percent of our domestic production and were insignificant compared with imports.

TABLE 7.—Asbestos and asbestos products exported from the United States, 1946–50 (average) and 1951–55

[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
1946–50 (average)	11,236	$2,028,514	1,580	$348,667	$9,277,936	$13,672
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
1953	2,780	540,273	296	51,949	10,615,832	11,461
1954	1,847	275,778	47	15,379	11,475,082	9,653
1955	2,161	236,336	626	31,440	12,820,917	37,587

[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 8.—Asbestos and asbestos products exported from the United States, 1954–55, by kinds

[U. S. Department of Commerce]

Product	1954		1955	
	Quantity	Value	Quantity	Value
Unmanufactured asbestos:				
Crude and spinning fibers .... short tons	286	$58,726	240	$48,858
Nonspinning fibers .... do	438	100,227	287	42,817
Waste and refuse .... do	1,123	116,825	1,634	144,661
Total unmanufactured .... do	1,847	275,778	2,161	236,336
Asbestos products:				
Brake lining and blocks:				
Molded, semimolded and woven	(1)	4,620,416	(1)	4,995,315
Clutch facing and lining .... number	1,138,760	879,450	1,182,728	927,597
Construction materials .... short tons	15,056	2,521,652	16,395	3,055,227
Pipe covering and cement .... do	2,094	635,224	3,040	806,976
Textiles, yarn, and packing .... do	1,387	2,434,904	1,210	2,605,656
Manufactures, n.e.c.	(2)	383,436	(2)	430,146
Total products	------------	11,475,082	------------	12,820,917

[1] Owing to changes in classification, values have been summarized; quantities not shown.
[2] Quantity not recorded.

TECHNOLOGY

Two technical publications on asbestos were issued in 1955. The first, by Oliver Bowles, was a comprehensive report covering all phases of asbestos production and use. This report utilized the vast reservoir of information available from many studies pertaining to the technique and equipment of mining and milling, new applications, economic problems, international trade, reserves, and various other aspects of this unique mineral. These data were supplemented by conferences with numerous authorities on the production and utilization of asbestos and visits to asbestos mines and deposits in the United States and foreign countries.[9] The second publication, by W. E. Sinclair, was a textbook with a great deal of information on mining and milling methods in South Africa.[10]

[9] Bowles, Oliver, The Asbestos Industry: Bureau of Mines, Bull. 552, 1955, 122 pp.
[10] Sinclair, W. E., Asbestos, Its Origin, Production, and Utilization: Mining Publications, Ltd., London, 1955, 365 pp.

Asbestos mining in Arizona was studied by the Stanford Research Institute of Stanford, Calif.,[11] and by the Bureau of Mines.[12] Recommendations made by the Stanford Research Institute to the San Carlos Apache Tribe Council included the following:

The leasing of land for mineral exploitation should be simplified to revive and create interest in mineral development.

As a result of a 7-year detailed study of asbestos occurrences at Thetford Mines, Quebec, a report was compiled describing the probable origin of the asbestos veins.[13]

New developments in block-caving methods used in the Quebec asbestos mines were described.[14]

The use of ball mills in the Johnson's Asbestos Co. mill at Black Lake, Quebec—an innovation in asbestos-milling processes—was described in several publications.[15]

Several patents were granted covering new types of apparatus to improve fiberization of asbestos in treatment plants.[16] A process was patented for recovering treated asbestos fibers from waste gasket material containing asbestos and metal.[17]

The so-called harsh and semiharsh asbestos fibers have certain definite advantages over those that are soft, silky, or slimy in wet-process manufacture of such products as asbestos-cement pipe. Research, conducted for several years, has shown that the soft fibers may be changed to any degree of harshness desired by a flash-heating process. The changes appear to be accomplished by the removal of part of the molecular water.[18]

Several processes for better utilization of asbestos fibers were described in patents granted during 1955.[19]

WORLD REVIEW

World production in 1955, about 15 percent larger than in 1954, showed a sizable increase for the first time in 5 years.

NORTH AMERICA

Canada.—Sales of asbestos in Canada increased nearly 15 percent in 1955 compared with 1954, both in quantity and value. Sales of fibers reached a new high of nearly 400,000 tons—13 percent above the previous high of 350,000 tons in 1952.

---

11 Western Mining Industrial News, Asbestos Mining Principal Mineral Resource on Apache Reservation: Vol. 23, No. 5, May 1955, pp. 13–14.

12 Stewart, Lincoln A., Chrysotile Asbestos Deposits of Arizona: Bureau of Mines Inf. Circ. 7706, 1955, 124 pp.

13 Riordon, P. H., The Genesis of Asbestos in Ultrabasic Rocks: Econ. Geol., vol. 50, No. 1, January–February 1955, pp. 67–81.

14 Antonides, Lloyd E., Asbestos Mines Improve Caving Schemes: Eng. and Min. Jour., vol. 157, No. 1, January 1956, pp. 100–103, 110.

15 Hardinge Highlights, Asbestos and Johnson's Company: April 1955, 4 pp.
Mining World, New Asbestos Milling Methods Pioneered by Johnson Company: Vol. 17, No. 9, August 1955, pp. 48–53.
Herod, Buren C., Johnson's Asbestos Opens New Mill, Mine at Black Lake, Que.: Pit and Quarry, vol. 48, No. 10, April 1956, pp. 138–142.

16 Donovan, J. J., and Donovan, R. A., Ore-Fiberizing Machine: U. S. Patent 2,700,511, Jan. 25, 1955.
Donovan J. J., and Donovan, R. A., Vertical Axis Rotary-Beater Mill for Treatment of Fibrous Materials: U. S. Patent 2,700,512, Jan 25, 1955.
Birdseye, C., Progressive Explosion Process of Defibration: U. S. Patent 2,711,369, June 21, 1955.

17 Lillie, S. M., and Toman, J. C., Process of Recovering Treated Fibrous Material: U. S. Patent 2,702,162, Feb. 15, 1955.

18 Badollet, M. S., and Streib, W. C., Heat Treatment of Chrysotile Asbestos Fibers: Canadian Min. and Met. Bull., vol. 48, No. 514, February 1955, pp. 65–69.

19 Spooner, L. W., Aluminum Phosphate Bonded Asbestos Insulating Material: U. S. Patent 2,702,068, Feb. 15, 1955.
Bump, C. K., Process of Bonding Asbestos Fibers With a Titanium Polymer and Article Produced Thereby: U. S. Patent 2,710,268, June 7, 1955.
Steck, R. F., Production of Friction Materials: U. S. Patent 2,702,770, Feb. 22, 1955.

TABLE 9.—World production of asbestos by countries,[1] 1946–50 (average) and 1951–55, in short tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada (sales) [3]	677,404	973,198	929,339	911,226	924,116	1,092,384
United States (sold or used by producers)	32,205	51,645	53,864	54,456	47,621	44,580
Total	709,609	1,024,843	983,203	965,682	971,737	1,136,964
South America:						
Argentina	289	(4)	(4)	(4)	(4)	198
Bolivia (exports)	140	348	513	810	33	----
Brazil	1,677	1,456	1,439	1,357	2,816	[5] 1,250
Chile	294	(4)	(4)	(4)	(4)	(4)
Venezuela	194	287	434	185	743	1,757
Total	2,594	[5] 2,500	[5] 2,800	[5] 2,800	[5] 4,000	[5] 3,400
Europe:						
Finland [6]	9,785	13,062	11,464	12,047	7,853	18,674
France	2,506	7,814	8,338	11,419	11,795	10,913
Greece	20	37	28	1	6	----
Italy	15,584	24,925	26,387	22,484	25,955	33,266
Portugal	137	344	185	105	30	56
Spain	25	45	33	----	176	(4)
U. S. S. R. [5]	176,400	240,000	240,000	240,000	240,000	240,000
Yugoslavia	[7] 862	1,679	2,762	4,131	3,598	4,305
Total [1] [5]	210,000	290,000	290,000	290,000	295,000	310,000
Asia:						
Cyprus	10,271	18,938	18,250	15,966	17,146	17,143
India	202	580	765	637	435	[5] 440
Iran	----	----	3	55	----	----
Japan	5,330	6,478	3,370	4,495	6,916	6,950
Korea, Republic of	(4)	(4)	(4)	(4)	233	2,048
Taiwan (Formosa)	282	39	26	----	163	405
Turkey	220	88	----	----	50	259
Total [1] [5]	18,000	28,000	25,000	27,000	33,000	38,000
Africa:						
Bechuanaland	----	41	528	548	729	1,426
Egypt	679	1,375	66	220	----	----
French Morocco	567	666	635	600	597	631
Kenya	485	418	390	166	224	152
Madagascar	1	19	3	8	----	----
Mozambique	----	----	----	----	193	301
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	65,970	77,663	84,834	87,739	79,962	105,261
Swaziland	31,832	34,964	34,769	30,103	30,142	32,613
Union of South Africa	50,887	107,368	133,839	94,817	109,151	119,699
Total	150,421	222,514	255,064	214,201	220,998	260,083
Oceania:						
Australia	1,475	2,865	4,546	5,566	5,279	5,993
New Zealand	9	911	764	----	----	----
Total	1,484	3,776	5,310	5,566	5,279	5,993
World total (estimate) [1]	1,090,000	1,570,000	1,560,000	1,505,000	1,530,000	1,755,000

[1] In addition to countries listed, asbestos is produced in China, Czechoslovakia, and North Korea. Estimates by author of chapter are included in the total.
[2] This table incorporates a number of revisions of data published in previous Asbestos chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[3] Exclusive of sand, gravel and stone (waste rock only), production of which is reported as follows: 1946–50 (average) 28,682 tons; 1951, 33,762 tons; 1952, 39,664 tons; 1953, 21,118 tons; 1954, 26,429 tons; 1955, 28,582 tons.
[4] Data not available; estimate by author of chapter included in total.
[5] Estimate.
[6] Includes asbestos flour.
[7] Average for 1947–50.

TABLE 10.—Sales of asbestos in Canada, 1954–55, by grades

[Dominion Bureau of Statistics]

	1954			1955		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Grade:						
Crudes	725	Can$645, 608	Can$890. 49	724	Can$610, 830	Can$843. 69
Fibers	326, 653	56, 724, 585	173. 65	395, 096	66, 813, 234	169. 11
Shorts	596, 738	29, 039, 019	48. 66	667, 982	32, 217, 034	48. 23
Total	924, 116	86, 409, 212	93. 50	1, 063, 802	99, 641, 098	93. 67
Rock mined	14, 793, 760			17, 696, 357		
Rock milled	11, 394, 571			12, 427, 002		

Optimism about the future of Canadian asbestos was indicated in reports showing increased ore reserves, greater production at the mines of Asbestos Corp. in Quebec,[20] shaft sinking at the Munro mine of the Johns-Manville Corp., Ltd., in Ontario,[21] and preliminary plans for opening new ore bodies in the Matheson area.[22] A record production of 592,000 tons was reported from the world's largest asbestos mine, the Jeffery mine of the Johns-Manville Corp., Ltd., at Asbestos, Quebec.

Lake Asbestos of Quebec, Ltd., began dredging operations at Black Lake, Quebec. Over 25 million yards of mud, sand, gravel, and boulder clay will be removed from the lake in preparation for open-pit mining of a large ore body.[23]

The block-caving method at the Jeffery mine [24] and the open pit at the Munro mine [25] of Johns-Manville Corp., Ltd., were described in a publication.

Many companies explored for new asbestos deposits. Canadian Johns-Manville Corp., Ltd., announced its interest in new asbestos "finds" anywhere in western Canada or the western United States. Continental Asbestos Mines, Ltd., a new firm in control of the property and mill of Continental Asbestos Co., considered a geomagnetic survey and diamond-drilling program of the property.[26] Derogan Asbestos Corp. used a second diamond drill to explore its property in Melborne Township, Quebec. One hole drilled showed fiber to a depth of 450 feet. Eastern Asbestos Co. explored by drifting and core sampling an asbestos deposit in Portland West Township, about 24 miles north of Buckingham, Quebec. The asbestos occurs in crossfiber veins in dolomite and is similar in origin and character to the Arizona fiber.[27] Golden Age mines carried out bulk sampling and

[20] Northern Miner, Asbestos Corp. Had Record Year-Sales Profits, Ore Reserves Up: Vol. 41, No. 49, Mar. 1, 1956, pp. 17, 25.
[21] Northern Miner, Johns-Manville Sinking Shaft at Munro Mine: Vol. 41, No. 27, Sept. 29, 1955, pp. 1, 15.
[22] Northern Miner, Johns-Manville Considers Opening Second Orebody: Vol. 41, No. 34, Nov. 17, 1955, p. 2.
[23] Canadian Mining and Metallurgical Bulletin, Asbestos: Vol. 48, No. 519, July 1955, p. 456.
Engineering and Mining Journal, Canada Moves a Lake to Mine Asbestos: Vol. 157, No. 1, January 1956, pp. 91–93.
[24] Briggs, Marion L., World's Largest Asbestos Block-Caving Method: Rock Products, vol. 58, No. 5, May 1955, pp. 58–61.
[25] Pit and Quarry, Johns-Manville's Munro Mine—First Asbestos Development in Ontario's "Golden Area": Vol. 48, No. 3, September 1955, pp. 74–76, 78.
[26] Northern Miner, New Owners Develop Continental Asbestos: Vol. 41, No. 35, Nov. 24, 1955, p. 23.
[27] Canadian Mining Journal, Eastern Asbestos Co.: Vol. 76, No. 1, January 1955, p. 118.

mill testing of the eastern portion of its property in the Eastern Township area of Quebec. An average recovery of 1.76-percent fiber was reported.[28] New Lafayette Asbestos Co., Ltd., announced plans to drive an adit to open up and sample an asbestos deposit found by diamond drilling on its property in Dorchester County, Eastern Townships district, Quebec. Estimates were over 10-million tons of 4-percent-asbestos ore had been found by diamond drilling. Exploration by Quebec Asbestos Corp. uncovered a large new deposit a few miles from its old operation near East Broughton, Quebec. The work of developing the deposit and erecting a new mill was begun in 1955. The mill will be operated as Carey Canadian Mines, Ltd., a subsidiary of Philip Cary Manufacturing Co. of Cincinnati, Ohio.[29] Chibougamau Asbestos, Ltd., announced plans to develop its properties under option in the Chibougamau district of Quebec.

Mining at the Cassiar mine in northern British Columbia continued to progress satisfactorily. The company completed its first full year of production in September with a net profit of nearly $700,000. The principal construction during the year was erection of an aerial tramway begun in 1954.[30] Shipments of 15,031 short tons of fibers were reported for the year 1955, and increased production was forecast for the coming year. Construction continued on a 300-mile road from Cassiar to Stewart, British Columbia, as part of the highway program of the Provincial Government.[31]

The discovery of a large deposit of asbestos has been reported by Advocate Mines on the Burlington Peninsula on the northeastern coast of Newfoundland. Airborne geophysical surveys, followed by drilling, have indicated an ore body 2,500 feet long and 300 feet wide.

Caposite Insulations, Ltd., was formed by Cape Asbestos Co., Ltd., for manufacture of asbestos thermal-insulation materials in Canada using amosite from the South African mines. A plant was begun near Sarnia, Ontario, on the shore of Lake Huron.[32]

EUROPE

Finland.—Anthophyllite asbestos was mined at Paakkila and Maljasalmi by underground and open-pit methods. The Suomen Mineraali Oy (company) owned the mines and used the output to produce asbestos board, insulation compounds, some yarn and packings, and asbestos-cement board. A deposit of chrysotile asbestos was found in Finnish Lapland by Suomen Mineraali Oy in 1955.[33]

AFRICA

Rhodesia and Nyasaland, Federation of.—In 1955 asbestos production in Southern Rhodesia increased 32 percent in quantity and 19 percent in value over 1954 and became the principal Southern Rhodesia mining industry, surpassing gold mining by nearly £500,000.

---

[28] Northern Miner, Golden Age Reports on Asbestos Work: Vol. 41, No. 29, Oct. 13, 1955, p. 5.
[29] Northern Miner, Another Big New Asbestos Mill Slated for Eastern Townships: Vol. 40, No. 49, Feb. 24, 1955, pp. 1, 5.
[30] Northern Miner, Cassiar Asbestos Makes All Profit in Six Months: Vol. 41, No. 40, Dec. 29, 1955, p. 3.
[31] United States Embassy, Montreal, Canada, State Department Dispatch 195, May 18, 1956, pp. 5-6.
[32] South African Mining and Engineering Journal, Asbestos Firm to Manufacture in Canada: Vol. 66, No. 3275, Nov. 19, 1955, p. 439.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 3, March 1956, p. 18.

Many small mines, unable to increase the grade of ore by selective mining, were forced out of production by steadily increasing working costs.[34]

Expansion plans were announced at Wynne's mine near Filabusi[35] and the Ethel mine near Salisbury, with expectations of increased mechanization as a means of meeting rising costs.

TABLE 11.—Asbestos produced in Southern Rhodesia, 1951–55

Year	Short tons	Value	Year	Short tons	Value
1951	77,663	£5,452,108	1954	79,962	£5,922,724
1952	84,834	6,651,975	1955	105,261	7,051,831
1953	87,739	6,542,731			

Union of South Africa.—Production of amosite and crocidolite (blue asbestos) was about 10 percent greater in the Union of South Africa during 1955 than in 1954. Demands for these products increased, and exports were nearly 20 percent greater than in 1954. Production of amosite increased, but the quantity allotted to the United States decreased in spite of an increasing demand.

The adjustments and consolidation effected by the asbestos industry in the Union of South Africa in 1954 were reflected by limited expansions and considerable standardization, which had favorable effects on the production during 1955.[36]

TABLE 12.—Asbestos produced in the Union of South Africa, 1951–55, by varieties and sources, in short tons

Variety and source	1951	1952	1953	1954	1955
Amosite (Transvaal)	54,053	63,280	38,258	45,922	50,137
Chrysotile (Transvaal)	19,509	24,970	18,840	19,373	20,535
Blue (Transvaal)	15,581	20,294	16,824	15,610	13,964
Blue (Cape)	18,078	24,441	20,883	28,136	34,878
Anthophyllite (Transvaal)	147	854	12	110	185
Total	107,368	133,839	94,817	109,151	119,699

TABLE 13.—Asbestos produced in and exported from the Union of South Africa, 1951–55

Year	Production (short tons)			Exports	
	Transvaal	Cape Province	Total	Short tons	Value
1951	89,290	18,078	107,368	89,735	£5,056,143
1952	109,398	24,441	133,839	106,576	6,899,086
1953	73,934	20,883	94,817	71,791	4,158,476
1954	81,015	28,136	109,151	94,322	5,453,116
1955	84,821	34,878	119,699	114,056	6,697,352

[34] Rhodesian Mining Review: A Steady Progress and a Healthy Future: Vol. 21, No. 7, July 1956, p. 37
[35] Mining, Expansion Programme at Wynne's Mine: Vol. 20, No. 13, December 1955, p. 27.
[36] Asbestos, South African Asbestos Market Review for 1955: Vol. 37, No. 8, February 1956, p. 14.

OCEANIA

Australia.—Production of crocidolite (blue asbestos) at Wittenoom increased during 1955, but production costs remained too high for competition with African asbestos. Both the Australian and the Western Australian Governments subsidized the mining of crocidolite in 1955.[37] A review of the obstacles overcome and still facing the Australian industry was published.[38]

---

[37] Mining World and Engineering Record (London), Asbestos in Australia: Vol. 170, No. 4445, June 9, 1956, p. 280.
[38] Mining Magazine (London), Australia Asbestos: Vol. 92, No. 4, April 1955, pp. 247–249.

Barite

By Albert E. Schreck [1] and James M. Foley [2]

PRODUCTION and consumption of primary barite reached an alltime high in 1955. Oil- and gas-well drillers required over 1 million tons of ground barite for use in drilling muds. Imports of barite were greater than in any previous year.

TABLE 1.—Salient statistics of the barite and barium-chemical industries in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Barite:						
Primary:						
Produced short tons	762,403	845,579	1,012,811	920,025	[1] 926,036	1,117,704
Sold or used by producers:						
Short tons	754,204	860,669	941,825	944,212	[1] 883,283	1,111,661
Value	$5,988,729	$7,968,023	$8,797,944	$9,435,749	[1] $8,508,177	$10,696,410
Imports for consumption:						
Short tons	47,129	52,755	107,918	334,788	317,093	359,636
Value	$343,564	$419,494	$923,336	$2,514,828	[2] $2,274,834	[2] $2,181,119
Consumption short tons [3]	791,575	950,893	1,033,843	1,149,451	1,215,678	1,459,671
Ground and crushed sold by producers:						
Short tons	552,803	703,014	839,428	920,084	1,037,590	1,232,176
Value	$9,768,951	$14,590,000	$16,608,546	$20,372,002	[1] $24,219,785	$30,613,095
Barium chemicals sold by producers:						
Short tons	71,242	86,032	83,156	97,508	86,745	105,913
Value	$6,919,782	$11,656,497	$12,101,474	$13,347,359	$11,599,394	$14,473,458
Lithopone sold or used by producers:						
Short tons	127,209	102,837	61,832	52,439	44,011	42,845
Value	$13,493,141	$14,470,742	$8,475,200	$6,923,487	$5,929,789	$6,002,832

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable with previous years.
[3] Includes some witherite.

DOMESTIC PRODUCTION

The output of primary barite totaled 1.1 million short tons in 1955—the largest tonnage ever produced by the domestic industry. Arkansas remained the leading producing State; Missouri and Georgia ranked second and third, respectively. Production in these three States was considerably greater than in 1954.

Production in Arizona, Idaho, Nevada, and New Mexico decreased in 1955; however, this deficit was counterbalanced by increased production in California, Montana, South Carolina, Tennessee, and Washington.

[1] Commodity specialist.
[2] Statistical assistant.

Magnet Cove Barium Corp. planned to construct a 175-ton mill at Battle Mountain, Nev., to process barite ore from its Graystone mine and other properties in the area. It was estimated that 30 persons would be employed at the mill when completed.[3]

TABLE 2.—Domestic barite sold or used by producers in the United States, 1946–50 (average) and 1951–55, by States

State	1946-50 (average)		1951		1952	
	Short tons	Value	Short tons	Value	Short tons	Value
Arkansas [1]	346,665	$2,626,191	407,085	$3,765,536	428,522	$3,963,828
Georgia, South Carolina, Tennessee	84,339	838,390	73,117	841,440	97,540	1,162,249
Missouri	248,033	2,081,925	281,895	2,697,200	304,080	2,919,795
Nevada	48,017	286,181	63,201	387,026	68,062	391,242
Other States [3]	27,150	156,042	35,371	276,821	43,621	360,830
Total	754,204	5,988,729	860,669	7,968,023	941,825	8,797,944

State	1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
Arkansas [1]	380,763	$3,945,583	370,621	$3,488,483	462,986	$3,755,094
Georgia, South Carolina, Tennessee	81,846	1,066,368	75,492	1,062,016	130,396	1,829,141
Missouri	330,763	3,338,395	312,791	3,047,436	363,692	4,003,842
Nevada	99,525	614,686	83,833	517,492	[2] 113,694	[2] 708,804
Other States [3]	51,315	470,717	[4] 40,546	[4] 392,750	40,893	[2] 399,529
Total	944,212	9,435,749	[4] 883,283	[4] 8,508,177	1,111,661	10,696,410

[1] Value partly estimated.
[2] Estimated.
[3] Includes Arizona (1946–55), California (1946, 1948–55), Idaho (1949–55), Montana (1951–55), New Mexico (1949–55), and Washington (1953 and 1955).
[4] Revised figure.

Westvaco Mineral Products Division of Food Machinery & Chemical Corp. leased a large barite deposit near Battle Mountain, Nev., from the Glidden Co., Cleveland, Ohio.[4] The ore will be shipped to the firm's barium-chemical plant at Modesto, Calif.

Sherwin Williams Co. of Cleveland, Ohio, began constructing a new barium carbonate plant at Coffeyville, Kans., to be operated in conjunction with an already existing lithopone plant of the firm.[5] It was reported that initial production would be about 7,500 tons of barium carbonate per year, but an increase in production was expected in future. Some of the carbonate produced was to be converted to barium citrate by the firm itself, and the remainder was to be offered to brick, ceramic, glass, and other consumers of barium chemicals.

Emery D. and Allen E. Strode of Mack, Colo., reported discovery of a deposit of high-grade barite on the Dolores River near Gateway, Colo.[6] A small tonnage of barite was reportedly shipped from this deposit to the Great Western Sugar Co. plant at Johnstown.

Occasionally small quantities of barium metal are produced by Kemet Laboratories Co., Cleveland, Ohio, and King Laboratories, Inc., Syracuse, N. Y.

[3] Engineering and Mining Journal, vol. 156, No. 7, July 1955, pp. 146, 148.
[4] Western Mining and Industrial News, vol. 23, No. 4, April 1955, p. 17.
[5] Oil, Paint and Drug Reporter, vol. 168, No. 16, Oct. 17, 1955, p. 3.
[6] Engineering and Mining Journal, vol. 156, No. 7, July 1955, p. 138.

TABLE 3.—Ground (and crushed) barite produced and sold by producers in the United States, 1946–50 (average) and 1951–55

Year	Plants	Production (short tons)	Sales	
			Short tons	Value
1946–50 (average)	24	553,950	552,803	$9,768,951
1951	24	704,709	703,014	14,590,000
1952	24	839,457	839,428	16,608,546
1953	29	924,392	920,084	20,372,002
1954	29	1,038,649	1,037,590	[1] 24,219,785
1955	29	1,314,810	1,232,176	30,613,095

[1] Revised figure.

CONSUMPTION AND USES

Nearly 1.5 million tons of crude barite was consumed in the United States in 1955; more than 85 percent was used in manufacturing ground barite. The remainder went into the manufacture of barium chemicals and lithopone.

Oil- and gas-well drillers, who use barite as a weighting agent in drilling muds, consumed 93 percent of the ground barite sold. More ground barite was used for this purpose in 1955 than in any other year on record. Consumption of ground barite by the glass, paint, and rubber industries increased slightly over 1954.

Although the quantity of crude barite used in manufacturing lithopone increased approximately 10,000 tons compared with 1954, the overall sales of lithopone continued to decline. The paint industry (the largest user of lithopone) in 1955 consumed less than half the amount it was consuming in 1951. The decline was due primarily to increased competition from titanium dioxide as a white pigment in paints.

The quantity of barite consumed in manufacturing barium chemicals increased some 20,000 tons over 1954 but was still below the alltime high established in 1953. Sales of barium chemicals in 1955 established a record high of 105,913 tons.

TABLE 4.—Crude barite (domestic and imported) used in the manufacture of ground barite and barium chemicals in the United States, 1946–50 (average) and 1951–55, in short tons

Year	In manufacture of—			Total	Year	In manufacture of—			Total
	Ground barite [1]	Lithopone	Barium chemicals [2]			Ground barite [1]	Lithopone	Barium chemicals [2]	
1946–50 (average)	562,462	129,377	99,736	791,575	1952	849,246	61,000	123,597	1,033,843
1951	711,531	107,094	132,268	950,893	1953	933,673	52,308	163,470	1,149,451
					1954	1,044,094	35,866	135,718	1,215,678
					1955	1,256,361	45,898	157,412	1,459,671

[1] Includes some crushed barite.
[2] Includes some witherite.

Rubarite, a powder composed of unvulcanized rubber and barite, was used to resurface 10 of the major business-area streets in Rapid City, S. Dak. This material was mixed with asphalt and then spread to an average thickness of 1½ inches. It was reported that, on a test patch studied during the winter of 1953–54, there was 90 percent less cracking than on streets resurfaced with other materials.[7] Rubarite is a product of Rubarite, Inc., Magnet Cove, Ark., which is jointly owned by the Goodyear Tire & Rubber Co., the National Lead Co., and Bird & Son, Inc.

TABLE 5.—Ground (and crushed) barite sold by producers, 1946–50 (average) and 1951–55, by consuming industries

Industry	1946–50 (average)		1951		1952		1953		1954		1955	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Well drilling	476,661	85	594,668	85	758,240	90	824,050	90	968,429	94	1,142,309	93
Glass	26,562	5	25,779	4	24,604	3	24,853	3	23,208	2	28,737	2
Paint	25,000	5	28,000	4	25,000	3	24,000	2	22,000	2	25,633	2
Rubber	17,600	3	15,000	2	18,000	2	21,000	2	20,000	2	25,104	2
Concrete aggregates	3,157	1	38,143	5	12,000	2	25,000	3	(1)	(1)	(1,2)	(1,2)
Undistributed	3,823	1	1,424	(2)	1,584	(2)	1,181	(2)	3,953	(2)	10,393	1
Total	552,803	100	703,014	100	839,428	100	920,084	100	1,037,590	100	1,232,176	100

1 Included with "Undistributed."
2 Less than 1 percent.

TABLE 6.—Lithopone sold or used by producers in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Plants	8	6	5	5	5	4
Short tons	127,209	102,837	61,832	52,439	44,011	42,845
Value	$13,493,141	$14,470,742	$8,475,200	$6,923,487	$5,929,789	$6,002,832

TABLE 7.—Distribution of lithopone shipments, 1946–50 (average) and 1951–55, by consuming industries

Industry	1946–50 (average)		1951		1952		1953		1954		1955	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Paints, varnishes, and lacquers	1 99,375	78	76,614	75	45,267	73	37,452	72	32,177	73	30,522	71
Floor coverings	15,944	13	4,620	4	3,009	5	2,575	5	2,351	9	2,378	6
Coated fabrics and textiles			4,814	5	5,698	9	5,806	11	3,995	5	4,242	10
Paper	(2)	(2)	6,462	6	3,089	5	2,096	4	1,841	4	1,970	4
Rubber	3,244	3	3,295	3	1,523	3	1,723	3	1,701	4	2,163	5
Other	8,646	6	7,032	7	3,246	5	2,787	5	1,946	5	1,570	4
Total	127,209	100	102,837	100	61,832	100	52,439	100	44,011	100	42,845	100

1 Includes a quantity, not separable, used for printing ink.
2 Included with "Other."

7 Rock Products, vol. 58, No. 2, February 1955, p. 27.

TABLE 8.—Barium chemicals produced and used or sold by producers in the United States, 1946–50 (average) and 1951–55, 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]					
1946–50 (average)	15	143, 512	143, 089	391	$23, 951
1951	12	152, 792	150, 434	455	28, 361
1952	12	121, 061	120, 562	649	42, 475
1953	11	138, 980	137, 801	1, 126	81, 647
1954	11	116, 246	112, 863	1, 020	73, 902
1955	9	135, 455	134, 202	1, 943	165, 502
Carbonate (synthetic):					
1946–50 (average)	5	43, 804	16, 413	27, 689	1, 933, 890
1951	4	60, 181	18, 541	40, 568	3, 322, 276
1952	4	57, 935	21, 591	37, 214	3, 175, 080
1953	4	74, 122	26, 116	46, 846	4, 223, 525
1954	4	65, 319	29, 150	43, 325	3, 985, 674
1955	4	78, 946	31, 938	53, 274	5, 021, 001
Chloride (100 percent $BaCl_2$):					
1946–50 (average)	3	12, 881	3, 391	9, 248	943, 957
1951	4	17, 959	4, 911	12, 364	1, 830, 070
1952	4	14, 157	3, 979	10, 409	1, 407, 986
1953	4	14, 838	2, 186	12, 303	1, 703, 796
1954	3	12, 167	45	10, 733	1, 407, 811
1955	3	14, 668	120	12, 343	1, 672, 662
Hydroxide:					
1946–50 (average)	4	5, 121	293	4, 777	830, 383
1951	5	13, 483	231	12, 757	3, 185, 405
1952	5	11, 759	585	10, 848	2, 211, 998
1953	5	12, 454	304	11, 843	2, 258, 279
1954	5	12, 616	326	11, 697	2, 200, 510
1955	4	15, 540	74	16, 150	3, 174, 167
Oxide:					
1946–50 (average)	3	6, 999	6, 068	922	190, 314
1951	3	9, 347	6, 334	3, 073	729, 379
1952	3	9, 843	6, 081	3, 818	907, 762
1953	3	14, 578	7, 604	6, 820	1, 678, 969
1954	3	15, 195	7, 035	7, 400	1, 853, 449
1955	3	16, 509	8, 102	8, 722	2, 128, 911
Sulfate (synthetic):					
1946–50 (average)	7	23, 052	6, 600	16, 612	1, 435, 440
1951	6	14, 237		13, 426	1, 448, 628
1952	7	13, 035		13, 274	1, 492, 324
1953	7	14, 390		13, 448	1, 653, 507
1954	6	10, 495		10, 486	1, 356, 346
1955	5	10, 722	367	9, 976	1, 347, 248
Other barium chemicals:[5]					
1946–50 (average)	6	14, 765	3, 637	11, 603	1, 561, 847
1951	(6)	6, 999	2, 545	3, 389	1, 112. 378
1952	(6)	8, 893	1, 669	6, 944	2, 863, 849
1953	(6)	7, 822	1, 762	5, 122	1, 747, 636
1954	(6)	2, 660	722	2, 084	721, 702
1955	(6)	2, 396	176	3, 505	963, 967
Total:[7]					
1946–50 (average)	20			71, 242	6, 919, 782
1951	18			86, 632	11, 656, 497
1952	19			83, 156	12, 101, 474
1953	18			97, 508	13, 347, 359
1954	17			86, 745	11, 599, 394
1955	16			105, 913	14, 473, 458

[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] Includes barium acetate, chromate, nitrate, perchlorate, peroxide, and sulfide. Specific chemicals may not be revealed by specific years.
[6] Plants included in above figures.
[7] A plant producing more than 1 product is counted but once in arriving at grand total.

Barium metal was used as a getter to remove the last traces of gases from vacuum tubes to improve the vacuum and increase the efficiency of the tube.

PRICES

E&MJ Metal and Mineral Markets quoted the following prices on barite in 1955: Barytes—f. o. b. cars: Georgia, crude, jig and lump, $15 per net ton; beneficiated, $17–$19 per net ton, in bulk, $21.50 in bags, prices remained unchanged throughout the year. Missouri: per ton, water ground and floated, bleached, $41.35, carlots, f. o. b. works. Crude ore, minimum 94 percent $BaSO_4$, less than one percent iron, $13.25 per short ton and increased to $14.25 per short ton by the end of the year.

Barium metal prices were not quoted in the trade journals.

Prices of barium chemicals remained relatively stable throughout most of 1955. In the latter part of the year the price of the carbonate, chloride, nitrate, hydrate, oxide, and peroxide were increased. Price ranges of various barium chemicals in 1955 are given in the following table.

TABLE 9.—Range of quotations on barium chemicals in 1955

[Oil, Paint and Drug Reporter]

Barium carbonate, precipitated, bags, carlots, works ... short ton	$92.50–$100.00
Barium chlorate, kegs, works ... pound	.32– .36
Barium chloride, anhydrous, bags, carlots, works ... short ton	158.00– 165.00
Barium chromate, bags, freight equaled ... pound	.35
Barium dioxide (peroxide), drums, freight equaled ... do	.20
Barium hydrate, crystals, bags, carlots, ton lots, freight equaled ... short ton	180.00– 200.00
Barium nitrate, barrels, carlots, ton lots, delivered ... pound	.16
Barium oxide, ground, drums, carlots, freight equaled ... short ton	255.00– 275.00
Blanc fixe (dry):	
Direct process, bags, carlots, works ... do	100.00– 110.00
Byproduct, bags, carlots, works ... do	190.00
Lithopone:	
Ordinary, bags, carlots, delivered ... pound	.07½
Less carlots, same basis ... do	.08¼– .08½
Titanated (high-strength), bags, carlots, delivered ... do	.10
Smaller lots ... do	.11

FOREIGN TRADE[8]

Imports of crude barite into the United States in 1955 were greater than in any previous year. Imports of barite from Brazil and Yugoslavia in 1955 decreased, while imports from Canada and Mexico increased.

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

TABLE 10.—Barite imported for consumption in the United States, 1952–55, by countries

[U. S. Department of Commerce]

	1952		1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Crude barite:								
North America:								
Canada	67, 854	$571, 196	204, 362	$1, 652, 076	165, 612	$1, 177, 616	187, 355	$1, 364, 285
Mexico	12, 188	97, 347	63, 450	344, 211	43, 750	130, 384	108, 240	329, 335
Total	80, 042	668, 543	267, 812	1, 996, 287	209, 362	1, 308, 000	295, 595	1, 693, 620
South America: Brazil	3, 180	14, 425	6, 365	42, 031	6, 184	35, 461	4, 960	22, 500
Europe:								
Italy			9, 830	52, 989	5, 600	37, 000		
Yugoslavia	24, 696	240, 368	50, 781	423, 521	95, 947	894, 373	59, 081	464, 999
Total	24, 696	240, 368	60, 611	476, 510	101, 547	931, 373	59, 081	464, 999
Grand total	107, 918	923, 336	334, 788	2, 514, 828	317, 093	[1] 2, 274, 834	359, 636	[1] 2, 181, 119
Ground barite:								
North America: Canada	6, 440	112, 265						
Europe:								
Germany, West			40	1, 368	63	2, 346	45	1, 614
Italy	1	25	23	434			18	509
Total	1	25	63	1, 802	63	2, 346	63	2, 123
Africa: Algeria	179	5, 900	196	6, 295	189	6, 351	232	7, 839
Grand total	6, 620	118, 190	259	8, 097	252	8, 697	295	9, 962

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to years prior to 1954.

TABLE 11.—Barium chemicals imported for consumption in the United States 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Lithopone		Blanc fixe (precipitated barium sulfate)		Barium chloride		Barium hydroxide	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	243	$36, 266	11	$1, 246	2	$2		
1951	794	151, 165	12	1, 616	856	99, 453	279	$55, 344
1952	11	2, 308	32	6, 481	84	11, 065	193	46, 979
1953	30	5, 658	1, 005	57, 346	50	4, 567	22	3, 018
1954	65	7, 029	788	64, 026	811	58, 238	51	7, 283
1955	30	4, 355	901	91, 341	994	[1] 75, 069	15	2, 431

Year	Barium nitrate		Barium carbonate precipitated		Other barium compounds	
	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	88	$11, 181	57	$5, 644	13	$4, 601
1951	368	62, 277	794	72, 977	32	12, 503
1952	456	80, 654	499	30, 427	82	36, 944
1953	235	36, 433	4, 219	297, 187	513	103, 100
1954	164	24, 516	325	26, 402	1, 344	265, 472
1955	77	14, 906	1, 638	105, 240	841	[1] 170, 345

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.

457676—58——14

TABLE 12.—Lithopone exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1946–50 (average)	[1] 13,627	[1] $1,762,666	[1] $129.35	1953	3,927	$584,279	$148.79
1951	20,473	3,615,915	176.62	1954	3,013	454,461	150.83
1952	9,985	1,632,106	163.46	1955	1,892	300,960	159.07

[1] Includes zinc sulfide.

Witherite imports (all from the United Kingdom) continued to decline.

TABLE 13.—Witherite, crude, unground, imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Short tons	Value [1]	Year	Short tons	Value [1]
1946–50 (average)	1,704	$53,383	1953	4,928	$178,846
1951	2,016	51,673	1954	4,415	153,139
1952	5,174	184,003	1955	2,363	77,867

[1] Valued at port of shipment.

TECHNOLOGY

A series of papers on barium titanate and other ceramic ferroelectrics was published.[9] The history of this field, the fundamental phenomena of ferroelectricity, literature on ferroelectricity, the crystal structure, and known electrical, electromechanical, and thermal properties were discussed.

A patent was issued on the use of barium to prevent blooming in latex paints.[10] The addition of not more than 2 grams of barium ions to 100 grams of the nonrubbery, synthetic polymer in the paint prevents blooming.

A process for producing barium oxide by mixing crushed barium sulfate and crushed iron sulfide was patented.[11] The iron sulfide is mixed in a ratio of 1 to 5 mols for each mol of barium sulfate, and the mixture is heated to between 750° and 1,100° C. Fusing of the mass is prevented by passing at least 3 parts by weight of steam for each part by weight of sulfur through the mixture at a velocity of at least 2 feet per second. This upsets conditions of equilibrium, and the sulfur is driven off with resulting formation of iron oxide and barium oxide. The barium oxide is recovered by adding water, thus removing it as barium hydroxide.

[9] McQuarrie, Malcom, Barium Titanate and Other Ceramic Ferroelectrics; I. Introduction: Bull. Am. Ceram. Soc., vol. 34, No. 6, June 1955, pp. 169–172. II. Properties of Barium Titanate: No. 7, July 1955, pp. 225–230. III. Related Materials: No. 8, August 1955, pp. 256–266. IV. Solid Solutions of Ferroelectrics: No. 9, September 1955, p. 295.

[10] Brock, Marlyn J. (assigned to Firestone Tire & Rubber Co.), Barium Compounds and Latex Paints: U. S. Patent 2,702,284, Feb. 15, 1955.

[11] de Jahn, Frederick W. (assignor of one-half to Alan N. Mann, Scarsdale, N. Y.), Process of Producing Barium Hydroxide: U. S. Patent 2,724,639, Nov. 22, 1955.

A flowsheet describing the recovery of barite from the gangue mineral by froth flotation was published.[12] The ore is passed over a grizzly with 10-inch openings and undergoes 2-stage crushing before grinding in a ball mill. After classification in a crossflow classifier and then in a hydroclassifier, the 200-mesh material overflows to an agitator and conditioner, where the necessary flotation reagents are added, and is then passed on to the flotation cells. The flotation concentrate is thickened, filtered, dried, and prepared for shipment.

WORLD REVIEW

NORTH AMERICA

Canada.—Barite deposits are widespread in Canada, but in 1955 only three were in production.

The major portion of Canada production was from the operation at Walton, Nova Scotia. This deposit was acquired during the year from Barymin Co., Ltd., by Magnet Cove Barium Corp., a subsidiary of Dresser Industries. Reserves at this operation were reported to be about 2.7 million tons. The purchase price for the property was reported to be $4,856,703; in addition, Barymin Co. will receive a royalty of $1.15 per ton on the ore mined.[13]

It was stated further in this article that the agreement called for a minimum royalty of $100,000 per year for 7 years. In 1955 the barite was mined by open-pit methods; but the quarry has reached a depth of 300 feet, and it was planned to begin underground mining in the near future.[14]

Mountain Minerals, Ltd., continued to operate its Brisco and Parsons properties in British Columbia and its grinding plant at Lethbridge, Alberta. It was reported that all production in 1955 came from the Brisco operation. Ore ground at the Lethbridge plant was used in drilling muds.

Giant Mascot Mines, a silver-lead and zinc producer at Spillimacheen, British Columbia, reportedly was negotiating with a large American firm to market the barite, which occurs as a gangue mineral in the silver-lead-zinc ore. Pilot-plant tests of the tailings are said to have resulted in recovery of a 98-percent $BaSO_4$ product. The rate of production is expected to be 150 tons a day. The barite will be used in manufacturing drilling muds for well drillers in the Alberta oil fields. Installation of equipment to recover the barite will be financed jointly by both firms.[15]

Investigation of the barite property on McKellar Island, in Lake Superior near Port Arthur, the barite-fluorspar deposit in the Lake Ainslie area of Nova Scotia, and the witherite deposit at Laird River Crossing, British Columbia, was continued.

It was estimated that 10,000 tons of barite was consumed in drilling muds and 2,500 tons for other uses in Canada during 1955.[16]

[12] Deco Trefoil, Flowsheet Study of Barite: July–August 1955, pp. 17–18.
[13] Northern Miner, vol. 41, No. 29, Oct. 13, 1955, pp. 17–18.
[14] Department of Mines and Technical Surveys, Ottawa, Barite in Canada, 1955 (Preliminary): 5 pp.
[15] Northern Miner, vol. 40, No. 50, Mar. 3, 1955, pp. 25, 29.
[16] Department of Mines and Technical Surveys, Ottawa, Barite in Canada, 1955 (Preliminary): 5 pp.

TABLE 14.—World production of barite, by countries,[1] 1946–50 (average) and 1951–55 in short tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	93,831	98,113	136,002	247,227	221,472	202,600
Cuba (exports)	72			4,904		
Mexico (exports)	[3] 2,892	1,542	12,421	63,042	56,871	117,654
United States	762,403	845,579	1,012,811	920,025	926,036	1,117,704
Total	859,198	945,234	1,161,234	1,235,198	1,204,379	1,437,958
South America:						
Argentina	19,272	11,023	17,637	[4] 14,000	22,046	[4] 22,000
Brazil	10,398	55	[5] 7,605	[5] 15,863	[5] 6,272	[5] 5,071
Chile	2,469	1,179	2,464	1,556	[4] 2,200	[4] 2,200
Colombia	[4] 5,300	2,240	4,480	8,543	9,921	6,614
Peru	5,493	25,370	10,035	17,129	12,348	9,410
Total	[4] 43,000	39,867	42,221	[4] 57,000	[4] 53,000	[4] 45,000
Europe:						
Austria	5,507	10,632	5,688	2,116	4,802	4,365
France	45,011	43,535	47,025	43,869	48,061	60,627
Germany:						
East [4]	11,700	22,000	22,000	27,600	27,600	27,600
West	[6] 134,950	428,618	314,513	334,422	414,542	449,052
Greece	16,559	32,407	23,897	28,064	24,251	21,451
Ireland	9,769	9,081	2,008			
Italy	58,989	84,372	62,031	76,411	79,254	103,819
Portugal	543	793	685	347	385	313
Spain	13,454	13,723	17,491	19,727	11,984	9,882
Sweden	1,038	165			108	
U. S. S. R.[4]	94,000	110,000	110,000	110,000	110,000	110,000
United Kingdom [7]	121,268	97,909	78,563	77,175	81,967	92,181
Yugoslavia	20,905	27,362	38,381	89,457	114,640	109,129
Total [1 4]	538,000	890,000	730,000	815,000	920,000	990,000
Asia:						
India	24,556	11,727	11,234	10,528	21,048	[4] 22,000
Japan	6,387	18,415	15,687	19,350	20,815	13,342
Korea, Republic of			874	1,012	336	933
Total [1 4]	38,700	41,000	39,000	42,000	53,000	53,000
Africa:						
Algeria	20,806	23,172	10,852	14,154	14,961	33,720
Egypt	44	45	33	33	35	67
French Morocco	[3] 2,609	3,589	3,429	55	10,246	27,170
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	218	93	299	268		
Swaziland	229	525	445	455	362	449
Tunisia	389	11	28			
Union of South Africa	2,474	2,247	1,894	2,092	2,342	1,892
Total	26,769	29,682	16,980	17,057	27,946	63,298
Oceania: Australia	6,310	6,919	5,537	6,358	7,696	7,016
World total (estimate) [1]	1,511,000	2,000,000	2,000,000	2,200,000	2,300,000	2,600,000

[1] In addition to countries listed, barite is produced in China, Czechoslovakia, and North Korea, but data on 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 Barite chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[3] Average for 1949–50.
[4] Estimate.
[5] Exports.
[6] Beginning in 1950 marketable production is shown.
[7] Includes witherite.

EUROPE

Yugoslavia.—Barite was reported being mined near Skoflica and Litija in the republic of Slovenia near Ridice and in the vicinity of Kresevo in Bosnia; late in 1953 a new mine was opened near Plevlje in Northern Montenegro. A barite deposit near Lokve in Croatia was reported to have a $BaSO_4$ content ranging between 92 and 98 percent.[17]

ASIA

Philippines.—It was reported that exploration of a copper-barite deposit in Bataugas had been started by Surigao Consolidated.

AFRICA

Rhodesia and Nyasaland, Federation of.—A large barite deposit occurs about 11 miles south of Que Que.[18] The barite occupies lenses in a series of quartz and silicified felsite terraces. Some of the material is pink due to iron staining, and patches of galena and pyrite occur occasionally in the deposit. The white barite assayed 95.18 percent and the iron-stained material 85.64 percent $BaSO_4$. Reserves were reported to be about 10,000 tons of ore within 15 feet of the outcrop.

OCEANIA

Australia.—Barite production in 1955 totaled 7,016 tons—a decrease from the 7,696 tons produced in 1954. Production in 1954 came from the States of New South Wales, Western Australia, and South Australia.[19]

The principal producing area in New South Wales in 1954 was Kempfield in the Trunkey mining division. Production also was reported from the Goulburn, Cootamundra, and Mudgee mining divisions.

The barite deposits in South Australia are northeast of Port Augusta in the Flinders Range and south of Adelaide at Noarlunga.

Barite produced in Western Australia came from Cranbrook and Chesterfield in the Murchison goldfield.

---

17 American Metal Market, vol. 62, No. 139, July 20, 1955, p. 15.
18 Rhodesian Mining Review, vol. 20, No. 5, May 1955, p. 19.
19 Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 6, June 1956, pp. 22, 23.

Bauxite

By Richard C. Wilmot,[1] Arden C. Sullivan,[2] and Mary E. Trought[3]

WORLD production of bauxite continued its upward trend to reach a new high of 16.8 million long tons in 1955. In contrast, domestic production declined to 1.8 million tons (dried equivalent), and imports declined slightly from 5.3 million tons to 5.2 million. The year represented a period of relative stability in both production and importation of bauxite. However, domestic consumption rose to a new alltime high of 7 million tons, a 9-percent increase over 1954. The alumina industry increased its relative consumption of both foreign and domestic ores slightly to 91.5 percent of the bauxite used. The ratio of domestic bauxite consumption to domestic aluminum production was 5.0, as compared with 4.9 for 1954 and 5.0 for 1953. Imports composed 74 percent of the total new supply. Jamaica shipments to the United States continued to increase in relative importance, supplying 48 percent of all imports. For the first time, imports from Jamaica exceeded those from Surinam. The exports declined to 14,117 tons of bauxite and bauxite concentrates.

On August 11, the Office of Defense Mobilization suspended the bauxite-expansion goal. Following a review of the industry, the expansion goal was closed September 29.

Six plants with a capacity of 3.5 million tons produced 3.25 million short tons of alumina and aluminum oxide products. Ninety-two percent of this production was consumed by the aluminum industry. Of the bauxite consumed 86 percent was used for the production of aluminum metal.

All expansion in alumina-plant capacity that took place in 1954 was completed by 1955. There was no significant change in capacity during the year.

TABLE 1.—Salient statistics of the bauxite industry in the United States, 1946–50 (average) and 1951–55, in long tons

	1946–50 (average)	1951	1952	1953	1954	1955
Crude-ore production (dry equivalent)	1,249,315	1,848,676	1,667,047	1,579,739	1,994,896	1,788,341
Imports (as shipped)	2,073,382	2,819,676	3,497,939	4,390,576	[1] 5,258,530	5,221,008
Exports (as shipped)	65,315	89,948	41,330	27,907	16,174	14,117
Consumption (dry equivalent)	2,636,355	3,945,667	4,228,404	5,628,276	6,427,785	6,984,098
World production	6,950,000	[1] 10,700,000	[1] 12,600,000	[1] 14,100,000	15,550,000	16,750,000

[1] Revised figure.

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

DOMESTIC PRODUCTION

Production of crude bauxite in the United States during 1955 totaled 1.8 million long dried tons, a 10-percent decline from the peacetime high of 2.0 million tons attained in 1954. The 1955 production represented 26 percent of the new supply, which is obtained by adding domestic production to imports. Shipments from mines and processing plants to consumers decreased 2 percent from those of the previous year. The dried-bauxite equivalent of the processed bauxite recovered decreased 6 percent from the previous year to 151,333 tons.

Bauxite production in Alabama and Georgia increased 47 percent to 67,098 long tons, dried-equivalent basis. The Aluminum Company of America and the D. M. Wilson Bauxite Co. operated mines in Barbour County, Ala. Alcoa dried its crude output at its plant nearby, while the D. M. Wilson Bauxite Co. shipped its production in crude form. During the latter part of the year Alcoa sold its mine and plant to R. E. Wilson Mining Co., which continued to operate it on the same basis. The American Cyanamid Co., operating mines in Bartow, Floyd, and Macon Counties, was the sole producer in Georgia. The crude ore was dried at the Halls Station plant and used in producing chemicals.

Arkansas production decreased 12 percent from the previous year and supplied 96 percent of the total domestic output. Ninety percent of the ore was mined in Saline County; the balance came from Pulaski County. Open-pit operation composed approximately 91 percent of the Arkansas production.

The Reynolds Mining Co. was the largest producer of bauxite in Arkansas in 1955, followed by the Aluminum Company of America. Both companies mined in Saline County and shipped crude ore for alumina production. The American Cyanamid Co. operated the Heckler and Lewis mines in Pulaski County and the Quapaw mine in Saline County. Ore was also shipped from the stocks of three of its other mines. The total output was sent to the company mill in Pulaski County for drying before use in the chemical market.

The Confederate Home pit and the Dixon pit in Pulaski County and the Anderson mine and the 400 B. C. mine in Saline County were operated by the Dulin Bauxite Co. Its Illing shaft mine was reported depleted. Part of the production was dried at its mill in Pulaski County, and the balance was sold as crude. Dickinson McGeorge, Inc., operated the Townsend mine in Saline County, and the product was shipped crude. The Norton Co. mined in Saline County, and part of its production was calcined. Consolidated Chemical Industries, Inc., operated its Penzil mine in Pulaski County. The product was dried at its Peiser Spur plant. The Campbell Bauxite Co., in Pulaski County, prepared crude ore largely from its stockpile for use as dried and activated bauxite. The Porcel Corp. produced activated bauxite from its plant in Pulaski County.

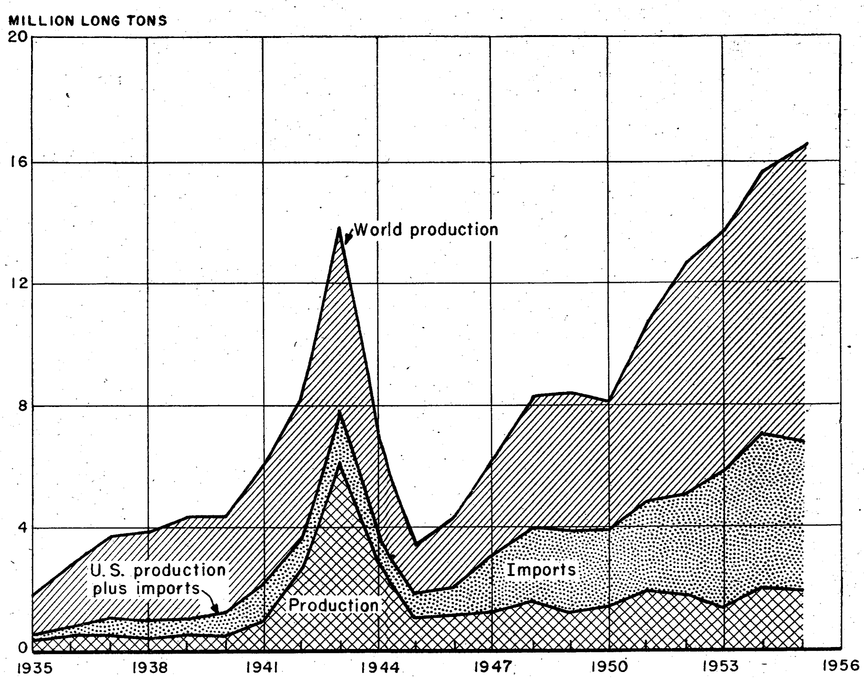

FIGURE 1.—United States supply and world production of bauxite, 1935–55.

TABLE 2.—Mine production of bauxite in the United States, 1951–55, by quarter years, in long tons [1]

(Dried-bauxite equivalent)

Quarter ended—	1951	1952	1953	1954	1955
March 31	378, 031	426, 269	378, 806	399, 300	486, 743
June 30	502, 088	458, 612	411, 070	367, 750	474, 147
September 30	453, 564	312, 370	387, 054	686, 323	402, 440
December 31	514, 993	469, 796	402, 809	541, 523	425, 011
Total	1, 848, 676	1, 667, 047	1, 579, 739	1, 994, 896	1, 788, 341

[1] Quarterly figures adjusted to final annual totals.

TABLE 3.—Mine production of bauxite and shipments from mines and processing plants to consumers in the United States, 1951–55, 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 and Georgia:						
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
1953	61,186	49,763	463,149	59,985	56,085	580,471
1954	56,431	45,528	409,501	58,446	55,050	705,950
1955	89,447	67,098	516,448	72,952	67,141	713,906
Arkansas:						
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
1953	1,802,797	1,529,976	12,975,992	1,889,206	1,689,207	15,042,236
1954	2,296,528	1,949,368	15,993,887	1,978,216	1,711,386	15,239,244
1955	2,049,623	1,721,243	14,026,190	1,938,811	1,660,263	14,844,798
Total United States:						
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
1953	1,863,983	1,579,739	13,439,141	1,949,191	1,745,292	15,622,707
1954	2,352,959	1,994,896	16,403,388	2,036,662	1,766,436	15,945,194
1955	2,139,070	1,788,341	14,542,638	2,011,763	1,727,404	15,558,704

[1] Computed from selling price and values assigned by producers.

TABLE 4.—Recovery of processed bauxite in the United States, 1946–50 (average) and 1951–55, in long tons

Year	Crude ore treated	Processed bauxite recovered			
		Dried	Calcined or activated	Total	
				As recovered	Dried-bauxite equivalent
1946–50 (average)	661,780	445,209	80,338	525,547	568,898
1951	1,059,645	756,060	103,588	859,648	914,433
1952	576,430	397,067	56,191	453,258	481,705
1953	200,970	100,632	34,288	134,920	155,248
1954	201,894	125,511	24,686	150,197	161,638
1955	199,313	114,863	23,166	138,029	151,333

CONSUMPTION AND USES

Domestic consumption of bauxite in 1955 increased 9 percent over that of 1954 to 7 million long dry tons. The relative proportion of domestic ore used to the total ore consumed was 27.4 percent, virtually the same as the 1954 and 1953 figures (27.1 percent). The tonnage of bauxite consumed in products other than alumina was approximately the same in 1955 as it was in 1954.

The silica content of the domestic ore shipped in 1955 was estimated at less than 8 percent in 12 percent of the ore, at 8 to 15 percent in 66 percent of the ore, and at over 15 percent in 22 percent of the ore.

The combination process in which the red-mud tailings from the standard Bayer leach was sintered with limestone and soda ash and then leached was essential for economic treatment of the high-silica ores.

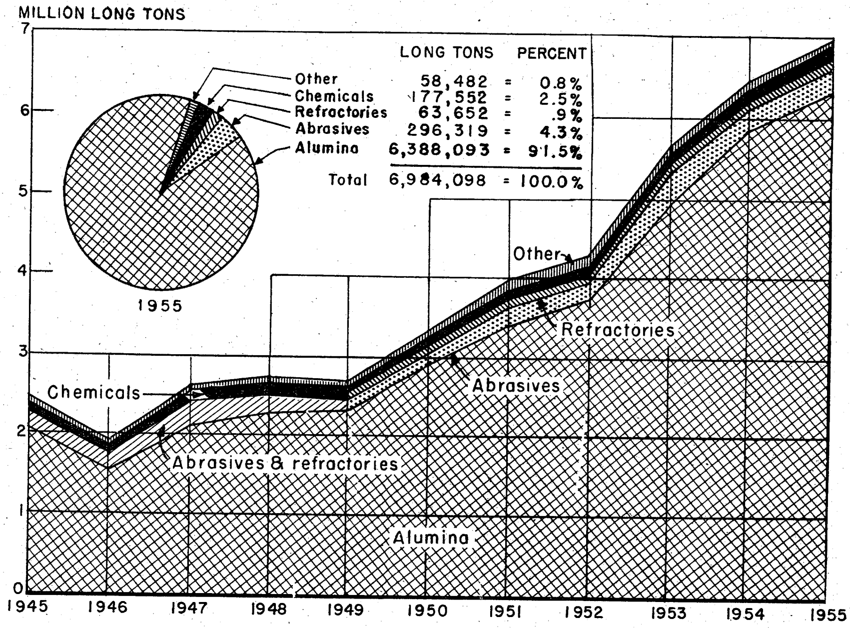

FIGURE 2.—Domestic consumption of bauxite by uses, 1945–55.

TABLE 5.—Bauxite consumed in the United States, 1954–55, by industries, in long tons

(Dried-bauxite equivalent)

Industry	Domestic	Percent	Foreign	Percent	Total	Percent
1954						
Alumina	1,594,633	91.4	4,250,305	90.8	5,844,938	90.9
Abrasive [1]	16,047	.9	309,132	6.6	325,179	5.1
Chemical	74,355	4.3	85,963	1.8	160,318	2.5
Refractory	11,750	.7	34,036	.7	45,786	.7
Others	47,893	2.7	3,671	.1	51,564	.8
Total [1]	1,744,678	100.0	4,683,107	100.0	6,427,785	100.0
Percent	27.1		72.9		100.0	
1955						
Alumina	1,741,576	91.1	4,646,517	91.6	6,388,093	91.5
Abrasive [1]	18,843	1.0	277,476	5.5	296,319	4.3
Chemical	84,055	4.4	93,497	1.8	177,552	2.5
Refractory	14,285	.7	49,367	1.0	63,652	.9
Others	53,735	2.8	4,747	.1	58,482	.8
Total [1]	1,912,494	100.0	5,071,604	100.0	6,984,098	100.0
Percent	27.4		72.6		100.0	

[1] Includes consumption by Canadian abrasives industry.

Six domestic alumina plants were operated by the aluminum producers. Their combined rated annual capacity was 3.5 million short tons of alumina; and their production, calculated on the basis of calcined equivalent of alumina, was 3,197,383 short tons or 91 percent of capacity. The actual tonnage produced of calcined alumina and aluminum oxide products was 3,251,257 short tons. Of this production, 93 percent was shipped to aluminum-reduction plants and 7

TABLE 6.—Consumption of crude and processed bauxite in the United States by grades, 1955, in long tons

(Dried-bauxite equivalent)

	Domestic origin	Foreign origin	Total	Percent
Crude	1,736,985	6,613	1,743,598	25.0
Dried	139,091	4,747,562	4,886,653	70.0
Calcined	24,982	317,429	342,411	4.9
Activated	11,436		11,436	.1
Total	1,912,494	5,071,604	6,984,098	100.0
Percent	27.4	72.6	100.0	

percent as commercial trihydrate or as activated, calcined, or tabular alumina for use primarily by the abrasive, ceramic and refractory, and chemical industries.

Compared with 1954, calcined-alumina production increased 7 percent to 3,065,494 short tons. The production of the other forms of alumina increased 6 percent to 185,763 short tons.

Since the plants were operating only slightly below capacity, any large expansion of metal production would require an equivalent increase in the size of the alumina plants. In December, Kaiser Aluminum & Chemical Corp. announced its intention of building a new plant at Gramercy, La., capable of producing 438,000 tons of calcined alumina per year. It was anticipated that production would begin late in 1957.

TABLE 7.—Alumina plants in operation in the United States, 1955

Company and plant	Capacity (short tons per year)	Percent
Aluminum Company of America:		
Mobile, Ala	876,000	25.0
East St. Louis, Ill	328,500	9.4
Bauxite, Ark	401,500	11.5
Total	1,606,000	45.9
Reynolds Metals Co.:		
Hurricane Creek, Ark	730,000	20.9
La Quinta, Tex	365,000	10.4
Total	1,095,000	31.3
Kaiser Aluminum & Chemical Corp.:		
Baton Rouge, La	800,000	22.8
Grand total	3,501,000	100.0

The 17 reduction plants, including the Columbia Falls, Mont., plant of the Anaconda Aluminum Co., which came into production in August, consumed 2,992,782 short tons of calcined alumina in 1955, an increase of 7 percent over 1954.

Calculations indicated that an average of 2.00 long dry tons of bauxite was necessary to produce 1 short ton of calcined alumina and an average of 1.91 short tons of alumina was required to produce 1 short ton of metal. The overall ratio was 3.82 long dry tons of bauxite to produce 1 short ton of aluminum.

Data on aluminum salts are shown in table 8. Bauxite was the principal source of the aluminum salts.

TABLE 8.—Production and shipments of selected aluminum salts in the United States, 1954–55

Type of Salt	1954				
	Production (short tons)	Number of plants producing	Shipments and interplant transfers: Quantity (short tons)	Shipments and interplant transfers: Value f. o. b. plant	Consumed in producing plants (short tons)
Aluminum sulfate:					
Ammonium	(1)	2	(1)	(1)	
Potassium	(1)	2	(1)	(1)	
Sodium	(1)	1	(1)	(1)	
General:					
Commercial (17 percent Al_2O_3)	724,923	40	707,064	$24,993,000	14,908
Municipal (17 percent Al_2O_3)	15,003	7			15,003
Iron-free (17 percent Al_2O_3)	23,745	9	23,100	1,633,000	
Sodium aluminate (62.2 percent Al_2O_3)	[2] 27,625	6	(1)	(1)	
Aluminum chloride:					
Liquid (32° B.) / Crystal (32° B.)	11,337	8 / 1	10,725	774,000	(1)
Anhydrous (100 percent $AlCl_3$)	36,397	9	31,639	8,790,000	(1)
Aluminum fluoride, technical	55,954	3	54,089	13,884,000	
Aluminum trihydrate (100 percent $Al_2O_3 \cdot 3H_2O$)	92,400	6	84,485	5,306,000	(1)
Other aluminum salts				[3] 12,565,000	
Total				67,945,000	

Type of Salt	1955				
	Production (short tons)	Number of plants producing	Shipments and interplant transfers: Quantity (short tons)	Shipments and interplant transfers: Value f. o. b. plant	Consumed in producing plants (short tons)
Aluminum sulfate:					
Ammonium	(1)	2	(1)	(1)	
Potassium	(1)	2	(1)	(1)	
Sodium	(1)	1	(1)	(1)	
General:					
Commercial (17 percent Al_2O_3)	851,764	43	791,205	$28,094,000	60,431
Municipal (17 percent Al_2O_3)	15,508	7			15,508
Iron-free (17 percent Al_2O_3)	25,225	9	24,687	1,694,000	
Sodium aluminate (62.2 percent Al_2O_3)	24,525	8	(1)	(1)	
Aluminum chloride:					
Liquid (32° B.) / Crystal (32° B.)	16,234	10 / 1	14,790	946,000	(1)
Anhydrous (100 percent $AlCl_3$)	36,911	9	32,238	8,901,000	(1)
Aluminum fluoride, technical	50,970	4	50,946	12,083,000	
Aluminum trihydrate (100 percent $Al_2O_3 \cdot 3H_2O$)	112,642	7	99,448	6,298,000	14,597
Other aluminum salts				[3] 11,670,000	
Total				69,686,000	

[1] Included with "Other aluminum salts."
[2] Includes an unspecified amount produced and consumed but previously not reported.
[3] Includes cryolite, sodium-aluminum sulfate, sodium aluminate, potassium-aluminum sulfate, ammonium-aluminum sulfate, aluminum hydroxide, and other aluminum compounds.

Source: 1954 figures based on Bureau of the Census, 1954 Census of Manufactures.
1955 figures based on Bureau of the Census, MA-19E reports, Annual Report on Shipments and Production of Inorganic Chemicals and Gases.

STOCKS

On December 31, 1955, the equivalent of 5 million long dry tons of bauxite was held as stocks in the United States. This was a decrease of less than 1 percent from 1954. Consumers' inventories decreased 2 percent, while those at mines and processing plants increased 7 percent. There was 1 withdrawal of 56,718 crude tons from the Government-held Nonstrategic Stockpile in Arkansas.

Metal- and Refractory-grade bauxite remained on the Group I list of strategic materials for the National Stockpile. Abrasive-grade ore was in Group II.

During the latter half of 1955 the Emergency Procurement Service completed contract arrangements to import a considerable quantity of bauxite from Jamaica to obtain a more balanced stockpile of raw material for the domestic aluminum industry if normal imports should be curtailed in an emergency. The stockpile position for Surinam-type bauxite had been satisfactory for some time; but this material, while consumed by a large part of the alumina industry, could not be used as efficiently as Jamaican ore in the facilities designed.

TABLE 9.—Stocks of bauxite in the United States December 31, 1951–55, 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
1951	890,336	18,552	44,169	1,008,767	2,630,792	4,592,616	4,069,796
1952	755,536	35,440	473,850	1,518,641	2,454,584	5,238,051	4,680,615
1953	759,165	44,097	697,653	1,405,587	2,261,392	5,167,894	[3] 4,623,552
1954	964,162	5,810	762,944	1,637,920	2,261,392	5,632,228	5,041,936
1955	1,042,832	4,979	637,508	1,705,298	2,204,674	5,595,291	5,010,656

[1] Excludes National Stockpile.
[2] Dried, calcined, and activated.
[3] Revised figure.

PRICES

Most bauxite mined in the United States was produced by companies for their own use, and only a small part of the output was sold to consumers on a contract basis at a negotiated price. Therefore, no open-market price for bauxite existed. The average values of bauxite produced and shipped in the United States in 1955, as shown in table 10, were calculated from reports to the Bureau of Mines by the several producers of bauxite. These values were determined from the approximate commercial value of the shipments and interplant transfers of crude and processed bauxite as assigned by the producers.

According to the 1955 reports, the average values of bauxite as shipped and delivered to the six domestic alumina plants were $9.03 per long ton for domestic ore and $13.99 per long ton for imported ore.

Table 11 summarizes the market quotations on bauxite in the United States as published in the E&MJ Metal and Mineral Markets. There was no change from the prices quoted in 1954.

Crude-ore equivalent to 48,210 long dry tons was sold from the Government Nonstrategic Stockpile at $7.81 per ton. The ore analyzed Al_2O_3, 51.9 percent; SiO_2, 11.0 percent; FeO, 2.5 percent.

TABLE 10.—Average value of bauxite produced and shipped in the United States, 1955

Type	Average value per long ton	
	As produced at mines or plants	Shipments f. o. b. mines or plants
Crude (undried)	$6.80	$7.00
Dried	9.65	9.65
Calcined	19.60	19.60
Activated	75.00	75.00

TABLE 11.—Market quotations on bauxite in the United States in 1955

[E&MJ Metal and Mineral Markets]

Type of ore	Al_2O_3, percent	Price
Domestic (per long ton):		
Crude [1]	50–52	$5.00–$5.50
Chemical, crushed, and dried [2]	[3] 55–58	8.00– 8.50
Other grades [1]	[4] 56–59	8.00– 8.50
Pulverized and dried [1]	[5] 56–69	14.00–16.00
Abrasive grade, crushed and calcined [1]	80–84	17.00
Imported (per long ton):		
Calcined, crushed (abrasive grade) [6]	83–86	19.75
Refractory grade	-----------	24.20

[1] F. o. b. Arkansas mines.
[2] F. o. b. Alabama and Arkansas mines.
[3] 1.5 to 2.5 percent Fe_2O_3.
[4] 5 to 8 percent SiO_2.
[5] 8 to 12 percent SiO_2.
[6] F. o. b. port of shipment, British Guiana.

The average values of bauxite imported into the United States changed little from 1954. Exports from the United States had an average value of $37.39 as compared with $41.21 for 1954.

The following market-price quotations for alumina and aluminum compounds were published in Oil, Paint and Drug Reporter for December 26, 1955:

Alumina, calcined, bags, carlots, works	per pound	$0.0425
Aluminum hydrate, heavy, bags, carlots, freight equalized	per pound	.0295
Aluminum hydrate, light, bags, delivered	per pound	.18
Aluminum sulfate, commercial-bulk, carlots, works	per 100 pounds	1.85
Aluminum sulfate, iron-free, bags, carlots, works, freight equalized	per 100 pounds	3.55

The September 19, 1955, issue of the periodical showed a rise in the price of calcined alumina and light hydrate from their 1954 prices of $0.0385 and $0.17 per pound, respectively. The price of heavy hydrate varied considerably, starting the year at $0.028 per pound and rising to $0.0305 per pound and then dropping to $0.0285 per pound on February 14. Its price remained unchanged until September 19, when it increased to $0.0295. The price of aluminum sulfate and iron-free aluminum sulfate remained constant throughout the year.

TABLE 12.—Average value of bauxite imported in the United States, 1955, in long tons

[U.S. Department of Commerce]

Type and country:	*Average value, port of shipment*
Crude and dried:	
British Guiana	$6.75
Jamaica	7.30
Surinam	6.75
Average	7.02
Calcined: British Guiana [1]	22.78

[1] For refractory use.

In 1955 the average value of shipments of calcined alumina, as determined from producers' reports, was $0.0298 per pound. According to the same source, shipments of commercial aluminum trihydrate had an average value of $61.66 per ton.

FOREIGN TRADE [4]

United States imports of bauxite in 1955 were 5.2 million long tons, a decline of less than 1 percent from 1954. This reversal of the upward trend of imports that had continued since the close of World War II resulted from decreased imports from Surinam as the minimum stockpile objective was met. Since consumption of bauxite continued its upward trend during the year and the post-World War II production of the American mines had not exceeded 2 million tons a year, it could be anticipated that the leveling off of imports was to be only temporary.

Imports from Jamaica were 48 percent of the total, a 27-percent gain over 1954. Imports from Surinam showed a 20-percent reduction from the previous year and constituted 47 percent of the total imports.

Forty-two percent of the bauxite imports entered the United States through the Mobile (Ala.) customs district, 40 percent through the New Orleans (La.) district, 16 percent through the Galveston (Tex.) district, and 2 percent through other districts.

Aluminum compounds imported into the United States totaled 9,804 short tons, of which 67 percent came from Canada and virtually all of the balance from Western Europe.

The duty on crude bauxite and on calcined bauxite used as a refractory remained suspended throughout the year. Calcined bauxite imported for other purposes was still dutiable at 15 percent ad valorem. The duty on alumina and aluminum hydroxide was also unchanged at ¼ cent per pound.

Bauxite exports (aluminum ores and concentrates) declined 13 percent in 1955 to 14,117 long tons. Of the total, 93 percent was exported to Canada. Approximately three-fourths of aluminum sulfate exports went to Canada, Colombia, and Venezuela, and three-fourths of the other aluminum compounds exported to Canada and Mexico.

The international flow of bauxite for 1953 is given in table 15. Total exports of 9.3 million long tons represented an increase of

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

1 million tons (12 percent) over the total exports in 1952. Countries with large increases in exports in 1953 compared with 1952 were Jamaica, French West Africa, Yugoslavia, and Malaya. Ninety-five percent (8.9 million long tons) of the total bauxite exported was received by the United States, Canada, West Germany, U. S. S. R., and United Kingdom. United States and Canada received 6.9 million long tons, or 73 percent of the total exports, and the remaining 3 countries 2.0 million long tons, or 22 percent of the total.

TABLE 13.—Bauxite (crude and dried [1]) imported for consumption in the United States, 1946–50 (average) and 1951–55, in long tons

[U. S. Department of Commerce]

Country	1946-50 (average)	1951	1952	1953	1954	1955
North America:						
Jamaica	300		264,988	1,176,494	[2] 1,987,408	2,520,695
Trinidad and Tobago	2,762	18,226	12,002			
Other North America	858					
Total	3,920	18,226	276,990	1,176,494	[2] 1,987,408	2,520,695
South America:						
British Guiana	91,025	127,477	178,379	101,911	[2] 175,002	237,748
Surinam	1,699,029	2,308,664	3,023,145	3,099,554	[2] 3,096,120	2,462,565
Other South America	4,034			2,360		
Total	1,794,088	2,436,141	3,201,524	3,203,825	[2] 3,271,122	2,700,313
Europe				10,257		
Asia: Indonesia	275,374	365,309	19,425			
Africa	(3)					
Grand total: Long tons	2,073,382	2,819,676	3,497,939	4,390,576	[2] 5,258,530	5,221,008
Value	$13,147,730	$17,794,192	$23,193,991	$29,585,129	[2]$36,288,926	$36,629,390

[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); 1953, 91,606 tons ($2,116,121); 1954, (Revised data) 99,421 tons ($2,361,008); 1955, 107,694 tons ($2,453,331).
[2] Revised figure.
[3] Less than 1 ton.

TABLE 14.—Bauxite (including bauxite concentrate [1]) exported from the United States, 1946–50 (average) and 1951–55, in long tons

[U. S. Department of Commerce]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	63,637	89,038	40,012	26,880	14,777	13,115
Other North America	720	722	1,105	379	1,014	606
Total	64,357	89,760	41,117	27,259	15,791	13,721
South America	25	57		95	27	70
Europe	740	81	171	553	133	326
Asia	180	19	42		172	
Africa	13	31			51	
Oceania	(2)					
Grand total as exported	65,315	89,948	41,330	27,907	16,174	14,117
Dried bauxite equivalent [3]	97,000	138,916	62,979	43,256	25,070	21,881
Total value	$1,271,558	$2,217,426	$845,452	$886,275	$666,459	$527,888

[1] Classified as "Aluminum ores and concentrates" by the U. S. Department of Commerce.
[2] Less than 1 ton.
[3] Calculated by Bureau of Mines.

TABLE 15.—Production and trade of bauxite in 1953, by major countries, in thousand long tons

[Compiled by Corra A. Barry]

Country of origin	Production	Exports	Country of destination: North America: Canada	North America: United States	Europe: Germany, West	Europe: Italy	Europe: Norway	Europe: U.S.S.R.	Europe: United Kingdom	Europe: Other Europe	Asia: Japan	Other
North America:												
Jamaica	[1] 1,203	1,203		1,203								
United States	1,580	28	28			(2)			(2)	(2)		(2)
South America:												
Brazil	18	1		1								
British Guiana	2,754	2,112	1,875	205	17				15			
Surinam	3,222	3,158	59	3,099								
Europe:												
Austria	18	9			9							
France	1,138	273			136				113	13		11
Greece	323	309		10	230		27		22	16		4
Hungary	1,372	[3] 980						[3] 980				
Yugoslavia	470	458			378	51			(2)	29		
Other Europe	[3] 1,180											
Asia:												
India	71	3									2	1
Indonesia	147	160			[3] 22						[3] 138	
Malaya	152	136									120	16
Africa:												
French West Africa	333	370	348	10						2		10
Gold Coast	[1] 115	115							115			
Mozambique	3	2										2
Oceania: Australia	4											
Total	[3] 14,100	9,317	2,310	4,528	792	51	27	[3] 980	265	60	[3] 260	44

[1] Exports.
[2] Less than 500 long tons.
[3] Estimate.

TECHNOLOGY

The preliminary results of Bureau of Mines research on the production of aluminum-silicon alloys from clays by arc furnaces were described.[5] Satisfactory conditions for producing the alloys were established. Future research was to be directed toward recovering aluminum from such alloys. One promising method under study was the subhalide process.

A diagram was developed to clarify, by graphic means, the theoretical chemical constituents of gibbsite-kaolinite-type bauxite for all possible proportions of these two minerals.[6]

The Bureau of Mines published a report describing the Cowlitz clay deposits near Castle Rock, Wash.[7] The exploration, carried out jointly with the Federal Geological Survey, proved that high-alumina clays, suitable for open-pit mining at low cost, occur in deposits 20 to 75 acres in extent. These clays are semiflint and semiplastic and consist of kaolinite-halloysite, gibbsite, and montmorillonite. A total

[5] Banning, L. H., and Hergert, W. F., Experimental Production of Al-Si Alloys in A Three-Phase Furnace: Jour. Metals, vol. 7, No. 5, May 1955, pp. 630–633.
[6] Branner, G. C., Graph of Components in Gibbsite-Kaolinite-Type Bauxite: Bureau of Mines Inf. Circ. 7709, 1955, 9 pp.
[7] Popoff, C. C., Cowlitz Clay Deposits Near Castle Rock, Wash.: Bureau of Mines Rept. of Investigations 5157, 1955, 60 pp.

of 11 million dry short tons of measured and indicated clay reserves was determined.

The demonstration plant at Laramie, Wyo., which had been operated experimentally by the Bureau of Mines producing alumina from anorthosite, was sold in May by General Services Administration to the Ideal Cement Co. of Denver. Although Ideal had been awarded a sale contract earlier, bids for the plant were reopened during May at the request of the House Special Subcommittee on Government Activities. The sale price was $1,373,000, and terms of the sale included an agreement by the purchaser to surrender the plant to the Government any time during a 10-year period if the facilities should be required for alumina production.

The Royal Institute of Chemistry published a monograph that was a thorough technical review of the chemistry and practices of the aluminum industry.[8] It included sections on the chemical characteristics and sources of bauxite, the extraction of alumina, the smelting of the metal, other processes for producing alumina, and other processes for producing aluminum.

An article was published that listed the comparative costs of stripping by several different methods as practiced by the Demerara Bauxite Co. in British Guiana.[9] An unusual feature of the operation was the use of dredges for stripping overburden.

The Kaiser Aluminum & Chemical Corp. alumina plant at Baton Rouge, La., was described in a comprehensive article.[10] Of special interest was the description of the "sweetening" process used by Kaiser for leaching Jamaica ore in combination with Surinam ore by two different types of digestion to obtain the necessary high recoveries. The monohydrate ore is first treated under the necessary conditions to dissolve the alumina. To this stream is added the sweetening stream, containing trihydrate bauxite, and a trihydrate digest follows. It was claimed that, by obtaining high-alumina concentrations, the process offered significant advantages over a single monohydrate or trihydrate digest.

In September the Anaconda Aluminum Co. requested the Federal Power Commission to allow importation of Canadian natural gas in order to insure adequate supplies for a proposed alumina plant in the Spokane, Wash., area. Anaconda representatives stated that they had developed a process for extracting alumina from clay, which they believed would permit economic production in the Northwest. Details of the method were not revealed.

WORLD REVIEW

Estimated world output reached 16.8 million long tons in 1955, an 8-percent increase over 1954 production. North and South America furnished 61 percent of the increase, Europe 32 percent, and Asia,

---

[8] Pearson, T. G., The Chemical Background of the Aluminum Industry: Royal Institute of Chemistry, 30 Russell Square, London, W. C. 1, Lectures, Monographs and Reports, No. 3, July 1955, revised April 1956, 103 pp.

[9] Sinke, R. E., Cost Performance Operation—Moving Soft Overburden by Tractor and Wagon, Self-Propelled Scrapers, Tractor-Scrapers, Walking Draglines, Hydraulic Methods: Min. Eng., vol. 7, No. 4, April 1955, pp. 352–356.

[10] Reese, K. M., and Cundiff, W. H., In Aluminum Production the First Stage Is Alumina: Ind. Eng. Chem., vol. 47, No. 9, September 1955, pp. 1672–1680.

Africa, and Australia the remaining 7 percent. The following table shows the countries having a significant increase or decrease in output during the year.

Country:	Increase, percent	Country:	Decrease, percent
Indonesia	52	Gold Coast	29
Greece	41	Surinam	11
Malaya	34	United States	10
France	17		
French West Africa	14		
Yugoslavia	14		
Italy	10		

The Federal Geological Survey published a bibliography describing bauxite deposits throughout the world.[11] It contained over 1,000 references and was intended to cover the literature through December 31, 1950. The papers listed discussed the origin, mineralogy, stratigraphic position, physiographic setting, reserves, or production of bauxite. The locations of the major bauxite deposits were shown on a map.

TABLE 16.—Relationship of world production of bauxite and aluminum

(Million long tons)

Commodity	1948	1949	1950	1951	1952	1953	1954	1955	Total
Bauxite	8.2	8.1	8.1	10.7	[1] 12.6	[1] 14.1	15.6	16.8	94.2
Aluminum	1.2	1.3	1.5	1.8	2.0	2.4	2.7	3.0	15.9
Ratio of bauxite to aluminum production	6.8	6.2	5.4	5.9	[1] 6.3	[1] 5.9	5.8	5.6	5.9

[1] Revised figure.

NORTH AMERICA

Haiti.—Reynolds Mining Corp. virtually completed mining facilities at its Miragoane bauxite mine during 1955. The company was reexploring some areas near Gonaives for bauxite, as technologic developments had increased the possibility that these deposits (considered uneconomic when surveyed 10 years ago) may have become profitable.

Alcoa inspected bauxite deposits in the Pine Forest area near the Dominican border. These deposits were a continuation of the zone being explored by Alcoa on the Dominican side. The ore could be shipped economically through the company Dominican facilities.

Kaiser Aluminum made extensive samplings in the Beaumont area between Les Cayes and Jeremie on the southern peninsula. The company also looked at the Pine Forest deposits and at the end of the year was exploring in the Cul-de-Sac plain.

Jamaica.—Reynolds Jamaica Mines, Ltd., and Kaiser Bauxite Co. shipped 2,529,138 long tons of bauxite to their plants in the United States in 1955, an increase of 27 percent over the 1,998,144 tons shipped in 1954. In addition, Alumina Jamaica, Ltd., exported a sample shipment of 225 tons of bauxite.

[11] Fischer, Elizabeth C., Annotated Bibliography of the Bauxite Deposits of the World: Geol. Survey Bull. 999, 1955, 221 pp.

TABLE 17.—World production of bauxite, by countries, 1946–50 (average) and 1951–55, in long tons [1]

[Compiled by Pearl J. Thompson]

Country	1946-50 (average)	1951	1952	1953	1954	1955
North America:						
Haiti	59					
Jamaica			[2] 375,875	[2] 1,203,208	[2] 1,998,144	[3] 3,000,000
United States (dried equivalent of crude ore)	1,249,315	1,848,676	1,667,047	1,579,739	1,994,896	1,788,341
Total	1,249,374	1,848,676	2,042,922	2,782,947	3,993,040	[3] 4,788,000
South America:						
Brazil	11,958	18,732	14,093	18,524	27,182	[3] 31,250
British Guiana	1,526,333	2,002,757	2,387,953	2,754,598	2,309,934	2,435,298
Surinam	1,774,265	2,657,364	3,172,854	3,222,630	3,371,703	3,013,580
Total	3,312,556	4,678,853	5,574,900	5,995,752	5,708,819	5,480,128
Europe:						
Austria	2,930	8,877	14,940	17,932	16,993	18,838
France	694,054	1,127,429	1,101,341	1,137,864	1,254,671	1,469,229
Germany, West	6,812	5,296	7,073	7,724	4,153	3,814
Greece	38,241	161,072	280,414	323,058	347,937	492,273
Hungary	399,600	741,000	1,188,000	1,372,000	1,240,000	1,221,000
Italy	127,706	171,266	261,353	267,100	290,423	320,815
Rumania [3]	800	9,800	9,800	14,300	14,800	15,800
Spain	8,206	10,414	11,512	5,106	5,644	6,290
U. S. S. R.[3]	576,000	837,000	886,000	886,000	984,000	984,000
Yugoslavia	168,422	490,417	603,753	470,016	675,846	772,527
Total [3]	2,023,000	3,563,000	4,364,000	4,501,000	4,835,000	5,305,000
Asia:						
India	32,808	67,047	63,505	70,848	74,748	[3] 80,700
Indonesia	201,645	[3] 387,500	338,326	147,191	170,504	259,512
Malaya			21,796	152,171	165,622	222,164
Taiwan (Quemoy)		[3] 9,800	(4)	(4)	(4)	(4)
Total	234,453	[3] 464,300	423,627	370,210	410,874	[3] 562,400
Africa:						
French West Africa	[5] 4,033		108,017	332,760	424,195	485,216
Gold Coast (exports)	120,363	129,329	74,369	115,076	163,517	116,285
Mozambique	2,008	3,276	2,449	3,058	2,398	2,611
Total	126,404	132,605	184,835	450,894	590,110	604,112
Oceania: Australia	4,602	5,084	7,235	4,052	5,487	7,563
World total (estimate)	6,950,000	10,700,000	12,600,000	14,100,000	15,550,000	16,750,000

[1] This table incorporates a number of revisions of data published in previous Bauxite chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[2] Exports.
[3] Estimate.
[4] Negligible.
[5] Average for 1949–50.

Shipments of alumina from the Alumina Jamaica, Ltd., plant at Kirkvine increased from 128,116 tons in 1954 to 183,969 tons in 1955, an increase of 44 percent. To meet increased demand for alumina, the company announced in 1955 that the capacity of the Kirkvine plant would be increased from 210,000 long tons to 274,000 tons, then to 493,000 tons by mid-1957. A new plant, with an ultimate capacity of 245,000 tons, was to be built at Ewarton at a cost of $35 million. Operations were scheduled to begin by mid-1958.

An article on the mineralogy of the bauxite deposits of Jamaica was published.[12]

In 1955 taxes on bauxite produced in Jamaica included a royalty

[12] Hill, V. G., The Mineralogy and Genesis of the Bauxite Deposits of Jamaica, B.W. I.: Am. Mineral., vol. 40, July–August 1955, pp. 676–688.

of 1 shilling (1 shilling = $0.14 U. S.) per long dry ton and an income tax based upon the value of the bauxite produced. Since this value was nominal, an arbitrary profit of $0.60 per ton was assumed. The tax was 40 percent of the profit, or $0.24 per long dry ton. The total of royalty and income tax was therefore 38 cents per ton.

Jamaican ore as mined had a moisture content of 20 to 22 percent. Because of handling difficulties, the ore was only partly dried before shipment. The Reynolds ore, which was primarily trihydrate, was dried to about 10 percent moisture. Kaiser ore, which contained some monohydrate, was dried to a moisture content of approximately 15 percent.

SOUTH AMERICA

Brazil.—Investigations by the Brazilian Geological Survey disclosed that many areas of the State of São Paulo were covered by rich, important deposits of bauxite. The most important reserves were in Cipo, Curucutu, Cabeveiras de Rio Claro, and Campo Grande and had been estimated at 3 million tons containing up to 66 percent Al_2O_3, less than 6 percent SiO_2, and 8 to 15 percent Fe_2O_3.

The discovery of bauxite deposits in the Cricu River region of the municipality of Oiapoque, Federal Territory of Amapa, was announced in April 1955. Bauxite was first discovered in the region in 1946, and in 1955 the deposits were being worked by Industria e Commercio de Minas Gerais in cooperation with the Bethlehem Steel Corp. The Government of the Territory of Amapa was making more accurate surveys of the deposits discovered in 1955, since it was interested in establishing an aluminum industry in the Territory in connection with the project for constructing a hydroelectric plant at the Paredo Falls on the Araguary River.

Estimated output of bauxite in 1955 was 31,250 long tons, a 15-percent increase over the 27,182 tons produced in 1954. Calcined-alumina output was 3,449 long tons compared with 3,433 tons in 1954.

Exports of bauxite were 3,256 long tons, of which 2,718 went to Argentina, 492 to Uruguay, 43 to Chile, and 3 to other countries.

British Guiana.—Bauxite production increased slightly in 1955. Demerara Bauxite Co. produced 2,187,175 long tons of the total output of 2,435,298 tons. The Mackenzie plant was operated at full capacity to meet increased demand for calcined ore. Surface prospecting, line cutting, surveying, and road building were carried out by the company in all five of its concessions.

Plantation Bauxite Co., partly owned by Demerara Bauxite Co., produced 35,260 tons of bauxite, a 30-percent decrease from the 50,640 tons produced in 1954.

Reynolds Metals Co. produced 212,847 tons, a 46-percent increase over the 145,289 tons produced in 1954. The company continued prospecting for commercial deposits and proved two new deposits near Kwakwani in Berbice.

Harvey Aluminum Co. and Barima Mines, Ltd., a gold producer, prospected in the Essequibo River region.

A detailed report on the bauxite deposits was published the previous year by the British Guiana Geological Survey.[13]

[13] Bishopp, D. W., Bauxite Resources of British Guiana and Their Development: British Guiana Geol. Surv. Bull. 26, 1954, 123 pp.

Exports also increased in 1955 to 2,169,221 tons valued at BW$24,787,365, of which 252,330 tons valued at BW$8,587,575 was calcined ore. The export duty remained unchanged at $1 for calcined ore and $0.45 for other bauxite ores, plus a royalty of $0.25 per ton on bauxite mined from areas explored after July 1947. The rate of $0.10 a ton on deposits explored before July 1947 remained unchanged.

TABLE 18.—Bauxite exported from British Guiana, 1954–55

Country of destination	1954		1955	
	Long tons	Value, BW$ [1]	Long tons	Value, BW$ [1]
Canada	1, 787, 300	16, 926, 463	1, 752, 433	16, 536, 644
United States	303, 155	5, 328, 493	352, 373	6, 278, 407
United Kingdom	12, 490	239, 055	19, 210	513, 882
Other countries	22, 590	740, 596	45, 205	1, 458, 432
	2, 125, 535	23, 234, 607	2, 169, 221	24, 787, 365

[1] 1 BW$=US$0.58.

Surinam.—Of the 3 million long tons of bauxite produced in 1955, 2. 9 million tons was exported as follows:

Mining area:	*1954* [1]	*1955*
Surinam Bauxite Co. (Alcoa):		
Moengo	1, 955, 110	1, 818, 801
Paranam	768, 903	594, 695
Billiton Co	493, 172	503, 900
	3, 217, 185	2, 917, 396

[1] Revised figures.

Surinam Bauxite Co. output of 2,509,680 tons was down 8 percent from the 2,724,013 tons reported in 1954. The company continued to develop the deeper ore bodies near the Paranam mine. The pilot plant treating low-grade ferruginous ore proved successful, thus adding substantial reserves to the Paranam mine.

Output of the Billiton Co. (503,900 tons) was 2 percent more than the 493,172 tons produced in 1954. The company announced in November 1955 that a 10-year contract had been signed with Olin-Mathieson Co. for shipment of bauxite, beginning in 1957.

Reynolds Metals Co. extended its search for bauxite into the Corantyne River area.

The Surinam Geological and Mining Service stated in its final report on the Nassau Mountain bauxite deposit that there was a probable reserve of some 14 million long tons of first-grade ore (dried basis), with 53.5 to 55.5 percent Al_2O, 3 to 3.5 percent SiO_2, 8.5 to 10.5 percent Fe_2O_3, and 27 to 29 percent loss on ignition. A possible reserve of some 6 million tons of low-grade ore was also indicated. The deposit had been reserved for the Brokopondo Dam project.

EUROPE

Austria.—Ranshofen Aluminium Werke Unterlaussa mine produced 18,838 long tons of bauxite in 1955, an 11-percent increase over the 1954 output of 16,993 tons. During the year 8,406 tons of bauxite was shipped to West Germany for conversion into alumina on a toll basis. Of the 6,631 tons of bauxite imported, 6,093 tons was from South America, 491 tons from The Netherlands, and 47 tons from Yugoslavia.

France.—Bauxite output in France reached a new high of 1,469,229 long tons in 1955. Société des produits chimiques et électrométallurgiques (Péchiney) was responsible for 82 percent of the output. Other producers were Union des bauxites, Société des bauxites de France, and Société des bauxites du Midi.

Imports of 10,224 tons were limited to high-grade ore for the abrasive and refractory industries. Exports totaled 344,400 tons during the year; 203,600 tons went to West Germany, 122,800 to the United Kingdom, 7,300 to Spain, 1,850 to Italy, and the remaining 8,850 to other countries.

Domestic consumption of bauxite was estimated at 1,030,000 tons and distributed as follows: Alumina, 935,000 tons (91 percent); abrasives, 41,000 tons (4 percent); cement, 39,000 tons (4 percent); and refractory, 12,000 tons (1 percent).

The price for bauxite containing 54 to 55 percent Al_2O_3 and 5.5 percent silica had been fixed at 1,170 francs a metric ton since July 1, 1954; the price of bauxite for qualities generally used ranged from 1,300 to 1,400 francs. The price of bauxite for other than aluminum production was not under Government control and therefore considerably higher.

Alumina output was 374,245 long tons in 1955, of which 79,239 tons was exported. Société d'électrochimie, électrométallurgie et aciéries électriques d'Ugine and Société des produits chimiques et électrométallurgiques (Péchiney) produced all but the 59,000 long tons produced by the Swiss-controlled company Société française pour la production d'aluminium (SFIA) and shipped to Switzerland and Austria.

Germany, West.—Output of bauxite in West Germany continued to decrease in 1955 and totaled 3,814 long tons compared with 4,153 tons in 1954. Imports of bauxite increased during the year, as shown in the following table:

Country of origin:	*1954, long tons*	*1955, long tons*
Austria	17, 988	8, 007
British Guiana	5, 608	11, 086
France	160, 534	183, 712
French West Africa	11, 496	49, 814
Greece	240, 421	228, 009
Indonesia	109, 174	57, 835
Surinam	8, 099	20, 022
United Kingdom	1, 289	3, 495
Yugoslavia	469, 894	547, 491
Other countries	148	2, 157
Total quantity	1, 024, 651	1, 111, 628
Value, DM [1]	48, 291, 000	56, 231, 000

[1] DM equals US$0.238.

During 1955 West Germany exported 76,375 long tons of alumina, principally to Austria (53,363 tons) Spain (16,855 tons) Switzerland (2,629 tons), and Norway (2,124 tons), the remainder going to other countries. Imports of alumina during the year totaled 2,178 tons and were from France (984 tons), Italy (1,181 tons), and the United States (13 tons).

Greece.—Bauxite output in Greece (492,273 long tons) represented a 41-percent gain over that of 1954. Sale of 118,902 long tons of bauxite to the Soviet Union under the Greek-Soviet trade agreement contributed to the increased output. Exports to other countries included 238,185 long tons to West Germany, 43,736 long tons to the United Kingdom, 25,357 long tons to Norway, 22,403 long tons to Sweden, 9,923 long tons to Spain, and 12,610 long tons to other countries—a total of 471,116 long tons.

In July 1955 Vereinigte Aluminium Werke, jointly with Aluminium Industrie A. G. of Switzerland, purchased three mines near Delphi from Canadian owners. These mines had been idle since the war.

The Institute for Geology and Subsurface Research had, during the last 5 years, made geological and geophysical studies of the Eleusis-Mandra bauxite deposits and in 1955 was making similar studies of the Elikon-Parnassus-Giona mountainous area where large bauxite deposits occurred.

Hungary.—Bauxite production declined from 1,240,000 long tons in 1954 to 1,221,000 tons in 1955. Output under the Five-Year Plan, 1956–60, was scheduled to reach 1,575,000 tons by 1960.

Alumina output was 151,600 long tons in 1955, a 17-percent increase over the 129,500 tons produced in 1954. Alumina consumed in producing aluminum was about 79,000 long tons in 1955 and 64,000 tons in 1954. The remainder of the alumina produced was shipped principally to Czechoslovakia and Poland.

Italy.—A 10-percent gain in bauxite output was noted in 1955, when 320,815 long tons were produced. A new bauxite deposit at Molina Aterno, in Aquila Province, was being worked. Imports of bauxite totaled 98,084 long tons in 1955, of which 94,019 tons came from Yugoslavia.

Output of calcined alumina increased from 150,679 long tons in 1954 to 165,468 in 1955. Exports of calcined alumina totaled 34,569 tons, of which 19,055 went to Austria, 14,530 to Switzerland, and 984 to other countries.

Yugoslavia.—Bauxite output in Yugoslavia reached a record high of 772,500 long tons in 1955, exceeding that in the highest prewar year (1939)—707,200 long tons. Bauxite had been exploited in Yugoslavia for over 40 years; during that time 10,942,000 long tons had been produced. Of the 3,749,000 tons produced in the postwar period (1946–55), 3,291,588 tons (about 88 percent) was exported. The increased production in 1955 was due to increased demand for exports and to a higher domestic consumption when the Boris Kidric alumina plant at Kidricevo began operations in 1954. Alumina output rose from 13,758 long tons in 1954 to 44,260 tons in 1955. An article describing the Dalmatian bauxite deposits was published during the year.[14]

[14] Franotovic, Damir, Dalmatia Leads Yugoslavia's Growing Bauxite Industry: Eng. and Min. Jour., vol. 156, No. 12, December 1955, pp. 78–84.

Production of the bauxite mines since 1953 is listed below, in long tons:

District	1953	1954	1955
Mostar	226,400	344,500	393,700
Niksic	108,300	147,600	196,800
Drnis	167,300	231,300	231,300
Rovinj	152,600	196,800	196,800
Umag	34,400	24,600	14,800

Bauxite exports increased from 553,221 long tons in 1954 to 647,953 tons in 1955. West Germany was again the largest recipient, taking 557,005 tons; Italy was next, with 90,902 tons; and Austria ranked third, with 46 tons. Alumina exports increased from 4,172 (all to Austria) in 1954 to 19,493 tons (17,214 to Austria and 2,279 to Poland) in 1955.

ASIA

India.—India's output of bauxite in 1955 was estimated at 80,700 long tons, of which 8,776 tons was exported.

An article describing the bauxite deposits of India was published, in which high-grade ore reserves were given as 56,367 million long tons.[15]

Alumina output was 13,276 long tons in 1955, a 16-percent increase over the 11,425 tons produced in 1954.

Indonesia.—Increased European and Japanese demand for bauxite resulted in a 52-percent gain in output during 1955, when 259,512 long tons was produced. Of the 266,150 long tons exported during the year, 188,354 went to Japan and 77,796 tons to West Germany via The Netherlands.

The discovery of aluminate deposits in Bukit Raya Mountain at the junction of the borders of southeast and west Kalimantan was reported.

Japan.—The upward trend in alumina output continued in 1955, when 136,172 long tons was produced, a 29-percent increase over the 105,313 tons for 1954. Alumina capacity was about 207,000 long tons a year. Exports of alumina during the year were 15,600 tons.

Bauxite imports increased to 337,891 long tons—149,582 tons from Malaya, 178,666 tons from Indonesia, and 9,643 tons from other countries.

Malaya.—Bauxite output in Malaya increased from 165,622 long tons in 1954 to 222,164 in 1955 and exports from 167,290 tons to 259,442. Japan again was the principal recipient, followed by Formosa and Australia.

A second bauxite producer was expected to begin operations in 1956. South-east Asia Bauxites, Ltd., (SEABA) was formed as a subsidiary of Aluminium, Ltd., to mine bauxite on a property adjoining that operated by Ramunia Bauxite Mining Co. in Johore. The property, said to contain 10 million tons of bauxite, was to be worked jointly by the two companies. A 5-year contract was signed between

[15] Chowdhury, M. K., Bauxite Deposits of India and Their Utilization: Indian Minerals, vol. 9, No. 3, July 1955, pp. 195–221.

the companies, whereby Ramunia was to mine and treat ore on a contract basis. Under the contract 40,000 tons was to be mined the first year, with subsequent increases according to world market requirements. Production from SEABA was to go to the Nippon Light Metals Co. in Japan initially. Aluminium Laboratories, Ltd., another subsidiary of Aluminium, Ltd., held a small concession for bauxite mining in the southeastern tip of Johore between Bukit Penerang and Tanjong.

Pakistan.—Low-grade bauxite deposits were discovered at Taxila near Rawalpindi in west Pakistan. The deposits were said to contain a high percentage of iron and silica but were extensive.

Sarawak.—Sematan Bauxite, Ltd., was formed toward the end of 1955 to make further tests of the bauxite in the Sematan district. The total area of the concession was about 20 square miles, 15 of which were in Munggu Belian area and 5 at Bukit Gebong. It was indicated that mining would begin in 1956.

AFRICA

French West Africa.—Société bauxite du Midi produced 485,216 long tons of bauxite in 1955, of which 471,946 tons was shipped to Canada. Studies of bauxite deposits in Northern French Guinea near the border of Portuguese Guinea and in the northeastern part of Guinea near the border of Sudan continued during the year.

Large deposits of bauxite were discovered by Société africaine de réceherehes et d'études pour l'aluminium (SAREPA) on the mainland in French Guinea.

Société bauxite du Midi began work at its new mines in the Boke area.

Gold Coast.—A general strike in the Gold Coast bauxite industry resulted in a 29-percent decrease in exports during the year. Exports in 1955, all to the United Kingdom, totaled 116,285 long tons compared with 163,517 tons in 1954.

Sierra Leone.—British Aluminium, Ltd., abandoned its licenses to prospect for bauxite in Freetown and other areas.

OCEANIA

Australia.—Although extensive reserves of bauxite had been proved on Wessel Island off the coast of the Northern Territory and deposits were under investigation around the Gulf of Carpentaria, higher grade bauxite was to be imported for reduction at the Bell Bay aluminum plant. During 1955 imports of 19,287 long tons were supplied by The Ramunia Bauxite, Ltd., of Indonesia. Late in 1955 the Australian Aluminium Production Commission called for tenders for its immediate future requirements of bauxite. It was understood that the commission had contracted with Billiton interests for a supply of 50,000 tons of bauxite from Bintan Island, Indonesia. A trial shipment of bauxite was expected from Saurashtra, India, during 1956. Commercial consumption in Australia was constant at about 5,000 tons a year before opening of the Bell Bay plant. No data were available on consumption of bauxite at Bell Bay during 1955, but annual requirements were expected to be about 40,000 tons.

Production of bauxite increased in 1955 and totaled 7,563 long tons, of which Queensland contributed 1,725 tons, New South Wales 2,847 tons, and Victoria 2,991 tons.

Commonwealth Aluminium Corp. (Pty.) was registered in Queensland to operate the large deposits discovered late in 1955 in the Cape York Peninsula.

Beryllium

By Donald E. Eilertsen[1]

BERYLLIUM is found in more than 30 minerals; but beryl, a beryllium-aluminum silicate containing about 14 percent of beryllium oxide (BeO) or 5-percent metallic beryllium (Be) when pure, has been the only commercial source-mineral of beryllium.

World production of beryl for 1955 was estimated to be 8,700 short tons,[2] United States imports 6,000 tons, and domestic production 500 tons or about 75 percent of the 1954 production. Domestic consumption was 4,000 tons, and end-of-year industrial stocks totaled 2,900 tons. World production and industrial consumption of beryl reached new high records.

Production of beryllium alloys and compounds increased substantially over 1954. Although production of beryl and beryllium products has fluctuated widely from year to year, the long-term trend has been upward.

TABLE 1.—Salient statistics on beryl[1] in the United States, 1946–50 (average) and 1951–55, in short tons

	1946–50 (average)	1951	1952	1953	1954	1955
Domestic mine shipments	276	484	515	751	669	[2] 500
World supply	4,100	6,700	8,300	8,200	7,200	8,700
Imports	2,434	4,316	5,978	[3] 7,998	5,816	6,037
Exports	.4	.3	[4] 1.9		6.8	1.1
Exports of metal, alloys, and compounds	85.6	94.8	94.7	9.7	3.8	16.9
Industrial consumption	1,751	3,388	3,476	2,661	1,948	3,995
Industrial end-of-year stocks[5]	1,450	1,417	2,492	4,978	4,101	2,888
Approximate value per unit BeO:						
Domestic[6]	$29	$33	[3] $45	$47	[3] $45	[2] $49
Imported	$21	$32	[3] $43	$47	[3] $44	$37

[1] Approximately 10 percent BeO.
[2] Approximately 11 percent BeO.
[3] Revised figure.
[4] Does not include an undisclosed quantity of secondary material exported to United Kingdom.
[5] Government stockpile figures restricted.
[6] F. o. b. mine.

DOMESTIC PRODUCTION

Mine Production.—A total of 500 short tons of beryl was shipped from numerous mines in 10 States during 1955, 25 percent less than 1954 and 33 percent less than 1953 (the record high year with a production of 751 tons).

Principal producers were the Harding mine in New Mexico; Barker, Beecher No. 3, Hugo, and Beecher and Someday mines in South Dakota; Friend Bros. mine in Colorado; and The Ruggles mine in New Hampshire. South Dakota produced almost 60 percent of the total domestic beryl.

[1] Commodity specialist.
[2] Preliminary annual statistics revised as new information received.

Of the domestic production of beryl 276 short tons was purchased by the Government in 1955.

The Government, through the DMEA program, continued to encourage exploration for unknown and undeveloped sources of beryl by giving aid to applicants for exploration projects that met certain requirements.

TABLE 2.—Beryl shipped from mines in the United States, 1946–50 (average) and 1951–55, by States, in short tons [1]

State	1946–50 (average)	1951	1952	1953	1954	1955
Colorado	(2)	97	54	75	59	46
New Hampshire	(2)	50	(2)	57	12	20
New Mexico	(2)	141	101	89	117	106
South Dakota	89	138	334	392	337	294
Other [3]	187	58	26	138	144	34
Total: Short tons	276	484	515	751	669	[4] 500
Value	$78,527	$161,361	$233,257	$354,487	$303,611	$267,927
Average value per ton	$284.52	$333.39	$452.93	$472.02	$453.83	$535.85

[1] Estimated 10 percent BeO.
[2] Included with "Other" to avoid disclosure of individual company confidential data.
[3] Arizona (1946–50, 1951, and 1953–55), Connecticut (1946–50, 1953, and 1955), Delaware (1954), Georgia (1952–55), Idaho (1953 and 1954), Maine (1946–50 and 1951–55), Maryland (1954), New York (1946–50 and 1954), North Carolina (1946–50, 1951, 1954, and 1955), Virginia (1954 and 1955), and States indicated by footnote 2.
[4] Estimated 11 percent BeO.

Refinery Production.—Two firms, The Beryllium Corp., Reading, Pa., and The Brush Beryllium Co., Cleveland, Ohio. were the only companies in the United States that processed the ore into beryllium metal and alloys. The Beryllium Corp. was the largest primary producer of beryllium products in the world. Beryl Ores Co., Arvada, Colo., made various products from beryl for the chemical and electronic industries. A. O. Smith Corp. (Milwaukee, Wis.), Lapp Insulator Co. Inc. (LeRoy, N. Y.), and Champion Sparkplug Co. (Detroit, Mich.) used beryl for ceramics.

CONSUMPTION AND USES

Industrial consumption of beryl not only reached a record high of nearly 4,000 tons in 1955 but also reversed the downward trend of the 2 previous years. Production of beryllium-copper, beryllium-aluminum, beryllium-nickel, and compounds showed substantial increases over 1954. Beryllium-copper continued to be the principal product of the two large producers of the metal and alloys.

Alloys of beryllium-copper have been found to resist fatigue, corrosion, heat, and wear; have hardness, strength, and low spark; and possess high electrical and thermal conductivity and nonmagnetic properties. Many common uses of beryllium metal, alloys, and salts have been described.[3] Important cost savings have been made in the plastics industry by using beryllium-copper molds [4] in the injection molding of many industrial and novelty parts. In electronics, use of plated beryllium-copper [5] has expanded steadily. Wrought products of beryllium-copper with improved quality are

[3] Bureau of Mines, Beryllium: Materials Survey, prepared for Nat. Security Res. Board, September 1953, 178 pp.
[4] Metallurgia, vol. 52, No. 309, July 1955, pp. 31–32.
[5] American Metal Market, vol. 62, No. 119, June 21, 1955, p. 5.

available in larger quantity and wider variety. Mass production [6] with many quality-control techniques has helped the beryllium industry to mature. The principal potential uses for beryllium in the atomic-energy [7] program are as a moderator and a reflector.

Late in 1955 the Atomic Energy Commission announced that it would invite industry to submit proposals early in 1956 for supplying up to 100,000 pounds of reactor-grade beryllium metal annually over a 5-year period.

STOCKS

End-of-year industrial stocks of beryl totaled 2,900 short tons, less than for the 2 previous years but somewhat larger than for preceding years. Stocks on hand of beryllium, beryllium alloys, and beryllium compounds were larger than in the previous year. National Stockpile figures for beryl and beryllium products are not available for publication.

PRICES

The Government, through GSA, purchased most of the domestic production of beryllium ore from depots at Franklin, N. H.; Spruce Pine, N. C.; and Custer, S. Dak. Small shipments accepted by the Government on the basis of visual inspection were purchased at the rate of $400 per short dry ton or 20 cents per pound. Shipments accepted on the basis of sampling and chemical analysis were purchased on the basis of short-ton units of contained berrylium oxide (BeO). Prices paid were $40 per unit for ore containing 8.0–8.9 percent BeO, $45 per unit for ore containing 9.0–9.9 percent BeO, and $50 per unit for ore containing 10 percent BeO or over. The expiration date of the purchase program was extended from June 1955 to June 1956.

Throughout 1955 E&MJ Metal and Mineral Markets quoted domestic beryllium ore, 10–12 percent BeO, from $46–$48 per short-ton unit of BeO, f. o. b. mine, Colorado. Quotations for imported ore per short-ton unit, based on 10–12 percent BeO, c. i. f. United States ports, ranged from $36–$40 per unit and remained at $36–$38 per unit throughout the last 6 months.

American Metal Market quoted the following prices: Beryllium, 97 percent lump or beads, f. o. b. Cleveland, Ohio, and Reading, Pa., $71.50 per pound; beryllium-copper master alloy, f. o. b., Reading, Pa., or Elmore, Ohio, $40–$43 per pound of contained beryllium, with remainder as copper at market price on date of shipment; and beryllium-aluminum, 5-pound ingot, f. o. b. Reading, Pa., or Elmore, Ohio, $72.25–$72.75, per pound of contained beryllium, plus aluminum at market price. Beryllium-copper strip ranged from $1.61–$1.84 per pound; and beryllium-copper rod, bar, and wire from $1.65–$1.81 per pound.

FOREIGN TRADE

Imports of beryl ore totaled 6,000 short tons at an average value of $368.74 per ton. This tonnage is slightly more than the 1954 imports but 25 percent less than the record high of 8,000 tons established in 1953.

---

[6] Steel, vol. 137, No. 15, Oct. 10, 1955, pp. 127, 130.
[7] White, D. W., Jr., and Burke, J. E. (eds.), The Metal Beryllium: 1955, p. 21.

Over 45 percent of the imported ore came from 7 areas in Africa, 36 percent from South America, more than 14 percent from Asia, and less than 5 percent from Europe. Imports of beryl were 12 times greater than domestic production.

Four countries produced almost three-quarters of the beryl imported into the United States: Brazil, 1,735 tons; Union of South Africa (including South-West Africa), 994 tons; Federation of Rhodesia and Nyasaland, 861 tons; and India, 845 tons.

TABLE 3.—Beryllium ore (beryl concentrate) imported for consumption in the United States, by countries, 1952–55, in short tons

[U. S. Department of Commerce]

Country	1952	1953	1954	1955	Total (short tons)	Percent of total
South America:						
Argentina	550	1,459		441	2,450	9.5
Brazil	2,590	2,614	1,828	1,735	8,767	34.0
Surinam			10		10	.0
Total	3,140	4,073	1,838	2,176	11,227	43.5
Europe						
Finland	3				3	.0
Portugal	105	332	338	283	1,058	4.0
Sweden			5		5	.1
Total	108	332	343	283	1,066	4.1
Asia:						
Afghanistan			11		11	.0
India	196	199	392	845	1,632	6.3
Korea	3	8	4	6	21	.1
Total	199	207	407	851	1,664	6.4
Africa:						
Belgian Congo			11	128	139	.5
British East Africa (principally Uganda)	18	22	23	93	156	.6
Federation of Rhodesia and Nyasaland	[1] 931	[1] 1,296	957	861	4,045	15.7
French Morocco	118	23			141	.6
Madagascar		330	77	28	435	1.7
Mozambique	308	392	1,295	620	2,615	10.1
Nigeria				3	3	.0
Union of South Africa (includes South-west Africa)	1,156	1,323	865	994	4,338	16.8
Total	2,531	3,386	3,228	2,727	11,872	46.0
Grand total: Short tons	5,978	7,998	5,816	6,037	25,829	100.0
Value	$2,548,423	$3,752,718	$2,574,061	$2,226,068		

[1] Southern Rhodesia.

TECHNOLOGY

Very dense ceramics, approaching theoretical density, were made by sintering compacts of high-purity, active BeO at 2,500°–3,200° F. in hydrogen. Compacts sintered at 2,300° F. were less dense than those sintered at higher temperatures but had bend strengths greater than previously reported values for pure BeO ceramics.[8]

Machined beryllium must be annealed, and its distorted surface must be etched to obtain maximum mechanical qualities. Thus treated, hot-pressed, hot-extruded beryllium has higher tensile strength and ductility than when fabricated otherwise. These

[8] Hyde, Collin, Quirk, John F., and Duckworth, Winston H., Preparation of Dense Beryllium Oxide: Battelle Memorial Inst. Rept. BMI-1020, Metallurgy and Ceramics, Contract W-7405-eng-92, July 21, 1955, 24 pp.

properties are exhibited mainly in the direction of the extrusive axis and depend upon the grain size of the powder from which the extrusion billet is formed.[9]

Data have been obtained on tensile and yield strengths, elongation, and hardness in contrast to aging time of a new beryllium-copper alloy containing 1.10–1.25 percent beryllium, 0.20 percent cobalt, 1.60 percent zinc, and the remainder copper. Aging curves were determined at 650°, 685°, and 715° F. Tests indicated an ultimate tensile strength of 150,000 pounds per square inch with 7-percent elongation, which is about 25 percent lower than the tensile strength of commercial 1.9-percent beryllium-copper alloy.[10]

Small quantities of magnesium and beryllium in aluminum alloys can be detected by a spectrochemical method, using a rotating-disk electrode. The method is said to be simple and less tedious than existing chemical methods.[11]

Flotation studies of beryl and the extraction of beryllium from beryl were made by the Federal Bureau of Mines at Rapid City, S. Dak. Numerous flotation tests also were made for recovering small particles of byproduct beryl from the Kings Mountain, N. C., area. The results obtained from these studies and tests were encouraging, although the tests were not entirely successful.

WORLD REVIEW

World production of beryl reached a record high of 8,700 short tons in 1955 and ended the downward trend of the past 2 years. Of this total, less than 6 percent was produced in the United States, and about 70 percent was imported into this country; combined, they total over 75 percent of the world production.

Africa and South America each produced over 38 percent of the total estimated world production of beryl, Asia almost 10 percent, North America and Europe each more than 5 percent, and Australia almost 3 percent.

Argentina.—The principal beryl-production centers in Argentina are: Las Tapias in Las Rosas district of Cordoba Province; various deposits near Concaran, La Toma, Rodriquez Saá, and San Luis, in San Luis Province; and the Ancaste zone of Catamarca Province. There were no exports of beryl to the United States in 1954; however, in 1955 shipments were resumed.

Belgian Congo.—Beryl production reached a new record high in 1955. The major part of the output came from the Maniema district of Kivu and from Ruanda-Urundi.

French Morocco.—Beryl mining in Morocco was suspended in August 1954, and the remaining stocks of ore were sold. In 1955 some prospecting was done at Tiouanamane, which led to extraction of a small quantity of beryl.

Hong Kong.—A deposit of beryl nearly 30 inches wide and about 300 feet long was found near Hong Kong by a British soldier who explored a dugout, excavated during World War II.[12]

---

9 Baldwin, E. E., and Koenig, R. F., Mechanical Properties of Beryllium: Knolls Atomic Power Lab., Rept. KAPL-1049, Metallurgy and Ceramics, Subproject 4, Contract W-31-109-eng-52, Feb. 15, 1954, 59 pp.

10 Kiszka, J. C., and Smith, L. M., Some Mechanical Properties of a New Copper Alloy: Pitman-Dunn Labs., Frankford Arsenal, AD-24476, January 1954, 18 pp.

11 Metallurgia, vol. 52, No. 311, September 1955, pp. 154-156.

12 Rhodesian Mining Review, vol. 20, No. 9, September 1955, p. 22.

India.—Beryl deposits were reported to have been discovered in the Srikakulam district of Andhra, and a further survey was made in that area.[13]

Rhodesia and Nyasaland, Federation of.—Herderite, a fluophosphate of calcium and beryllium, was found in the Miami area in the northern part of Southern Rhodesia. So far, six minerals of beryllium have been found in this area.[14]

TABLE 4.—World production of beryl, by countries,[1] 1946–50 (average) and 1951–55, in short tons[2]

[Compiled by Augusta W. Jann]

Country[1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	[3,4] 29					
United States (mine shipments)	276	484	515	751	669	500
Total	305	484	515	751	669	500
South America:						
Argentina	77	171	694	683	705	1,488
Brazil	1,817	1,918	3,177	2,126	1,581	[5] 1,820
Surinam				2	10	
Total	1,894	2,089	3,871	2,811	2,296	3,308
Europe:						
France	[6] 2	2		(7)	(7)	(7)
Norway	[3,8] 6					
Portugal	14	112	103	414	368	327
Total (estimate)[1]	130	220	210	520	480	440
Asia:						
Afghanistan	[4] 8	2			[9] 35	
India	[9] 90	237	[9] 600	[3] 199	[3] 392	[3] 845
Korea, Republic of			(10)	4	[3] 4	[3] 6
Total	[9] 100	239	[9] 600	203	431	851
Africa:						
Belgian Congo (including Ruanda-Urundi)				8	50	362
British Somaliland						19
French Morocco	[6] 71	93	142	36	17	2
Madagascar	115	584	438	516	648	316
Mozambique	115	254	229	276	[9] 500	960
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	[4] 6	4	9	6	1	20
Southern Rhodesia	[8] 480	1,110	1,186	1,774	1,077	965
South-West Africa	230	830	592	590	564	472
Tanganyika	[6] 1					
Uganda	36	2	3	55	77	110
Union of South Africa	[8] 589	654	413	531	203	126
Total	1,643	3,531	3,012	3,792	3,137	3,352
Oceania: Australia	42	126	98	140	166	230
World total (estimate)[1]	4,100	6,700	8,300	8,200	7,200	8,700

[1] In addition to 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. An estimate is included for U. S. S. R.
[2] This table incorporates a number of revisions of data published in previous tables. Data do not add to totals shown owing to rounding where estimated figures are included in detail.
[3] United States imports.
[4] Average for 1 year only, as 1950 was first year of commercial production.
[5] Exports.
[6] Average for 1948–50.
[7] Data not available; estimates by author of chapter included in total.
[8] Average for 1949–50.
[9] Estimate.
[10] Less than 0.5 ton.

[13] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 1, January 1956, p. 3.
[14] Rhodesian Mining Review, vol. 21, No. 7, July 1956, p. 46.

Bismuth

By Abbott Renick [1] and E. Virginia Wright [2]

ESTIMATED world production of 3.8 million pounds of bismuth in 1955 was about 200,000 pounds higher than in 1954 and exceeded the 1946–50 average (3.1 million pounds) by 23 percent. In 1955 the Western Hemisphere produced about 76 percent of the Free World output and supplied 92 percent of the total United States imports of bismuth.

The quoted market price of bismuth metal in New York remained throughout the year at $2.25 per pound, in ton lots, unchanged since September 5, 1950.

In the United States industrial consumption of refined bismuth exceeded 1.5 million pounds, 8 percent more than in 1954, and compares with the annual average during 1951–55, inclusive, of 1.6 million pounds.

The quantity of bismuth refined in the United States in 1955 was 24 percent greater than in 1954. General imports of metallic bismuth decreased 8 percent from the previous year, whereas exports of bismuth metal and alloys increased 48 percent. Total refiners', consumers', and dealers' stocks on December 31 were less than those reported on hand at the beginning of the year.

DOMESTIC PRODUCTION

Virtually all bismuth produced in the United States was derived 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 the 1955 output increased 24 percent from that of 1954.

Companies reporting output of refined bismuth metal in 1955 were American Smelting & Refining Co., at Omaha, Nebr., and Perth Amboy, N. J.; Anaconda Copper Mining Co., Anaconda, Mont.; and United States Smelting Lead Refinery, Inc. (subsidiary of United States Smelting, Refining & Mining Co.), East Chicago, Ind. The Cerro de Pasco Corp. continued as a principal domestic producer of bismuth alloys. The bismuth metal used was obtained from the company smelting operation at La Oroya, Peru.

[1] Commodity specialist.
[2] Statistical assistant.

TABLE 1.—Salient statistics of bismuth, 1946–50 (average) and 1951–55, in pounds of contained metal

	1946–50 (average)	1951	1952	1953	1954	1955
Consumers' and dealers' stocks beginning of year	(1)	[2] 238,000	195,400	211,500	166,700	252,800
Consumption	(1)	[3] 1,737,000	1,775,000	1,568,000	1,439,000	1,548,000
Imports [4]	471,200	527,400	708,300	641,400	644,300	595,600
Exports [5]	227,200	147,000	244,800	127,000	137,900	203,700
World production [6]	3,100,000	3,900,000	3,900,000	4,200,000	[7] 3,600,000	3,800,000
Price per pound, New York	$1.89	$2.25	$2.25	$2.25	$2.25	$2.25
Consumers' and dealers' stocks end of year	(1)	195,400	211,500	166,700	252,800	234,300

1 Data not available.
2 Stocks on hand Feb. 1. Data for January not available.
3 Estimated annual figures. Based on 11 months' data compiled by National Production Authority, U. S. Department of Commerce.
4 Data 1946–50 are imports for consumption; 1951–55 are general imports.
5 Gross weight. Includes weight of alloys.
6 Exclusive of U. S. S. R.
7 Revised figure.

CONSUMPTION AND USES

In 1955 domestic consumption of bismuth totaled 1.5 million pounds, representing an increase of more than 100,000 pounds (8 percent) over the previous year. Of this total, consumption of bismuth in pharmaceuticals was 471,000 pounds. This represented 30 percent of the total requirements of bismuth metal. The remaining 70 percent, or 1.1 million pounds was consumed in fabricating alloys.

STOCKS

Consumers' and dealers' stocks of metallic bismuth totaled 234,300 pounds at the end of 1955. This represented a 7-percent decrease from that reported on hand January 1. Producers' inventories of refined metal likewise decreased.

TABLE 2.—Bismuth metal consumed in the United States, 1951–55, by uses

Uses	1951[1]		1952		1953	
	Pounds	Percentage of total	Pounds	Percentage of total	Pounds	Percentage of total
Fusible alloys	204,000	12	261,700	15	191,200	12
Solder	109,300	6	145,900	8	221,000	14
Other alloys	560,100	32	865,800	49	613,800	39
Selenium rectifiers	55,000	3	25,500	1	47,500	3
Pharmaceuticals[2]	621,400	36	417,000	23	419,500	27
Other uses	187,200	11	59,100	4	75,000	5
Total	1,737,000	100	1,775,000	100	1,568,000	100

Uses	1954		1955	
	Pounds	Percentage of total	Pounds	Percentage of total
Fusible alloys	192,300	13	176,000	11
Solder	139,600	10	122,000	8
Other alloys	415,000	29	568,000	37
Selenium rectifiers	42,600	3	26,400	2
Pharmaceuticals[2]	433,500	30	471,000	30
Other uses	216,000	15	184,600	12
Total	1,439,000	100	1,548,000	100

[1] Estimated annual figures. Based on 11 months' data compiled by National Production Authority, U. S. Department of Commerce.
[2] Includes industrial chemicals.

PRICES

The New York price for refined bismuth metal remained unchanged at $2.25 per pound, in ton lots, throughout 1955, according to the E & MJ Metal and Mineral Markets. The Metal Bulletin (London) quotations for bismuth metal and ores also remained unchanged throughout the year. London quotations were as follows:

Item	*Price per pound contained bismuth*[1]
Metal: 2 cwt., ex. warehouse	$2.24
Ore:[2]	
65 percent minimum	1.19
30 percent minimum	.70
20 percent minimum	.45
18–20 percent minimum	.18

[1] Based on an exchange rate of $2.80 to £ 1.
[2] Ore or concentrate.

Likewise, prices of bismuth chemicals remained unchanged throughout the year. Prices per pound as quoted by the Oil, Paint and Drug Reporter were:

	Price		*Price*
Chloride	$5.11	Subcarbonate	$3.20
Hydroxide	4.65	Subgallate	3.15
Nitrate	2.10–2.17	Subiodide	5.37
Oxide	4.47–5.05	Subnitrate	2.65
Oxychloride	4.37–4.42	Subsalicylate	3.50
Phenolsulfonate	5.22	Ammonium citrate	4.22

FOREIGN TRADE [3]

Imports.—During 1955, imports (general) of refined metal totaled 595,600 pounds. This represented an 8-percent decrease from that in 1954, resulting from substantial decreases of receipts from Peru and Korea. Of the total imports, Peru supplied 55 percent, Mexico 21 percent, Yugoslavia 11 percent, Canada 9 percent, and Netherlands and Japan 4 percent.

Exports.—Exports of bismuth metal and alloys (gross weight) increased 48 percent above the 137,900 pounds exported in 1954. The Netherlands received 104,700 pounds, France 62,500 pounds, United Kingdom 24,800 pounds, and all other countries 11,700 pounds.

Tariff.—The duty on bismuth metal remained at 1⅞ percent ad valorem, a level held since October 1951. The duty on salts and compounds continued at 35 percent ad valorem. On bismuth alloys, the duty was 22½ percent ad valorem. Bismuth ore enters the United States duty-free.

TABLE 3.—Bismuth metal and alloys imported for consumption and exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Imports of metallic bismuth		Exports of metal and alloys [1]	
	Pounds	Value	Pounds	Value
1946–50 (average)	471, 249	$706, 300	227, 211	$416, 200
1951	514, 020	1, 003, 285	146, 998	376, 246
1952	708, 254	1, 451, 729	244, 797	635, 260
1953	641, 428	1, 273, 417	127, 010	300, 963
1954	628, 833	1, 235, 321	137, 856	185, 841
1955	603, 649	1, 127, 789	203, 667	363, 186

[1] Gross weight.

TABLE 4.—Metallic bismuth imported [1] into the United States, 1952–55, in pounds

[U. S. Department of Commerce]

Country	1952	1953	1954	1955
North America:				
Canada		21, 670	34, 723	54, 788
Mexico		26, 605	63, 866	123, 722
Total		48, 275	98, 589	178, 510
South America: Peru	661, 822	437, 779	400, 278	326, 415
Europe:				
Belgium-Luxembourg		11, 641		
Netherlands		7, 716	3, 307	17, 204
Yugoslavia	35, 330	49, 419	74, 725	66, 039
Total	35, 330	68, 776	78, 032	83, 243
Asia	[2] 11, 102	[2] 86, 599	[2] 67, 358	[3] 7, 398
Grand total	708, 254	641, 429	644, 257	595, 566

[1] Data are "general" imports; that is, they include bismuth imported for immediate consumption plus material entering the country under bond.
[2] Republic of Korea.
[3] Japan.

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

TECHNOLOGY

A technical paper on the study of diffusion in liquid lead-bismuth alloys stated in the abstract:[4]

Diffusivity of bismuth in liquid Pb-Bi alloys has been measured by the capillary reservoir method as a function of temperature and composition. Fair agreement between theory and experiment is found for the measured diffusion coefficients and activation energies of diffusivity and viscosity in dilute lead alloys. The measured diffusion coefficients in the high bismuth alloys describe mass transport in special concentration gradients.

In one of the designs for a liquid-metal fuel reactor under investigation,[5] the fuel selected is a solution of uranium dissolved in bismuth. The blanket or fertile material is a dispersion of an intermetallic compound of thorium and bismuth (probable composition Th_3Bi_5) in bismuth. Graphite is being considered as the moderator for the core and blanket. The choice of these materials has given rise to a number of corrosion and chemical problems. The problems that have been studied to date are the rate and extent of reaction of uranium with graphite, the reaction of uranium with materials of construction, and the mass transport of materials of construction (steels) by the U–Bi solution. The status of this work was the subject of an article. The authors' conclusion stated:

* * * In conclusion, although it has not yet been established that low chrome steels and graphite can be used as containing and moderating materials, the experimental and engineering evidence suggest that these materials show promise as construction materials for a reactor in which U–Bi is the fuel.

The refining of bismuth in Peru was described in a paper.[6]

The slimes from the corroded anodes of both the copper and lead refineries, after drying, weighing, and sampling, are mixed and treated together for the recovery of bismuth, silver and gold. * * *

* * * As the refining of bismuth is somewhat unusual, it may be described in more detail. The crude metal reduced from the cupel slags is melted and first treated with caustic soda to remove tellurium; it is next cooled and a copper dross taken off. After transference to another kettle, zinc is added, which collects any silver and gold remaining; usually two zinc treatments are necessary. In a third kettle, chlorine gas is passed through the metal to remove lead and zinc as chlorides. In the following kettle, the dissolved bismuth chloride is removed from the metal by the passage of air. After a final treatment with caustic soda to clean up the metal, it is cast by hand from the fifth kettle into ten-pound bars. Refined bismuth is the most pure of all our products and contains close to 99.999% bismuth.

Other products of the slimes treatment plant are a bullion containing 60% bismuth and 40% lead and a eutectic alloy of 55.5% bismuth and 44.5% lead, melting at 255° F., which was developed locally and is known as "Cerro Base." Another of our numerous low-melting alloys is "Cerrolow," a eutectic of bismuth, lead, tin, cadmium, and indium which has a melting point of 117° F. and is of interest.

The conclusions of a technical paper describing the results of investigation on the production of high-purity metallic bismuth follows:[7]

---

[4] Grace, R. E., and Derge, G., Diffusion in Liquid Lead-Bismuth Alloys: Jour. Metals, vol. 7, No. 7 July 1955, pp. 839–842.

[5] Weeks, J. R., Klamut, C. J., Silberberg, M., Miller, W. E., and Gurinsky, D. H., Corrosion Problems With Bismuth Uranium Fuels: United Nations, Peaceful Uses of Atomic Energy, vol. 9, August 1955 pp. 341–355.

[6] Barker, I. L., Complex Metallurgy by Cerro de Pasco: AIME Tech. Paper, Ann. Meeting, New York, N. Y., Feb. 20–23, 1956, pp. 6, 7.

[7] Sajin, N. P., and Dulkina, P. Y., (U. S. S. R.), Production of High-Purity Metallic Bismuth: United Nations, Peaceful Uses of Atomic Energy, vol. 9, August 1955, pp. 265–269.

1. A study was made of a method of purifying bismuth nitrate solutions from silver by cementation.
2. The hydrometallurgical scheme of obtaining high-purity bismuth is proposed including the method of cementation of silver on metallic bismuth.
3. The behaviour of a number of impurities during the refining of bismuth by crystallophysical methods has been studied.
4. The possibility of obtaining high-purity bismuth by the Czochralski method and the method of zone-melting has been established.

A United States patent was issued in 1955 relative to bismuth.[8]

WORLD REVIEW

Australia.—Bismuth ores were smelted and refined by Bismuth Products Pty., Ltd., Sydney.

Bolivia.—In 1955 bismuth exports totaled 113,000 pounds contained in ore and concentrate, compared with 102,000 pounds in 1954.

Canada.—The Consolidated Mining & Smelting Co. of Canada, Trail, B. C., continued during 1955 as Canada's largest bismuth producer. Some shipments of low-quality bismuth metal were made by the Molybdenite Corp. of Canada, Ltd., from its operations at La Corne, Quebec.

Korea.—In 1955 bismuth production at the Sang Dong mine decreased to 250,000 pounds in 1955 from 254,000 pounds in 1954.

Mexico.—Mexican production of bismuth in 1955 totaled about 774,000 pounds, of which 256,000 pounds was refined metal and 518,000 pounds of bismuth contained in impure lead bullion. The principal Mexican producers were the American Smelting & Refining Co. and Compania Metalurgica Penoles, S. A. (subsidiary of The American Metal Co.).

---

[8] Aragones, J. J. F. G., Devaud, Charles, and Reinwald, Oskar (assignors to Voltohm Processes Limited, Tangier, Morocco), Process of Making Bismuth Resistances: U. S. Patent 2,712,521, July 5, 1955.

TABLE 5.—World production of bismuth, by countries,[1] 1946–50 (average), and 1951–55, in pounds [2]

(Compiled by Augusta W. Jann)

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada (metal) [3]	211,926	230,298	162,373	117,366	258,675	207,670
Mexico [3]	469,661	745,100	672,297	739,209	759,900	773,800
United States	(4)	(4)	(4)	(4)	(4)	(4)
South America:						
Argentina:						
Metal	[5] 19,400	(6)	[5] 1,100	(6)	(6)	16,314
In ore [5]	14,100	(6)	1,100	1,340	10,140	20,720
Bolivia (in ore and bullion exported) [7]	81,411	150,788	35,119	138,731	101,467	94,600
Peru [3]	547,365	579,049	714,828	631,990	691,726	734,714
Europe:						
France (in ore)	109,348	198,000	190,000	159,000	23,631	69,445
Spain (metal)	39,857	33,466	27,044	56,006	32,985	43,500
Sweden	10,337		(6)	(6)	(6)	145,500
Yugoslavia (metal)	90,486	193,476	217,600	217,047	241,842	229,516
Asia:						
China (in ore)	[5] 12,743	(6)	(6)	(6)	(6)	(6)
Japan (metal)	53,435	92,615	96,068	110,159	118,610	142,364
Korea, Republic of	[5 8] 211,950	27,600	243,000	529,000	254,000	287,000
Africa:						
Belgian Congo (in ore)	[9] 1,367	496	1,036		2,127	(6)
Mozambique	728	1,567	11,199	7,057	1,905	4,145
South-West Africa (in ore) [5]	[10] 8,488	200		100	2,500	2,370
Uganda	[8] 10,567	6,385	6,200	1,100	400	320
Union of South Africa (in ore)	6,543	7,019	3,391	[5] 2,200	1,120	228
Oceania: Australia (in ore)	4,905	2,575	3,153	880	1,345	(6)
World total (estimate) [1]	3,100,000	3,900,000	3,900,000	4,200,000	3,600,000	3,800,000

[1] Bismuth is believed to be produced also in Brazil, East Germany, Rumania, and U. S. S. R. Production figures are not available for these countries, but estimates by senior author of chapter are included in total.
[2] This table incorporates a number of revisions of data published in previous Bismuth chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[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 senior author of chapter included in table.
[7] Excludes bismuth content of tin concentrates exported.
[8] Average for 1948–50.
[9] Average for 1947–50.
[10] Average for 1949–50.

Spain.—Production of bismuth in Spain totaled about 44,000 pounds compared with 33,000 pounds in 1954.

United Kingdom.—A report [9] stated that imports of bismuth from the dollar area were limited to the value of approximately $1.4 million yearly. Imports from all countries outside the dollar area were admitted under Open General License.

[9] Metal Bulletin (London), No. 3991, May 6, 1955, p. 25.

Boron

By Henry E. Stipp[1] and Annie L. Marks[2]

PRODUCTION of boron minerals in 1955 increased 17 percent to a record high of 924,000 short tons. Increased future production was indicated, as one firm announced plans for a major expansion program and a new mining concern entered the field. Two firms offered large quantities of high-purity elemental boron at reduced prices.

TABLE 1.—Salient statistics of boron minerals and compounds in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Sold or used by producers: [1]						
Short tons:						
Gross weight	499,777	862,797	583,828	715,228	[2] 790,449	924,496
B_2O_3 content	148,080	241,000	169,100	213,300	[2] 230,500	293,165
Value [3]	$11,993,920	$20,030,000	$14,105,000	$17,668,000	$26,714,440	$24,357,723
Imports for consumption (refined):						
Pounds	21,519	1,424	[4] 860	624		22,046
Value	$1,429	$497	[4] $306	$216		[5] $2,401
Exports:						
Short tons	92,410	213,445	103,292	139,317	205,614	222,588
Value	$5,307,092	$13,322,383	$6,723,925	$8,971,987	$12,904,410	$14,532,971
Apparent consumption: Short tons [6]	407,378	649,353	480,536	575,911	[2] 584,835	701,919

[1] Borax, anhydrous sodium tetraborate, kernite, boric acid, and colemanite.
[2] Revised figure.
[3] Partly estimated.
[4] In addition, 88 pounds of crude valued at $2.
[5] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to earlier years.
[6] Quantity sold or used by producers, plus imports minus exports.

For boron minerals, Bureau of the Census quantity figures represent net shipments, whereas Bureau of Mines quantity figures represent gross shipments. Moreover, Bureau of the Census figures for the value of shipments of boron minerals represent the value of net shipments of crude boron minerals and boron minerals prepared by crushing, milling, magnetic separation, drying, fusing, evaporation, and carbonation. Bureau of Mines figures for the value of shipments represent the value of gross shipments of boron minerals prepared by the methods described above and, in addition, include the value of shipments of refined boron compounds, such as refined borax, boric

[1] Commodity specialist.
[2] Statistical assistant.

acid, and ammonium borate, obtained from crude or prepared boron minerals. The refining of crude or prepared boron minerals to obtain boron compounds is classified by the Census Bureau in the manufacturing Industry 2819, Industrial inorganic chemicals, n. e. c.

DOMESTIC PRODUCTION

The entire domestic production of boron minerals came from California in 1955, as it has for many years. Boron minerals were mined in Inyo and Kern Counties and extracted from brines in San Bernardino County.

Pacific Coast Borax Co. began work on an $18 million expansion program, which was scheduled to be completed in the summer of 1957. Construction of a new refinery concentrator, adequate for handling all types of ore, will enable the company to convert to a system of open-pit mining. The program was aimed at increasing productive capacity by enabling lower grade portions of the deposit to be exploited.

California Borate Co. began preliminary work on two properties, the old Western Borax mine and the adjacent Little Placer lease near Boron, Calif. Reconditioning and unwatering of a mine shaft, preliminary extension of drifts and crosscuts, and erection of a head frame and hoist installation were completed.

The following firms reported production of boron compounds in 1955 all from California: American Potash & Chemical Corp. recovered boron minerals from the brine of Searles Lake at Trona; Pacific Coast Borax Co. mined kernite from a bedded deposit in the Kramer district and colemanite (hydrous calcium borate) at Death Valley Junction; United States Borax Co. produced colemanite from a vein deposit near Shoshone; and West End Chemical Co. recovered boron minerals from Searles Lake brine.

The following firms produced boron alloys and related compositions:

Producer:	*Products*
American Electro Metal Corp., Yonkers, N. Y.	Miscellaneous metal borides; experimental.
American Potash & Chemical Corp., Trona, Calif.	Elemental amorphous boron (purity: 90 to 92 percent).
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.
Foote Mineral Co., Philadelphia, Pa.	Ferroalloys.
F. W. Berk Co., Inc., Wood-Ridge, N. J.	Elemental boron.
Kawecki Chemical Co., Boyertown, Pa.	Grain refiners; boron alloys.
Metal Hydrides, Inc., Beverly, Mass.	Borohydrides of sodium, lithium, beryllium, and other elements.
Metalsalts Corp., Hawthorne, N. J.	Elemental amorphous boron.
Molybdenum Corp. of America, Washington, Pa.	Ferroboron, manganese boron, cobalt boron, chromium boron, calcium boron.

Producer—Continued	*Products*
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.
Stauffer Chemical Co., Niagara Falls, N. Y.	Boron trichloride.
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, New York, N. Y.	Grainal alloys, ferroboron, boron-ferrosicilon.

CONSUMPTION AND USES

Numerous diverse uses for boron and boron compounds were reported in 1955. Elemental boron served as a deoxidizer in nonferrous-metal production, an igniter in rectifier and control tubes, a neutron absorber in atomic work, and a grain refining alloy. Extremely small percentages of boron in low-carbon and alloy steels increase their hardenability and effect a saving of other alloying metals. The element has been suggested for use in fuel for jet engines, motor-starting devices, thermal cutouts for transformers, thermoelectric couples, pivot bearings, wire dies, and variable resistor devices and as a reducing agent for many refractory oxides.

Compounds of boron with many metals are some of the hardest substances known, next to the diamond. Borides of zirconium and titanium are superrefractories, since they have melting points of about 3,000° C.

Inorganic borates were used in soaps, cleansers, and synthetic detergents. Borax or boric acid was used in pharmaceuticals, starches, adhesives, chemicals, fireproofing, and smelting.

Boron trifluoride was used in the resins and allied organic field as a catalyst for the production of polybutene.

TABLE 2.—Consumption of alloying metals in the manufacture of steel in the United States, 1951–55 [1]

	Net tons of named alloying metal contained [2]				
	1951	1952	1953	1954	1955
Boron	15	26	18	14	9
Chromium	152,009	138,950	160,826	117,578	174,292
Cobalt	1,291	1,317	1,273	703	849
Columbium and tantalum	227	170	150	178	178
Manganese	(3)	503,959	624,751	550,680	743,186
Molybdenum	9,281	8,117	9,348	7,090	10,659
Nickel	37,973	42,439	39,607	31,425	44,021
Titanium	1,921	1,877	1,742	1,062	1,438
Tungsten	1,875	1,093	1,383	947	1,803
Vanadium	1,562	1,279	1,339	817	1,364
Zirconium	854	663	846	498	756

[1] American Iron and Steel Institute, Annual Statistical Report: New York, N. Y., 1955, p. 24 (these figures supersede those shown on p. 19 of the Annual Statistical Report for 1954).
[2] Does not include alloying metal contained in scrap.
[3] Data not available.

TABLE 3.—Production of alloy-steel ingots (other than stainless-steel ingots) in the United States, net tons [1]

Grade	1954		1955	
	Without boron	With boron	Without boron	With boron
Carbon-boron		22,974		51,047
Nickel	26,796		35,554	
Molybdenum	455,131	53,782	678,558	33,346
Manganese	194,709	23,222	277,947	18,286
Manganese-molybdenum	307,631		329,397	
Chromium	1,116,999	64,168	1,769,489	121,337
Chromium-vanadium	41,284		74,449	
Nickel-chromium	96,648		141,599	
Chromium-molybdenum	686,609		1,047,464	73
Nickel-molybdenum	359,567	2,466	495,293	6,244
Nickel-chromium-molybdenum	851,406	57,018	1,358,455	76,323
Silico-manganese	69,171		119,204	
All other	413,389	3,546	606,647	10,577
Subtotal	4,619,340	227,176	6,934,056	317,233
High-strength steels	528,894	17,752	843,357	15,057
Silicon sheet steels	902,429		1,263,829	
Total all grades	6,050,663	244,928	9,041,242	332,290

[1] American Iron and Steel Institute, Annual Statistical Report: New York, N. Y., 1955, p. 59.

Boron trichloride was used as a catalyst in silicone production, as a source of boron for borocarbon resistors, as an extinguishing agent for magnesium fires, and as a synthesis intermediate.

Borate esters were used as dehydrating agents, synthesis intermediates, special solvents, sources of boron for catalysts, plasticizers and adhesion additives for latex paint, fire retardants in plastics, and protective coatings and ingredients of soldering or brazing fluxes.

PRICES

In September the price of most boron compounds was increased. This was the first increase since May 1953. According to Oil, Paint and Drug Reporter, the following prices for boron compounds were quoted during 1955:

	Jan.-Aug.	*Sept.-Dec.*
Borax, tech., anhydrous, bags, carlots, works, ton	$78.00	$80.50
Ton lots, ex warehouse, New York or Chicago, ton	125.75	130.25
Bulk, carlots, works, ton	70.00	71.50
Crystals, 99½ percent, bags, carlots, works, ton	67.25	69.25
Ton lots, ex warehouse, New York or Chicago, ton	115.00	119.00
Granular decahydrate, 99½ percent, bags, carlots, works, ton	41.25	43.25
Ton lots, ex warehouse, New York or Chicago, ton	89.00	93.00
Bulk, carlots, works, ton	35.75	36.75
Pentahydrate, 99½ percent, bags, carlots, works, ton	55.50	57.75
Ton lots, ex warehouse, New York or Chicago, ton	108.25	107.50
Powder, 99½ percent, bags, carlots, works, ton	46.25	48.25
Ton lots, ex warehouse, New York or Chicago, ton	94.00	98.00
Borax packed in kegs is $45.50 per ton higher than in paper bags; in barrels $24.50 higher. U. S. P. borax $15 per ton higher than technical.		
Acid, boric, tech., 99½ percent:		
Crystals, bags, carlots, works	124.25	126.75
Ton lots, ex warehouse, New York or Chicago, ton	172.00	176.50
Granular, bags, carlots, works, ton	99.25	101.75
Ton lots, ex warehouse, New York or Chicago, ton	147.00	151.50

Boric acid in kegs $45.50 per ton higher than in paper bags. U. S. P. boric acid $25 per ton higher.

In September, the price of amorphous elemental boron 90–92 percent purity, shipments of 2,000 pounds or more, produced by Pacific Coast Borax Co., was quoted at about $10 to $13 per pound; and 95–97 percent purity, shipments of 2,000 pounds or more at about $12 to $15 per pound.

American Potash & Chemical Corp. reduced prices for elemental boron (90–92 percent purity) during 1955. The following prices were quoted in the latter part of the year: 1–4 lb. lots, $25 per lb.; 5–24 lb. lots, $20 per lb.; 25–99 lb. lots, $15 per lb.; 100 lb. and over, $13 per lb.

FOREIGN TRADE[3]

Exports of boron minerals and compounds from the United States in 1955 rose to 222,600 short tons valued at $14.5 million. Imports of refined-boron compounds totaled 22,000 pounds valued at $2,400. Canada, West Germany, and Austria were the only countries that exported boron products to the United States in 1955.

TABLE 4.—Boric acid and borates (crude and refined) exported from the United States, 1954–55, by countries of destination

[U. S. Department of Commerce]

Country	1954		1955	
	Short tons	Value	Short tons	Value
North America:				
Canada	9,987	$768,768	11,657	$907,579
Canal Zone	8	1,400		
Costa Rica	320	23,138	75	5,566
Cuba	437	29,921	476	36,076
Dominican Republic	28	2,549		
El Salvador	3	1,140	3	1,260
Guatemala	5	1,710	(1)	1,220
Haiti	1	810	1	1,000
Honduras			20	1,480
Mexico	3,236	294,952	3,694	341,538
Nicaragua	10	3,517	8	3,466
Panama	7	2,480		
Trinidad and Tobago	36	2,542	25	1,891
Total	14,078	1,132,927	15,959	1,301,076
South America:				
Argentina	48	21,125	1	1,093
Bolivia			16	2,525
Brazil	7,479	550,082	2,587	182,431
British Guiana			18	1,316
Colombia	550	51,882	716	64,817
Ecuador			2	846
Peru	344	31,002	219	12,790
Uruguay	288	27,632	267	27,994
Venezuela	343	27,760	320	26,537
Total	9,052	709,483	4,146	320,349
Europe:				
Austria	2,304	109,911	2,358	111,004
Belgium-Luxembourg	4,710	269,816	4,883	300,312
Denmark	1,531	74,528	432	26,751
Finland	996	56,807	767	46,625
France	21,255	1,178,905	25,520	1,475,077
Germany, West	45,146	2,474,578	53,357	3,121,099
Greece	154	7,805	136	10,129
Ireland	831	54,698	710	52,781
Italy	6,844	348,991	10,017	495,413

[1] Less than 1 ton.

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

TABLE 4.—Boric acid and borates (crude and refined) exported from the United States, 1954–55, by countries of destination—Continued

[U. S. Department of Commerce]

Country	1954		1955	
	Short tons	Value	Short tons	Value
Europe—Continued				
Netherlands	10,762	$696,186	11,184	$807,779
Norway	899	65,287	1,456	111,792
Portugal	797	53,764	685	41,634
Spain			688	34,892
Sweden	3,418	212,706	3,361	208,100
Switzerland	4,176	282,688	4,192	276,158
Turkey			15	2,670
United Kingdom	51,675	3,330,367	47,201	3,305,298
Yugoslavia	213	12,946	346	26,113
Total	155,711	9,229,983	167,308	10,453,627
Asia:				
Ceylon	60	6,236	109	6,227
Hong Kong	3,098	190,671	4,765	292,379
India	3,624	234,385	3,759	269,289
Indonesia	72	5,497	421	22,140
Iran	181	18,036	231	11,420
Israel	150	11,986	352	21,589
Japan	11,185	717,511	15,082	997,846
Korea, Republic of	123	9,873		
Lebanon	28	2,274	18	1,480
Malaya			111	7,302
Pakistan	38	1,768	340	21,409
Palestine	55	4,599		
Philippines	411	31,439	335	27,234
Syria	10	700	28	2,513
Taiwan	602	37,499	485	30,288
Thailand	6	810	93	6,472
Vietnam, Laos, Cambodia [2]			59	2,868
Other Asia			11	631
Total	19,643	1,273,284	26,199	1,721,087
Africa:				
Egypt	424	24,188	370	29,347
Federation of Rhodesia and Nyasaland	295	22,690	289	19,164
Union of South Africa	1,321	123,017	2,019	182,802
Other Africa			39	5,299
Total	2,040	169,895	2,717	236,612
Oceania:				
Australia	4,111	313,112	5,239	415,446
British Western Pacific Islands	7	2,277	15	4,692
New Zealand	972	73,449	1,005	80,082
Total	5,090	388,838	6,259	500,220
Grand total	205,614	12,904,410	222,588	14,532,971

[2] Formerly Indochina.

TECHNOLOGY

During 1955 extensive research on the use of boron in glass and ceramics, metallurgy, agriculture, atomic energy, chemistry, and medicine was reported in trade journals and the scientific press.

A reactor control system using boron trifluoride gas as the neutron absorber was described.[4] Greater economy compared to a control-rod system and very fine reactivity control are the chief advantages claimed for the carefully designed system. A disadvantage was danger of gas leakage during reactor operation. The strength of the

[4] Cawley, W. E., Using Boron Trifluoride Gas for Reactor Control: Nucleonics, vol. 13, No. 8, August 1955, pp. 30–33.

B^{10} isotope was checked constantly, owing to burnout of the isotope during operation of the reactor.

Techniques of producing zirconium diboride by interacting ZrO_2, B_4C, B_2O_3, and carbon in a simple resistance furnace at 2,000° C. was reported.[5] Borides such as TiB_2, CrB, W_2B_5, CoB, FeB, and MnB_2 have been made by the same technique.

Coatings of refractory boron compounds applied to several types of steel by welding, hard facing, and pack diffusion methods resisted corrosion in molten zinc.[6] Sintered mixtures of iron and chromium borides resisted corrosion at 600° C. and developed strengths of about 30,000 p. s. i.

A self-bonded boron nitride body was made by hot pressing at relatively high temperature and moderate pressure.[7] The material had an average boron nitride content of 97 percent and a density of about 2.1 grams per cubic centimeter. It had high electrical resistivity, was stable in air to 700° C. and oxidized slowly from 700° to 1,000° C., had low weight loss in chlorine at 700° C., resisted some corrosive liquids, and was not wet by molten glass. The boron nitride resembled graphite in crystalline structure, machining, and lubricating properties.

Storage stability and engine cleanliness of cracked gasolines were reported to be improved by treatment with anhydrous boron trifluoride.[8] Treatment at room temperature for 1 to 10 minutes with 0.1 percent of boron trifluoride produced stable naphthas from highly unstable, high-sulfur, heavy-fluid, catalytically cracked naphthas. An unstable, high-sulfur, heavy, thermally cracked naphtha was treated with 0.05 percent of boron trifluoride.

A report that described a convenient method for preparing pyridine-borane ($C_5H_5NBH_3$) was published.[9] Pyridine was reacted with sodium borohydride to yield pyridine-borane, sodium chloride, and hydrogen. The halide was precipitated quantitatively from the solution and separated from the pyridine-borane by filtration. The excess pyridine was distilled away under vacuum at 50°. Unreacted pyridine was precipitated by adding an equal volume of ether. The ether was pumped off and the treatment repeated 2 or 3 times to yield pure pyridine-borane.

A method was developed for reacting sodium borohydride and aluminum chloride to give aluminum borohydride and sodium chloride.[10] Side reactions produced diborane and hydrogen as byproducts. Since the preparation and handling of the borohyride are complicated by high volatility, ease of hydrolysis, and spontaneous flammability in air, all operations were conducted in the absence of air or moisture.

A report was published on the determination of traces of boron (0.1 to 1 p. p. m.) in silicon, germanium, and germanium dioxide.[11]

5 Baroch, C. T., and Evans, T. E., Production of Zirconium Diboride From Zirconia and Boron Carbide: Jour. Metals, vol. 7, No. 8, August 1955, pp. 908–911.

6 Hodge, Webster, Evans, R. M., and Haskins, A. F., Metallic Materials Resistant to Molten Zinc: Jour. Metals, vol. 7, No. 7, July 1955, pp. 824–832.

7 Taylor, K. M., Hot-Pressed Boron Nitride: Ind. Eng. Chem., vol. 47, No. 12, December 1955, pp. 2506–2509.

8 Beuther, H., and Goldthwait, R. G., Boron Trifluoride Treatment of Cracked Gasolines: Ind. Eng. Chem., vol. 47, No. 4, April 1955, pp. 764–769.

9 Taylor, M. D., Grant, L. R., and Sands, C. A., A Convenient Preparation of Pyridine-Borane: Jour. Am. Chem. Soc., vol. 77, No. 6, Mar. 20, 1955, pp. 1506–1507.

10 Hinkamp, J. B., and Hnizda, V., Aluminum Borohydride Preparation: Ind. Eng. Chem., vol. 47, No. 8, August 1955, pp. 1560–1562.

11 Luke, C. L., Determination of Traces of Boron in Silicon, Germanium, and Germanium Dioxide: Anal. Chem., vol. 27, No. 7, July 1955, pp. 1150–1153.

457676—58——17

Sodium silicate or germanate was removed by precipitation from aqueous sodium hydroxide solution, with the addition of excess methanol. Boron was isolated by distillation as methyl borate and determined photometrically.

Trimeric N-methylaminoborane was prepared conveniently and in yields of 80 to 90 percent by heating methylaminoborane at 100°.[12] The compound was very soluble in methyl and ethyl alcohol, acetone, and liquid ammonia. It was moderately soluble in benzene, ether, and chloroform and insoluble in carbon tetrachloride, petroleum, ether, and water.

The preparation of three quaternary ammonium fluoborates—tetramethyl-, tetraethyl-, and tetra-n-butylfluoborate—was discussed.[13] The method of preparation consisted of reacting tetraalkylammonium chloride and hydroxide with an aqueous solution of fluoboric acid.

Infrared absorption spectra of fused B_2O_3 and of soda borate glasses were obtained using vacuum-pressed briquets of powdered glass and powdered KBr.[14] The fused B_2O_3 was said to consist of complexes of B_9O_{14} held together by hydrogen bonds. One in nine borons was tetrahedrally coordinated. Glasses of low soda content were similar to fused B_2O_3. Spectra for soda concentrations greater than 15 percent differed from that found in 10-percent Na_2O glasses.

A cermet layer was brazed to alloys and to ingot iron by dipping or spraying the metal with a slip consisting of chromium-boron-nickel powder, frit, clay, and water and heating to 1,900° to 2,000° F. in a combustion-gas atmosphere.[15] In addition to its moderate ductility and excellent thermal-shock resistance, cermet layers as thin as 0.002 inch provided oxidation protection for more than 800 hours at 1,500° F. in heating tests.

An experiment in which diborane reacted rapidly with an ether slurry of lithium amide to give lithium borohydride and polymeric aminoborine was reported.[16] When the reaction is carried out under controlled conditions, there is an absence of side reactions.

The direct synthesis of boron hydrides by reaction of metal borides and hydrogen at 250° to 400° C. was described.[17] Diborane was also prepared by reacting commercial boron and hydrogen at about 840° C.

An investigation to determine the effect of boron on the relative interfacial tension of gamma iron was conducted.[18] In all instances boron appeared to reduce interfacial energy; however, this was not considered to be adequate evidence to explain completely the hardenability effect.

A study of the effect of boron in low-carbon steels indicated that boron increased the hardenability by decreasing the nucleation rate

[12] Bissot, T. C., and Parry, R. W., Preparation and Properties of Trimeric N-Methylaminoborane: Jour. Am. Chem. Soc., vol. 77, No. 13, July 5, 1955, pp. 3481–3482.
[13] Wheeler, C. M., Jr., and Sandstedt, R. A., Preparation of Substituted Quaternary Ammonium Fluoborates: Jour. Am. Chem. Soc., vol. 77, No. 7, Apr. 5, 1955, pp. 2025–2026.
[14] Anderson, S., Bohon, R. L., and Kimpton, D. D., Infrared Spectra and Atomic Arrangement in Fused Boron Oxide and Soda Borate Glasses: Jour. Am. Ceram. Soc., vol. 38, No. 10, October 1955, pp. 370–377.
[15] Moore, D. G., and Cuthill, J. R., Protection of Low-Strategic Alloys With a Chromium-Boron-Nickel Cermet Coating: Am. Ceram. Soc. Bull., vol. 34, No. 11, Nov. 15, 1955, pp. 375–382.
[16] Schaeffer, G. W., and Basile, L. J., The Reaction of Lithium Amide With Diborane: Jour. Am. Chem. Soc., vol. 77, No. 2, Jan. 20, 1955, pp. 331–332.
[17] Newkirk, A. E., and Hurd, D. T., The Direct Synthesis of Boron Hydrides: Jour. Am. Chem. Soc., vol. 77, No. 1, Jan. 5, 1955, pp. 241–242.
[18] Adair, A. M., Spretnak, J. W., and Speiser, R., Effect of Boron on the Relative Interfacial Tension of Gamma Iron: Jour. Metals, vol. 7, No. 2, February 1955, pp. 353–354.

of ferrite and bainite.[19] Boron concentrated at grain boundaries or lattice imperfections, decreasing energy available for the formation of ferrite and bainite nuclei. Increased boron content or increased temperature gave a greater concentration of boron at grain boundaries, a loss of the boron hardenability effect, and the precipitation of boron.

Motion pictures taken through the transparent head of an automobile engine showed that boron reduced surface ignition.[20] Surface-ignition counts and ionization-gap measurements were used to study the antiknock effect of boron in gasoline.

A number of patents that described the nature of boron compounds used in motor fuel were reported in 1955.[21] Alkyl boronic acid or its ester, or an ester of an alkanediol and an alkyl boronic acid, was added to motor fuel to minimize the octane requirement of engines using the fuel.

A motor fuel containing from 0.5 to about 5 ml. per gallon of tetraethyl lead and from 0.1 to about 3 ml. per gallon of a boronate ester was patented.[22]

A flux that contained powdered boron efficiently reduced the oxide coating on sintered chromium carbide making possible its brazing in air without special equipment.[23] Best results were secured with a combination of borated flux and a special silver-alloy filler metal. The new technique is expected to pave the way toward wider use of cemented chromium carbide in applications around the 600° F. range.

A series of experiments designed to test the toxic effects of decaborane ($B_{10}H_{14}$) on laboratory animals was reported.[24] Varying amounts of the compound were administered by intraperitoneal injection, oral administration, and percutaneous application. Severity of intoxication depended on the dosage of the compound, regardless of the mode of administration. Evidence of damage to liver and kidney and harmful effects to the central nervous system were observed.

WORLD REVIEW

Argentina.—Argentina produced 13,000 metric tons of ulexite (boronatrocalcite) in 1955.[25]

Germany, West.—Production of boron compounds in West Germany in 1955 was reported to be 40,470 metric tons.[26]

Italy.—Production of 3,707 metric tons of boric acid (98 percent H_3BO_3) was reported.[27]

---

[19] Simcoe, C. R., Elsea, A. R., and Manning, G. K., Study of the Effect of Boron on the Decomposition of Austenite: Jour. Metals, vol. 7, No. 1, January 1955, pp. 193–199.

[20] Chemical and Engineering News, Fuel Additives Leveling Off?: Vol. 33, No. 39, Sept. 26, 1955, pp. 4048–4049.

[21] Darling, Samuel M. (assigned to The Standard Oil Co., Cleveland, Ohio), Motor Fuel Containing an Alkyl Boronic Acid: U. S. Patent 2,710,251, June 7, 1955 (assigned to The Standard Oil Co., Cleveland, Ohio) Alkanediol Esters of Alkyl Boronic Acids and Motor Fuel Containing Same: U. S. Patent 2,710,252, June 7, 1955.

[22] Arimoto, Fred S. (assigned to E. I. du Pont de Nemours & Co., Wilmington, Del., a corporation of Delaware), Motor Fuels: U. S. Patents 2,720,448 and 2,720,449, Oct. 11, 1955.

[23] Iron Age, New Flux Simplifies Brazing of Chrome Carbide: Vol. 176, No. 25, Dec. 22, 1955, p. 82.

[24] Svirbely, J. L., Toxicity Tests of Decaborane for Laboratory Animals: Arch. Ind. Health, vol. 11, No. 2, February 1955, pp. 132–136.

[25] United States Embassy, Buenos Aires, State Department Despatch 824, Apr. 27, 1956, 4 pp.

[26] United States Embassy, Bonn, Germany, State Department Despatch 2489, June 11, 1956, 2 pp.

[27] United States Embassy, Rome, Italy, State Department Despatch 1929, May 16, 1956, 3 pp.

Turkey.—During 1955 Turkey produced 42,186 metric tons of boron minerals.[28]

Boron ores in Turkey are obtained from the Sultan Cayir mines (Susurluk County, Balikesir Il), 60 kilometers south of the port of Bandirma on the Sea of Marmara and between Susurluk and Balikesir. Calcium borate (priceite or pandermite) was the principal ore mineral. Recent prospecting has resulted in the discovery of boron minerals south of the old mining area in Digadic County. A new boron deposit was reported to be under development in Mustafa Kemalposa County in Bursa Il and in the vicinity of Egridir County seat in Isporta Il.

[28] United States Embassy, Ankara, Turkey, State Department Despatch 510, Apr. 24, 1956, 1 p.

Bromine

By Henry E. Stipp [1] and Annie L. Marks [2]

PRODUCTION of bromine and bromine compounds in the United States during 1955 declined slightly below the record production of 1954. The antiknock-gasoline market remained the principal outlet for bromine, but in 1955 there was widespread interest in the technical aspects and commercial development of other uses.

DOMESTIC PRODUCTION

Bromine is said to have been produced for the first time in the United States from natural brines at Freeport, Pa., about 1846. Natural brines from West Virginia, Ohio, and Michigan continued to be the leading source of bromine production until 1937. In 1934 Ethyl-Dow Chemical Co. began commercial extraction of bromine from ocean water near Wilmington, N. C. Bitterns from solar evaporation of ocean water had been used previously as a source of bromine in California. In 1955 bromine was recovered from sea water, well brines, and saline lake brines. Most of the supply was recovered from sea water, much of it being produced as a coproduct of magnesium.

Ethyl-Dow Chemical Co. recovered bromine from sea water at Freeport, Tex., and Westvaco Chemical Division of Food Machinery & Chemical Corp. operated a sea-water plant in the San Francisco Bay area. The following firms recovered 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. Westvaco Chemical Division at South Charleston, W. Va., also treated well brines. American Potash & Chemical Corp. recovered bromine from the brine of Searles Lake in California.

Michigan Chemical Corp. (St. Louis, Mich.) was reported planning to build a bromine plant near El Dorado, Ark., in collaboration with Murphy Corp. of El Dorado. Completion of construction is scheduled for the fall of 1956.[3] The Smackover oil district is to be the source of bromine-bearing brine.

[1] Commodity specialist.
[2] Statistical clerk.
[3] Chemical Week, vol. 77, No. 22, Nov. 26, 1955, p. 18.

TABLE 1.—Bromine and bromine in compounds sold by primary producers in the United States, 1946–50 (average) and 1951–55

Year	Pounds	Value	Year	Pounds	Value
1946-50 (average)	76,846,827	$14,657,179	1953	164,143,348	$35,372,386
1951	129,563,073	26,179,556	1954	187,399,110	41,312,669
1952	156,201,577	30,639,292	1955	184,453,846	39,855,508

TABLE 2.—Bromine and bromine compounds sold by primary producers in the United States, 1954–55

	Pounds		Value
	Gross weight	Bromine content [1]	
1954			
Elemental bromine	8,886,400	8,886,400	$2,224,332
Sodium bromide	(2)	(2)	(2)
Potassium bromide	3,024,996	2,031,284	844,347
Ammonium bromide	(2)	(2)	(2)
Other, including ethylene dibromide	208,538,592	176,481,426	38,243,990
Total	220,449,988	187,399,110	41,312,669
1955			
Elemental bromine	7,643,812	7,643,812	$1,884,715
Sodium bromide	(2)	(2)	(2)
Potassium bromide	2,660,742	1,786,688	753,992
Ammonium bromide	(2)	(2)	(2)
Other, including ethylene dibromide	206,381,298	175,023,346	37,216,801
Total	216,685,852	184,453,846	39,855,508

[1] Theoretical bromine content present in compound.
[2] Included with "Other, including ethylene dibromide."

CONSUMPTION AND USES

The chief bromine compound used in 1955 was ethylene dibromide, which is added to tetraethyl lead for use as an antiknock mixture in gasoline. The increasing number of high-compression automobile engines and the complex problem of preignition has been responsible for the growth in consumption of gasoline with higher octane ratings and the consequent greater use of ethylene dibromide. Prospects for continued high consumption of ethylene dibromide may be affected by sale of high-octane gasoline made without additives and development of types of engines that do not require high-octane fuel.

Bromine compounds, such as ethylene dibromide, methyl bromide, and chlorobromopropene, were used in soil fumigants. Methyl bromide was reported used as a fumigant of stored, sacked food to control the Khapra beetle.[4]

Sodium, potassium, lithium, calcium, strontium, and magnesium bromides were used in medicinal and pharmaceutical preparations. According to one estimate, they comprise 10 to 15 percent of all medical prescriptions.

The consumption of elemental bromine used for water treatment has increased because difficult transportation and handling problems have been solved.

[4] Chemical Week, Firm Base for a Boost: Vol. 77, No. 8, Aug. 20, 1955, p. 83.

Cotton with superior flame resistance was produced by Southern Regional Research Laboratory, using treatments with tetrakis hydroxymethyl phosphonium chloride and bromoform allyl phosphate.[5]

The compound "bromochloromethane" is an effective extinguisher of gasoline and electrical fires. Efficiency and safety are its chief advantages over other extinguishing agents, but its corrosive properties could become deterrent to wider use.

Bromine and bromine compounds also were used in photography, leather and rubber products, flour and bread, and many organic syntheses.

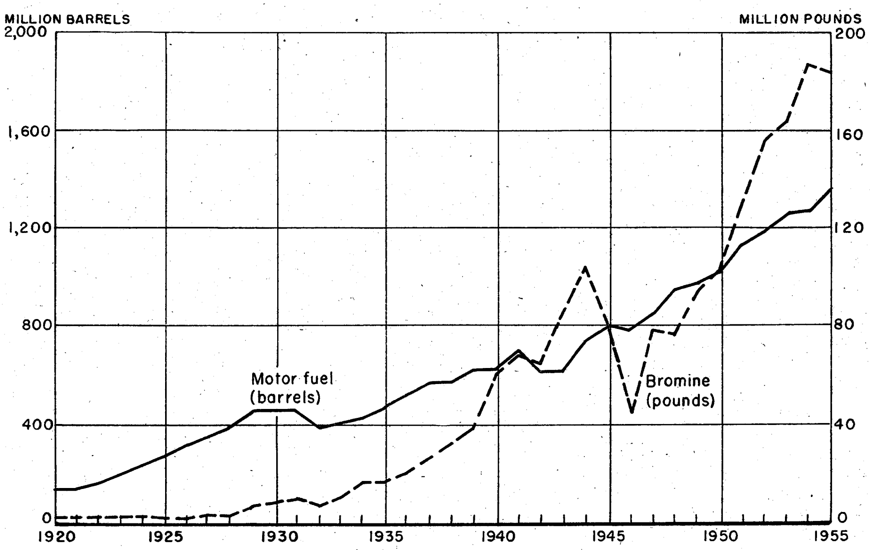

FIGURE 1.—Bromine and bromine in compounds sold or used and motor fuel produced, 1920–1955.

PRICES

According to Oil, Paint and Drug Reporter, the following prices were quoted for bromine and bromine compounds, January through December 1955: Bromine, purified, cases, carlots, delivered east of the Rocky Mountains, was quoted at 31 cents a pound; less than carlots, up to 1,000-pound lots, same basis, was quoted at 33 to 38 cents a pound; drums, lead-lined, delivered east of the Rocky Mountains, was quoted at 30 cents a pound. Potassium bromide, U. S. P., granular, barrels, kegs, was quoted at 34 to 35 cents a pound from January to March, 35 to 36 cents a pound from March to September, and 36 cents a pound for the remainder of the year. Potassium bromate, barrels, 1,000 pounds or more, was quoted at 50 to 52 cents a pound from January through February, 47 cents a pound from February to October and 50 cents a pound for the remainder of the year. Sodium bromide, U. S. P., barrels, kegs, works, was quoted at 34 to 35 cents a pound from January to April, 35 cents a pound from April to September, and 36 cents a pound for the remainder of the year.

[5] Chemical and Engineering News, Cotton With Superior Flame Resistance: Vol. 33, No. 34, Aug. 22, 1955, p. 3453.

FOREIGN TRADE [6]

Exports of bromine, bromides, and bromates (not separately classified) totaled 3,649,861 pounds valued at $1,656,202 in 1955. The largest quantity of bromine and bromine compounds (1,587,160 pounds) went to Brazil, 468,959 pounds went to Canada, and the remainder (in small lots) to 36 other countries.

A small quantity of bromine and bromine compounds was imported into the United States in 1955. A total of 659 pounds valued at $110,949 was imported from 8 countries; the largest quantities came from the United Kingdom, West Germany, and Australia. Imports of 27 pounds of sodium bromide came from Denmark and 6 pounds from the United Kingdom. No imports of potassium bromide and ethylene dibromide were recorded.

TECHNOLOGY

The introduction of 1.0 to 3.5 percent (by weight) of bromine to butyl-type polymers caused a significant increase in their vulcanizing rate without adversely affecting other useful properties of butyl.[7] Both sulfur and metal oxide served as vulcanizing agents for brominated butyl which was covulcanized with natural rubber and GR–S, imparting to them properties such as low air diffusion and resistance to ozone and flex cracking.

An investigation of the Armstrong procedure for determining bromates added to flour showed that fairly close estimates of bromate can be made by using the Armstrong procedure and dividing the results obtained by the factor 0.95.[8] Standardizing of procedure by determining a recovery factor as directed by Armstrong was recommended.

Two types of unbleached and untreated flour were fumigated with methyl bromide and tested for bromide residues and taint.[9] The flour was subjected to a high dose of 95 grams for a period of 25 hours, 45 minutes, and a low dose of 35 grams for a period of 19 hours, 30 minutes, at 20° C. in a space, of 3,000 liters. After a high dose, residues detected in 1 type of flour ranged from 49 to 52 p. p. m. bromide ion and 41 to 49 in the other type of flour. Low-dose residues ranged from 14 to 21 and from 14 to 18 p. p. m. It was concluded that, in general, no significant abnormal taints were produced by the levels of fumigation described.

The addition of small quantities of potassium bromate (0.008 percent) to wheat flour was said to reduce fermentation time of bread dough and improve its potential baking properties.[10] Overtreatment of bread doughs with potassium bromate was characterized by ruptures of the dough surface, prolonged fermentation periods, irregular bread grain, and irregular bread crust. The defects of a

---

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

[7] Morrissey, R. T., Butyl-Type Polymers Containing Bromine: Ind. Eng. Chem., vol. 47, No. 8, August 1955, pp. 1562–1569.

[8] McRoberts, Lewis H., Report on Potassium Bromate in Flour: Jour. Assoc. Off. Agric. Chemists, vol. 38, No. 3, Aug. 15, 1955, pp. 563–572.

[9] Brown, W. Burns, and others, The Fumigation of Flour With Methyl Bromide: Chem. and Ind., Mar. 19, 1955, pp. 324, 325.

[10] Doose, O., and Walter, K., The Influence of Flour Treated With Potassium Bromate and Ammonium Persulfate Upon Dough Produced by Various Methods: Am. Assoc. Cereal Chem., vol. 13, No. 2, June 1955, pp. 130–146.

dough damaged by overtreatment with bromate were relieved by remixing the dough with 1 to 2 liters of water per 100 kg. of flour.

Resistant stages of three common parasites were tested under controlled laboratory and semifield conditions with concentrations of methyl bromide.[11] It was concluded that *Aspergillus fumigatus* on agar, *Ascoridia galli* eggs in water, and *Eimeria tenella* oocysts in water are killed by methyl bromide when 1 cc. per quart of space or 1 pound per 100 sq. ft. of floor space is used.

The concentration of methyl bromide at 3 positions in a stack of 225 nursery-soil flats was correlated with its ability to kill 6 species of fungi and the root-knot nematode.[12] The results showed that all test organisms were killed, with the exception of *Verticellium alboatrum*.

Ratio measurements of two bromide isotopes by precision mass spectrometry were reported.[13] The ratio $NaBr^{79+}/NaBr^{81+}$ averaged as follows: Michigan brines, 1.0231 ± 0.0040; Searles Lake brines, 1.0224 ± 0.0062; Pacific Ocean brines, 1.0214 ± 0.0043; West Virginia brines, 1.0202 ± 0.0016; and Gulf water (ethylene dibromide) 1.0206 ± 0.0040.

The extinguishing efficiency of carbon tetrachloride and bromochloromethane was measured in laboratory tests by determining their effect on the flammability limits of a combustible.[14] It was concluded that bromochloromethane was markedly superior to carbon tetrachloride because of its effect on rich mixtures of combustible with air near the upper flammability limit.

WORLD REVIEW

France.—French production of bromine in 1955 was reported at 1,350 metric tons.[15]

Germany, West.—Production of 1,411 metric tons of bromine and bromine compounds was reported.[16]

Israel.—The withdrawal of one firm as an active participant in the venture to produce and market bromine in connection with potash operations at S'dom caused delay in initiating bromine production. Political unrest was said to be responsible for the decision.

Italy.—Italy produced 43,592 kg. of bromine during the 1955 calendar year.[17]

---

[11] Edgar, S. A., and King, D. F., The Effectiveness of Methyl Bromide in Sterilizing Poultry Litter: Poultry Sci., vol. 34, No. 3, May 1955, pp. 595-597.
[12] Nunnecke, D. E., and Lindgren, D. L., Chemical Measurements of Methyl Bromide Concentration in Relation to Kill Off Fungi and Nematodes in Nursery Soil: Phytopathology, vol. 44, No. 10, October 1954, pp. 605-606.
[13] Cameron, A. E., and Lippert, E. I., Jr., Isotopic Composition of Bromine in Nature: Science, vol. 121, No. 3135, Jan. 28, 1955, p. 136.
[14] Coleman, E. H., and Stark, G. W. V., A Comparison of the Extinguishing Efficiencies of Bromochloromethane and Carbon Tetrachloride: Chem. and Ind. (London), May 14, 1955, p. 563.
[15] United States Embassy, Paris, France, State Department Despatch 2478, June 22, 1956, 3 pp.
[16] United States Embassy, Bonn, Germany, State Department Despatch 2489, June 11, 1956, 2 pp.
[17] United States Embassy, Rome, Italy, State Department Despatch 1929, May 16, 1956, 3 pp.

Cadmium

By Arnold M. Lansche[1]

DEMAND for cadmium in 1955 balanced supply. Demand, based on apparent consumption, was 44 percent above that of 1954 and 12 percent over the previous record of 1953. New supply, consisting of metal production at domestic plants and imports of metal, was 9 percent above that of 1954. Total stocks declined 26 percent during the year. The Office of Defense Mobilization announced that minimum objectives for cadmium stocks in the National Stockpile had been met. Measured consumption was 24 percent less than apparent consumption.

Imports of cadmium metal (for consumption) exceeded those of 1954 by 131 percent; cadmium in imported flue dust was up 24 percent. Exports (metal and metal content of flue dust) were about 40 percent above those of 1954.

TABLE 1.—Salient statistics of the cadmium industry in the United States, 1946–50 (average) and 1951–55, in pounds of contained cadmium

	1946-50 (average)	1951	1952	1953	1954	1955
Production (primary)	8,034,400	8,311,337	8,567,159	9,767,197	9,551,710	[1] 9,753,699
Imports for consumption (metal)	166,966	90,065	1,478,770	1,555,140	402,299	927,495
Exports [2]	580,722	[3] 812,451	300,918	65,866	998,959	1,393,915
Consumption, apparent	7,907,849	7,170,930	9,007,577	9,570,063	[3] 7,424,134	10,689,376

[1] Metallic cadmium production only.
[2] Includes metal, dross, flue dust, residues, scrap, and alloys.
[3] Revised figure.

DOMESTIC PRODUCTION

The entire domestic plant output of primary cadmium was recovered as a byproduct from the flue dusts of zinc blende roasting furnaces and copper and lead blast furnaces, from zinc dust collected in the early stages of distillation in zinc retorts, from the high-cadmium precipitate obtained in purifying zinc electrolyte at electrolytic zinc plants, and from the zinc-cadmium sludge resulting from purification of zinc sulfate solutions used in manufacturing lithopone. United States production of primary cadmium was not wholly from domestic materials; a large portion of the output was obtained from foreign materials, notably imports of cadmium-bearing flue dust and zinc and lead ores and concentrates. In 1955, as in the 3 previous years, United States imports of zinc concentrates were considerably above the average for earlier years; consequently, in 1952–55 it was estimated that over 60 percent of the cadmium metal produced at domes-

[1] Commodity specialist.

tic plants was of foreign origin. New cadmium-bearing raw materials were obtained from countries in the Western Hemisphere. Mexico, Canada and Peru, in that order, were the primary sources.

A relatively small quantity of secondary metal was recovered from old bearings and other alloy scrap.

Production of primary cadmium metal at domestic plants in 1955 increased about 4 percent above 1954 and nearly 1 percent over 1953, the previous peak year. Recovery of cadmium as secondary metal and in compounds produced from secondary materials increased 107 percent.

TABLE 2.—Cadmium produced and shipped in the United States, 1946–50 (average) and 1951–55, in pounds of contained cadmium

	1946–50	1951	1952	1953	1954	1955
Production:						
Primary:						
Metallic cadmium	7,732,790	8,114,238	8,387,824	9,682,197	9,415,710	9,753,699
Cadmium compounds [1]	301,610	197,099	179,335	85,000	136,000	(2)
Total primary production	8,034,400	8,311,337	8,567,159	9,767,197	9,551,710	9,753,699
Secondary (metal and compounds) [1 3]	278,495	167,957	80,000	70,000	138,000	285,800
Shipments by producers:						
Primary:						
Metallic cadmium	7,678,321	7,767,055	7,746,361	8,137,045	7,921,741	11,166,830
Cadmium compounds [1]	301,610	197,099	179,335	85,000	136,000	(2)
Total primary shipments	7,979,931	7,964,154	7,925,696	8,222,045	8,057,741	11,166,830
Secondary (metal and compounds) [1 3]	285,665	87,633	122,785	59,636	148,874	285,800
Value of primary shipments:						
Metallic cadmium	$12,774,306	$19,397,411	$17,130,966	$15,229,861	$11,925,068	$15,729,230
Cadmium compounds [4]	489,366	492,215	396,581	158,950	204,000	(2)
Total value	13,263,672	19,889,626	17,527,547	15,388,811	12,129,068	15,729,230

[1] Excludes compounds made from metal.
[2] Bureau of Mines not at liberty to publish.
[3] Bureau of Mines not at liberty to publish figures separately for secondary cadmium compounds.
[4] Value of metal contained in compounds made directly from flue dust or other cadmium raw materials (except metal).

TABLE 3.—Recovery of cadmium per ton of recoverable zinc, 1941–45 (average) and 1946–55

	1941–45 (average)	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
Mine production of recoverable zinc (thousand short tons)	719	575	638	623	593	623	681	661	547	465	504
Imports of recoverable zinc in zinc concentrates (thousand short tons) [1]	340	231	253	225	212	237	260	383	436	386	418
Total production of primary cadmium (thousand pounds)	8,047	6,471	8,508	7,776	8,227	9,191	8,311	8,567	9,767	9,552	9,815
Cadmium recovered from imported flue dust (thousand pounds) [2]	1,723	1,488	2,120	1,645	1,611	1,442	1,446	1,793	1,678	1,340	1,853
Cadmium recovered from domestic and foreign zinc concentrates (thousand pounds)	6,324	4,983	6,388	6,131	6,616	7,749	6,865	6,774	8,089	8,212	7,962
Cadmium recovered per ton of recoverable zinc (pounds)	6.0	6.2	7.2	7.2	8.2	9.0	7.3	6.5	8.2	9.6	8.6

[1] Calculated as 85 percent of the zinc content.
[2] Calculated as 90 percent of the cadmium content.

The efficiency of cadmium recovery operations was improved in the period 1941–55 as a larger market for cadmium developed. The quantity of cadmium recovered in 1955 per ton of recoverable zinc was 43 percent above the 1941–45 average of 6 pounds.

The plants producing cadmium metal in the United States in 1955 were:

Primary metallic cadmium

Colorado: Denver—American Smelting & Refining Co.
Idaho:
- Bradley—The Bunker Hill & Sullivan Mining and Concentrating Co.
- Silver King—Sullivan Mining Co.

Illinois:
- Depue—The New Jersey Zinc Co.
- East St. Louis—American Zinc Co. of Illinois

Kansas: Coffeyville—Sherwin-Williams Co.
Missouri: Herculaneum—St. Joseph Lead Co.
Montana: Great Falls—The Anaconda 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.

Texas: Corpus Christi—American Smelting & Refining Co.
Utah: International—International Smelting & Refining Co.

Secondary metallic cadmium

Arkansas: Jonesboro—Arkansas Metals Co.
New York: Whitestone, L. I.—Neo-Smelting & Refining, Inc.
Illinois: Chicago—United Smelting & Refining Corp.

A number of zinc- and lead-producing plants that did not produce refined cadmium had facilities for collecting cadmium fume, dust, sponge, or residues; these plants are listed as follows:

Arkansas:
- Fort Smith—Athletic Mining & Smelting Co.
- Fort Smith—The Residue Co.

Colorado: Canon City—New Jersey Zinc Co.

Illinois:
- Alton—American Smelting & Refining Co.
- La Salle—Matthiessen & Hegeler Zinc Co.
- Monsanto—American Zinc Co. of Illinois

Oklahoma: Blackwell—Blackwell Zinc Co.

Pennsylvania: Palmerton—New Jersey Zinc Co.

Texas:
- Amarillo—American Smelting & Refining Co.
- Dumas—American Zinc Co. of Illinois

Utah:
- International—International Smelting & Refining Co.
- Midvale—United States Smelting, Refining & Mining Co.

The cadmium content of sulfide pigments increased by 29 percent in 1955. Output of cadmium oxide which was published in the past cannot be disclosed beginning with 1955. Production data on other cadmium compounds were not collected.

TABLE 4.—Cadmium oxide and cadmium sulfide produced in the United States, 1946–50 (average) and 1951–55, in pounds

Year	Oxide		Sulfide [1]	
	Gross weight	Cd content	Gross weight	Cd content
1946–50 (average)	459,904	401,076	3,458,310	1,240,149
1951	606,369	528,645	3,118,413	955,742
1952	608,236	531,018	2,665,955	898,629
1953	1,094,263	956,100	3,920,402	1,229,282
1954	958,709	838,222	3,470,127	1,045,669
1955	(2)	(2)	4,190,837	1,348,100

[1] Includes cadmium lithopone and cadmium sulfoselenide.
[2] Bureau of Mines not at liberty to publish.

CONSUMPTION AND USES

The apparent consumption of primary cadmium in all forms approximated 10.7 million pounds in 1955, as computed by adding production and net imports of metal and adjusting for producers', compound manufacturers', and distributors' stock changes. Apparent consumption for 1955 was 44 percent above that of 1954 and 12 percent over the previous record set in 1953. Factors that contributed to the sharp increase in apparent consumption in 1955 were: (1) The lack of a premium price on cadmium in special shapes for platers; (2) the high level attained in the production of manufactured goods using cadmium; (3) the increased popularity of the colors red and yellow and their various shades on automobiles and trucks (production of automobiles and trucks was up 29 and 9 percent, respectively, in 1955).

A consumption canvass was undertaken in 1955 to establish the pattern of cadmium use by industry and geographic areas and to determine changes that might have developed since World War II, when such a canvass was made.

Measured consumption was 76 percent of apparent consumption; the difference was attributed to incomplete coverage of the cadmium consuming industry. Electroplating, pigment and chemical production, and low-melting-point alloys accounted for about 92 percent

TABLE 5.—Distribution, by uses, of cadmium consumed in the United States during 1955

Use	Pounds	Percent of total
Electroplating	4,705,186	57.60
Pigments and chemicals	2,464,488	30.17
Low-melting alloys	351,931	4.31
Brazing alloys	208,697	2.55
Other metal and alloys	177,614	2.17
Solder	10,209	0.13
Bearing alloys	4,550	0.06
Other uses [1]	245,969	3.01
Total	[2] 8,168,644	100.00

[1] Includes copper-cadmium alloys (1,280 pounds), paints and varnishes, ceramics, leather, chemical reagents, plastics and photography.
[2] Includes 522,814 pounds of cadmium oxide (cadmium content) of which 167,371 pounds were used for electroplating and other metal alloys, 182,609 and 172,834 pounds for pigments and chemicals and other uses, respectively.

of the measured consumption, with electroplating by far the largest use. For 1940–44 (the last use-canvass), 71 percent of total consumption was for electroplating, 11 percent for bearing alloys, and the remainder for pigments, solders, miscellaneous alloys and various chemicals.

Electroplating.—Cadmium was used as a protective coating for iron and steel and to a much smaller extent for high-copper alloys and other metals and alloys. Cadmium coatings were applied most commonly by electrodeposition and to some extent by spraying or hot dipping.

Table 6 shows consumption of cadmium in electroplating, by uses. Although more than 19 uses were reported, consumption in fasteners of various types, automotive parts, communications, aircraft parts, electrical equipment, and hardware represented 75 percent of the total.

TABLE 6.—Distribution of cadmium consumed in electroplating in 1955

Use	Pounds	Percent of total
Nuts, bolts, screws, nails, tacks, rivets, fasteners, etc	880,357	18.7
Automobile, truck, tank, and tractor parts	781,224	16.6
Communications (radio, television, telephone signal apparatus)	569,788	12.1
Aircraft parts (including rivets, bolts, etc.)	516,942	11.0
Electrical equipment (exclusive of communications)	430,044	9.1
Hardware (not classifiable elsewhere)	336,502	7.2
Building materials and equipment (including conduit fittings)	196,400	4.2
Ordnance parts (guns, ammunition, and containers)	193,270	4.1
Office machinery and supplies	95,240	2.0
Textile machinery parts	88,638	1.9
Household appliances	43,824	.9
Ship parts and equipment	25,647	.5
Control instrument parts	22,522	.5
Bicycles	20,392	.4
Heating and refrigeration equipment	14,127	.3
Amusement and vending machines	12,306	.3
Industrial machinery parts	9,063	.2
Petroleum industry equipment	7,044	.1
Medical, health, and safety equipment	2,504	.1
Other electroplating [1]	459,352	9.8
Total	4,705,186	100.0

[1] Products plated included food containers, conveyor parts, toys, grocery racks, instruments, fishing equipment, fire-fighting equipment, job plating, decorative items, machine and hand tools, and other manufactured items.

Cadmium-Base Bearing Alloys.—One of the major uses of cadmium was as a bearing alloy. Cadmium-base bearing metals were used in internal-combustion engines for service under high pressures and temperatures and at high speeds.

Cadmium Solders and Other Cadmium Alloys.—Cadmium alloyed with such metals as copper, lead, tin, zinc, and silver forms solders; the most widely used were the cadmium-silver solders.

Cadmium metal was alloyed with lead, bismuth, and tin to make low-melting-point alloys for fire-detection apparatus, fusible elements in automatic sprinkler heads, firedoor release links, automatic shutoffs for gas and electric water-heating systems, safety plugs for compressed-gas cylinders, and temperature-controlled safety clutches.

Cadmium alloys easily with copper, and master alloys containing up to 50 percent cadmium were marketed for addition to copper and bronze. Low-cadmium copper (0.7 to 1 percent cadmium), which is very ductile, found wide use in telegraphic, telephonic, and power-transmission wires. An alloy of copper-zirconium-cadmium, also used for power-transmission lines, is superior in strength and hardness to copper-cadmium alloys.

Cadmium Compounds.—The most important cadmium compounds were the sulfide and the sulfoselenide. Their chief uses were as paint pigments that provide colors ranging from yellow to dark maroon. These compounds, extended with barium sulfate, are known as cadmium lithopones. Cadmium pigments were used as finishes on automobiles where heat resistance is essential; the increased use of cadmium pigments in automotive finishes provided much of the increase demand experienced by the cadmium industry in 1955.

The shortage of selenium since 1950 continued to limit the output of cadmium sulfoselenide pigments. A new line of cadmium colors in which mercury was substituted for selenium as a basic material was introduced on the market in late 1955. These nonbleeding, heat-resistant, alkali-fast permanent colors were expected to supplement the cadmium sulfoselenide pigments and relieve the shortage.

Virtually all the cadmium oxide, hydrate, and chloride produced was used in electroplating solutions. Cadmium chloride, bromide, and iodide were 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 the Minerals Yearbook, 1949.

Nickel-Cadmium Batteries.—These batteries were used chiefly for heavy-duty purposes, such as in buses and diesel locomotives. More widespread use of the automobile-type battery appears to be hindered by high cost, which was considerably above that of a comparable lead-acid battery.

Cadmium in Atomic Energy.—Small quantities of cadmium were used for shielding and fission control in atomic energy reactors. In the latter use cadmium absorbs neutrons and thus reduces their availability for supporting the chain reaction. The thermal neutron-absorption cross section of cadmium is one of the highest of any material readily available. Its ability to absorb neutrons makes it valuable for shielding purposes in conjunction with lead.

STOCKS

The Office of Defense Mobilization announced that the minimum objective for cadmium in the National Stockpile was met in 1955. Industry stocks of cadmium metal and cadmium contained in compounds decreased 31 and 24 percent, respectively, in 1955.

PRICES

Throughout 1955 the quoted price of cadmium metal in sticks, bars and platers' shapes, delivered in 1- to 5-ton lots, was $1.70 per pound.

The London market quotation per pound of cadmium varied from 11s. 6d. ($1.61) to 11s. 8d. ($1.63), holding the lower price for the last quarter. The French market quotation per kilo (2.2046 pounds) of cadmium showed a 100-franc variation ranging from 1,300 to 1,400

TABLE 7.—Industry stocks at end of year, 1954–55, in pounds of contained cadmium [1]

	1954 [2]			1955		
	Metallic cadmium	Cadmium compounds	Total cadmium	Metallic cadmium	Cadmium compounds	Total cadmium
Metal producers (primary)	4,541,714		4,541,714	3,128,583		3,128,583
Compound manufacturers	99,445	468,660	568,105	129,294	301,223	430,517
Distributors [3]	244,454	48,853	293,307	359,187	82,742	441,929
Total stocks	4,885,613	517,513	5,403,126	3,617,064	383,965	4,001,029
Consumers' stocks	738,792	151,888	890,680	784,326	193,213	977,539

[1] Excludes cadmium in National Stockpile.
[2] Revised figures.
[3] The increase in distributors' stocks above those previously reported is due to the increase in the number of distributors reporting in the cadmium consumption survey conducted for 1955.

francs ($1.69 to $1.82) per pound during the year, ending the year at 1,400 francs. The Italian market quotation began the year at a high of 2,500 to 2,800 lire per kilo ($1.81 to $2.03 per pound) of cadmium, then slid to a low of 2,300 lire ($1.67 per pound) and ended the year slightly recovered at 2,350 lire ($1.70 per pound).

FOREIGN TRADE [2]

Imports.—General imports of cadmium metal and flue dust (cadmium content) in 1955 were 126 percent above those of 1954.

Total imports for consumption in 1955 were 46 percent over those of the previous year. The increase in imports for consumption was attributed to the increase in cadmium consumption during the year. Canada and Belgium-Luxembourg together supplied 80 percent of the metallic cadmium imported for consumption. Mexico supplied all of the flue dust.

Exports.—United States exports of cadmium (metal, alloys, dross, flue dust, residues, and scrap) increased 40 percent to 1,394,000 pounds in 1955. Of this quantity the United Kingdom received 812,000 pounds, West Germany 307,000 pounds, and the Netherlands 187,000 pounds.

Tariff.—The import duty on cadmium metal remained at 3.75 cents per pound in 1955, the rate established January 1, 1948, as a result of action taken at the Geneva Trade Conference of 1947. Before that time the import duty had been 7.50 cents per pound, as established in the Canadian Trade Agreement of 1939. Cadmium contained in flue dust remained duty free in 1955.

TECHNOLOGY

Cadmium in the form of cadmium oxide found use in the manufacture of electrical contacts. It was reported that cadmium oxide and silver when mixed,[3] pressed, and sintered together by a new sintering process can be made into low-cost electrical contacts with improved life and performance over the conventional silver ones. The current-

[2] Figures on U. S. imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.
[3] American Metal Market, vol. 62, No. 182, Sept. 20, 1955, pp. 1, 11.

457676—58——18

TABLE 8.—Cadmium metal and flue dust imported[1] into the United States, 1953–55, by countries

[U. S. Department of Commerce]

Country	1953 Pounds	1953 Value	1954 Pounds	1954 Value	1955 Pounds	1955 Value
METALLIC CADMIUM						
North America: Canada	508,946	$901,300	159,400	$248,529	665,392	$959,236
South America: Peru	10,925	21,850	28,637	50,500	27,826	47,744
Europe:						
Belgium-Luxembourg	536,523	933,860	93,000	165,557	263,344	382,350
Germany, West	4,079	7,341				
Italy	66,142	120,800	22,047	28,617	760,587	1,070,797
Netherlands	3,000	5,700			91,557	131,328
Norway	66,138	103,896				
United Kingdom			224	587		
Total Europe	675,882	1,171,597	115,271	194,761	1,115,488	1,584,475
Asia: Japan	211,175	337,867	44,094	65,224	247,046	347,480
Africa: Belgian Congo					220,500	330,750
Oceania:						
Australia	123,289	204,732	54,897	94,558		
New Zealand	24,923	36,507				
Total Oceania	148,212	241,239	54,897	94,558		
Total metallic cadmium	1,555,140	2,673,853	402,299	653,572	2,276,252	3,269,685
FLUE DUST (CD CONTENT)						
North America:						
Canada	67,959	132,801			160,774	186,189
Mexico	1,863,538	1,586,895	1,505,819	1,117,523	1,865,335	1,200,835
Total North America	1,931,497	1,719,696	1,505,819	1,117,523	2,026,109	1,387,024
South America:						
Bolivia	3,704	6,667				
Peru	2	4	11,400	18,167	32,562	35,330
Total South America	3,706	6,671	11,400	18,167	32,562	35,330
Total flue dust	1,935,203	1,726,367	1,517,219	1,135,690	2,058,671	1,422,354
Grand total	3,490,343	4,400,220	1,919,518	1,789,262	4,334,923	4,692,039

[1] Data are "general imports," that is, include cadmium imported for immediate consumption plus material entering the country under bond.

carrying capacity of electrical equipment can be significantly increased through use of these contacts. Increased capacity is due to the fact that cadmium oxide-silver contacts tend to weld together less than do the silver types. They were said to maintain a relatively uniform contact resistance over long periods of operation, even when arcing is severe. That is explained by the fact that cadmium oxide is not subject to oxidation as a result of arcing, as are contact materials such as tungsten.

WORLD REVIEW

NORTH AMERICA

Canada.—Production of cadmium in 1955 was 81 percent over that in 1954. The Consolidated Mining & Smelting Company of Canada, Ltd., Trail, British Columbia, and Hudson Bay Mining & Smelting Co., Ltd., Flin Flon, Manitoba, produced refined cadmium from the treatment of zinc concentrate from company and custom

TABLE 9.—Cadmium metal and flue dust imported for consumption in the United States, 1953–55, by countries

[U. S. Department of Commerce]

Country	1953 Pounds	1953 Value	1954 Pounds	1954 Value	1955 Pounds	1955 Value
METALLIC CADMIUM						
North America: Canada	508, 946	$901, 300	159, 400	$248, 529	565, 392	$802, 121
South America: Peru	10, 925	21, 850	28, 637	50, 500	27, 826	47, 744
Europe:						
Belgium-Luxembourg	536, 523	933, 860	93, 000	165, 557	175, 829	252, 828
Germany, West	4, 079	7, 341				
Italy	66, 142	120, 800	22, 047	28, 617	66, 143	88, 082
Netherlands	3, 000	5, 700			54, 606	77, 161
Norway	66, 138	103, 896				
United Kingdom			224	587		
Total Europe	675, 882	1, 171, 597	115, 271	194, 761	296, 578	418, 071
Asia: Japan	211, 175	337, 867	44, 094	65, 224	37, 699	52, 025
Oceania:						
Australia	123, 289	204, 732	54, 897	94, 558		
New Zealand	24, 923	36, 507				
Total Oceania	148, 212	241, 239	54, 897	94, 558		
Total metallic cadmium	1, 555, 140	2, 673, 853	402, 299	653, 572	927, 495	1, 319, 961
FLUE DUST (CD CONTENT)						
North America: Mexico	1, 863, 538	1, 586, 895	1, 482, 565	1, 077, 992	1, 832, 827	1, 146, 253
Total flue dust	1, 863, 538	1, 586, 895	1, 482, 565	1, 077, 992	1, 832, 827	1, 146, 253
Grand total	3, 418, 678	4, 260, 748	1, 884, 864	1, 731, 564	2, 760, 322	2, 466, 214

TABLE 10.—Cadmium metal, alloys, dross, flue dust, residues and s rap exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Pounds	Value	Year	Pounds	Value
1946–50 (average)	580, 722	$997, 054	1953	65, 866	$60, 256
1951	[1] 812, 451	2, 217, 651	1954	998, 959	1, 422, 040
1952	300, 918	1, 005, 370	1955	1, 393, 915	1, 938, 355

[1] Revised figure.

ores. The metal was accumulated in cadmium-rich precipitate resulting from purification of the zinc electrolyte used in the electrolytic process for making refined zinc.

EUROPE

European production amounted to approximately 3,746,000 pounds of cadmium, an increase of 7 percent above 1954. West German production totaled 709,000 pounds compared with 618,000 pounds in 1954. The principal producers of cadmium in West Germany were Unterharzer Berg-und Hüttenwerke G. m. b. H. and Berzelius Mettelhütten G. m. b. H. whose plants are at Harlingerode and Duisburg, respectively.

TABLE 11.—World production of cadmium, by countries, 1946–50 (average) and 1951–55, in thousand pounds [1]

[Compiled by Berenice B. Mitchell]

Country	1946–50 (average)	1951	1952	1953	1954	1955
Australia	572	517	641	665	645	674
Belgian Congo	51	54	45	71	139	366
Belgium [2]	373	990	1,210	1,040	1,100	(3)
Canada	796	1,327	949	1,118	1,087	1,971
France	119	187	195	283	313	397
Germany, West	10	154	141	227	618	709
Italy	121	441	293	401	458	433
Japan	78	259	367	459	600	750
Mexico [4]	1,724	1,969	1,618	2,113	1,130	2,855
Norway	128	221	163	197	178	255
Peru	3	-------	38	23	66	138
Poland [2]	305	400	420	485	500	550
South-West Africa [5]	829	1,434	1,112	1,194	1,620	1,402
Spain	7	9	12	16	21	[2] 22
U. S. S. R. [2]	129	180	225	275	300	330
United Kingdom	249	326	347	380	315	332
United States:						
Metallic cadmium	7,733	8,114	8,388	9,682	9,416	9,754
Cadmium compounds (Cd content)	302	197	179	85	136	(6)
World total (estimate)	10,980	13,380	14,610	15,410	15,900	17,920

[1] This table incorporates a number of revisions of data published in previous Cadmium chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[2] Estimate.
[3] Data not available; estimate included in total.
[4] Cadmium content of flue dust exported for treatment elsewhere; represents in part shipments from stocks on hand. To avoid duplicating figures, data are not included in the total.
[5] Cadmium content of concentrates exported for treatment elsewhere. To avoid duplicating figures data are not included in the total.
[6] Bureau of Mines not at liberty to publish.

United Kingdom.—Production of cadmium was up about 5 percent over 1954. Consumption of cadmium for 1955 was up 24 percent over 1954. Details of quantities used during the year for various purposes are as follows: Plating anodes, 1,008,000 pounds; plating salts, 219,500 pounds; alloys (including cadmium-copper), 210,600 pounds; batteries, 188,200 pounds; solder, 85,100 pounds; colors, 389,800 pounds; miscellaneous uses, 51,500 pounds. Commercial stocks of cadmium in the United Kingdom at the end of September 1955 totaled 347,200 pounds compared with 459,200 pounds at the end of the second quarter and 495,000 pounds at the end of the first quarter 1955.

AFRICA

Belgian Congo produced 366,000 pounds of cadmium from the Katanga plant at Kolwezi and was the source of most cadmium refined in Belgium. The Tsumeb mine in South-West Africa produced 1,402,000 pounds of cadmium in zinc concentrate, which was shipped abroad to recover contained metals.

Calcium and Calcium Compounds

By Richard A. Sperberg[1] and Annie L. Marks[2]

THE ELEMENT calcium is found in abundance as natural compounds in the crust of the earth. The most common occurrences are as limestone or marble, and dolomite. Other important calcium minerals are fluorspar (fluorite, CaF_2), phosphorite ($Ca_3(PO_4)_2$), gypsum (calcium sulfate, $CaSO_4.2H_2O$) and anhydrite ($CaSO_4$).

Calcium chloride and calcium-magnesium chloride are present in small quantities in sea water and as major constituents of natural brines and dry lake deposits.

Commercial manufacture of a number of commodities results in the byproduct production of large quantities of calcium chloride and calcium-magnesium chloride.

DOMESTIC PRODUCTION

Output of calcium chloride and calcium-magnesium chloride (produced from natural brines and dry lake deposits) in 1955 was one-third greater than in 1954.

Shipments of solid and flake (calcium chloride and calcium-magnesium chloride 77–80 percent) were 515,338 short tons valued at $13,040,000 in 1955, compared with 437,262 short tons valued at $10,786,000 in 1954.

Liquid calcium chloride and calcium-magnesium chloride (40–45 percent) shipments were 161,556 short tons valued at $1,533,000 in 1955, compared with 155,877 short tons valued at $1,351,000 in 1954.

Calcium silicon was produced, but production and consumption data are not available for publication.

Calcium-metal was produced by Nelco Metals Inc., Canaan, Conn. This firm produces the metal by thermal reduction of lime with aluminum in vacuum retorts. Ethyl Corp., Baton Rouge, La., discontinued production in 1953. The Electro Metallurgical Division, Union Carbide & Carbon Corp., Sault Ste. Marie, Mich., discontinued in 1954.

The following firms produced calcium chloride (and calcium-magnesium chloride) from natural brines in 1955: Hill Bros. Chemical Co., Saltus, Calif.; National Chloride Co. of America, Amboy, Calif.; Michigan Chemical Corp., St. Louis, Mich.; Wilkinson Chemical Co., Mayville, Mich.; The Dow Chemical Co., Midland, and Ludington, Mich.; Pomeroy Salt Corp., Minersville, Ohio; Westvaco Chlor-

[1] Commodity specialist.
[2] Statistical assistant.

Alkali Division, Food Machinery & Chemical Corp., South Charleston, W. Va.

The production by the two California producers was from the brine of Bristol Lake. In Michigan, Ohio, and West Virginia calcium chloride was recovered from well brines, with bromine and magnesia as coproducts.

CONSUMPTION AND USES

Calcium metal had many uses in the metallurgical industry—as a debismuthizer for lead; as a deoxidizer for stainless steel, other high-alloy steels, and copper; and as a desulfurizer for alloys and steels. As an alloying agent, calcium was used with aluminum, magnesium, tin, zinc, nickel, and many other metals and alloy compositions. It was also used in separating argon and nitrogen, dehydrating alcohol, and removing sulfur from petroleum fractions. Calcium also had potential applications as a reducing agent in preparing uranium, titanium, vanadium, thorium, zirconium, and chromium from their refractory oxide ores.[3]

Calcium chloride was used as a freezeproof agent for stockpiled materials, such as coal and iron ore. It was employed extensively for controlling ice and snow on highways and streets and in winter concreting work. The addition of calcium chloride at a rate of 2 percent by weight of cement in the mix is reported to be advantageous to the performance and quality of concrete. It was used also as a liquid ballast in tires of heavy vehicles, such as tractors. Calcium chloride solution not only protects against freezing within the tire, but adds extra weight, resulting in more drawbar pull, less tire wear and greater maneuverability. Extensive use was made of calcium chloride to stabilize and control dust on secondary roads, unpaved streets, and highway shoulders. Other uses included refrigeration brines in icemaking, dust control in the coal industry, and as a fire protective medium.

Calcium-silicon was used as a reducing agent in steel manufacture.

PRICES

E&MJ Metal and Mineral Markets quoted calcium metal, cast in slabs and small pieces, in ton lots, at $2.05 per pound, throughout 1955.

In 1955 the Oil, Paint and Drug Reporter quoted the price of calcium chloride as follows: Crystalline, purified, drums, jars, 27 cents per pound; flake, 77–80 percent, paper bags, carlots, works, freight equalized, $27 per ton for January through August and $29 per ton for September through December; liquor, 40 percent, tank cars, works, freight allowed, $11.35 per ton for January through August and $12.35 per ton for September through December; pellets, bags, carlots, works, $33 per ton for January through August, $35 per ton for September through November, and $35.40 per ton for December; powder, bags, carlots, works, $37.65 per ton for January through August and $39.65 per ton for September through December; solid, 73–75 percent, drums, carlots, freight equaled, $25.50 per ton for January through August and $27.50 per ton for September through

[3] Ethyl Corp., Crystalline Calcium Metal: New York, N. Y., 1952, 16 pp.

December; less than carlots, works, same basis, $34 to $71 throughout the year; U. S. P., granulated, drums, 40 cents per pound for January through March and 32 cents per pound for April through December.

FOREIGN TRADE[4]

Imports of calcium metal in 1955 increased slightly over 1954, but were still below the record year of 1953. Canada was the only supplier of metallic calcium. The imports of calcium-silicon alloy reached an alltime high. These imports were divided about equally between France and Italy.

TABLE 1.—Calcium metal and calcium-silicon imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Calcium metal		Calcium-silicon	
	Pounds	Value	Pounds	Value
1946–50 (average)	16,083	$14,860	338,867	$33,296
1951	574,636	602,226		
1952	751,215	807,997		
1953	990,017	1,009,934		
1954	685,417	728,379	178,138	22,055
1955	699,799	834,732	689,114	92,366

In 1955 calcium chloride was imported from Canada, United Kingdom, Belgium-Luxembourg, and West Germany. Approximately 95 percent of the calcium chloride exported went to Canada, Mexico, Cuba, and the Union of South Africa; Canada received over four-fifths of the total. The remaining 5 percent was distributed among 19 countries in Latin America, the Philippines, and southeast Asia.

TABLE 2.—Calcium chloride imported for consumption into and exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Imports		Exports	
	Short tons	Value	Short tons	Value
1946–50 (average)	690	$14,908	14,040	$443,930
1951	813	37,451	18,637	559,284
1952	1,333	45,888	19,193	594,904
1953	2,671	84,594	11,572	370,799
1954	1,547	51,249	10,987	374,332
1955	1,844	57,881	20,743	607,579

TECHNOLOGY

A report on roads treated with calcium chloride was made on research by the Calcium Chloride Institute, Highway Research Board Committee on Soils. It included data on shear tests, moistures, densities, raveling and potholing, road roughness and bond, and the use of calcium chloride in stabilizing soils.[5]

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.
[5] Calcium Chloride Institute News, vol. 5, No. 4, August 1955, pp. 6, 7.

The technical panel of the Calcium Chloride Institute reported that it is conducting research on the effects of calcium chloride on cement hydration.[6]

A simplified dehumidifier using flake calcium chloride was developed. The construction is reported to be simple and inexpensive and uses a standard 55-gallon drum. The reduction of high humidities in cooler rooms of cold-storage warehouses was an early application of this portable dehumidifying unit.[7]

Two new uses of calcium chloride were patented during the year. In one calcium chloride was used with sodium formate in a silage-preservative additive.[8] The other was a device, using bentonite and calcium chloride, that will indicate whether or not a frozen-food package has been permitted to reach a temperature that permits deterioration of the contents.[9]

WORLD REVIEW

Canada.—Canada continued to be the world leading producer of calcium. Calcium metal was produced by Dominion Magnesium, Ltd., Haley, Ontario, by the distillation method, through reduction of lime with aluminum in vacuum retorts. After collection, the crystalline calcium was melted and cast into ingots and billets or supplied in powder and granular form. Most of the calcium produced was exported to the United States and the United Kingdom. The growing importance of calcium is shown by the increase in production from 260 tons in 1949 to an estimated 2,100 tons in 1955.[10]

[6] Calcium Chloride Institute News, vol. 5, No. 5, October 1955, p. 5.
[7] Work cited in footnote 5, p. 5.
[8] Russell, E. J. (assigned to Trojan Powder Co., a corporation of N. Y.), Silage Preservative: U. S. Patent 2,714,067, July 26, 1955, Chem. Abs., vol. 49, No. 18, Sept. 25, 1955, col. 12752b.
[9] Beckett, J. S., and Marenus, W. J. (assigned to Aseptic Thermo Indicator Co., Los Angeles, Calif.), Telltale for Frozen-Food Packages: U. S. Patent 2,716,065, Sept. 23, 1955; Chem. Abs., vol. 49, No. 22, Nov. 25, 1955, col. 16263b.
[10] U. S. Consulate, Toronto, Canada, State Department Dispatch 188: Nov. 14, 1956.

Cement

By D. O. Kennedy [1] and Betty M. Moore [2]

ALTHOUGH production of cement in the United States continued to increase throughout 1955, rumors of future shortages were prevalent. Announcements by cement companies of expansion plans were countered by tales of delays in road projects in some sections of the country and grumblings about retarded building construction in others. Heavy imports of European cement tended to disturb the domestic cement industry further. During debate in the Congress of President Eisenhower's highway program, considerable interest was manifested in the future production of cement. Rejection of the program by the House of Representatives in July resulted in a temporary lull in the discussion of the cement-supply situation. Revival of the bill in the fall session of the Congress reopened and intensified the subject of whether enough cement would be available for the program.

During the year 33 portland-cement companies released to the press plans for expanding 62 operating plants and erecting 7 new plants. Such plans involved expending approximately $270 million and an expansion in annual production capacity of about 59 million barrels.[3] Seven new cement companies were formed, two of which actually began constructing plants during the year. These announcements were based on a wide variety of circumstances, ranging from firm commitments through mildly optimistic plans to visionary proposals with little hope of realization.

Planning agencies of the Federal Government with the responsibility for correlating Federal construction programs with State and local programs were unable to solve the problem of conflicting predictions as to future cement supplies. The Bureau of Mines was asked to undertake an expansion canvass of the portland-cement industry, with particular regard to expansion projects underway and plans definitely decided upon, with assured completion dates.

Concurrently three trade magazines conducted independent surveys of most of the cement companies, and the Select Committee on Small Business of the House of Representatives likewise undertook an expansion canvass.

The Bureau of Mines canvass, conducted in December 1955, showed expected expansions within the continental United States from 311 million barrels capacity in December 1955 to 358 million, 381 million, and 392 million barrels in December 1956, 1957, and 1958, respectively. These figures corroborated, to a large extent, the estimates of the portland-cement industry in the Bureau of Mines expansion

[1] Assistant chief, Branch of Construction and Chemical Materials.
[2] Statistical clerk.
[3] Barrel as used in this chapter, unless otherwise stated, refers to a 376-pound barrel.

canvass of 1954, which did not include increases that some companies felt might be made if changes in business conditions warranted.

In 1955 the cement industry in the United States produced four classes of cement—portland, natural, slag, and hydraulic lime—and prepared masonry cements.

Overall value of output increased more than 16 percent, owing in part to a 4-percent increase in average unit value.

TABLE 1.—Salient statistics of the cement industry in the United States, 1946–50 (average) and 1951–55 [1]

	1946–50 (average)	1951	1952
Production:			
Portland .... barrels	198, 357, 012	246, 022, 476	249, 256, 154
Prepared masonry .... do	(2)	(2)	(2)
Natural, slag, and hydraulic lime .... do	[3] 3, 259, 510	[3] 3, 449, 463	[3] 3, 401, 684
Total .... do	201, 616, 522	249, 471, 939	252, 657, 838
Capacity used at portland-cement mills .... percent	78. 0	87. 4	87. 8
Shipments from mills:			
Portland .... barrels	199, 040, 217	241, 153, 272	251, 368, 503
Prepared masonry .... do	(2)	(2)	(2)
Natural, slag, and hydraulic lime .... do	[3] 3, 257, 646	[3] 3, 475, 423	[3] 3, 447, 390
Total .... do	202, 297, 863	244, 628, 695	254, 815, 893
Value of shipments [4]	$427, 815, 270	$623, 003, 439	$648, 264, 065
Average value per barrel	$2. 11	$2. 55	$2. 54
Stock at mills, Dec. 31 .... barrels	12, 154, 138	18, 223, 906	16, 045, 980
Imports .... do	362, 177	921, 953	475, 986
Exports .... do	4, 967, 422	2, 932, 787	3, 174, 405
Apparent consumption [6] .... do	197, 692, 618	242, 617, 861	252, 117, 474
World production (estimated) .... do	601, 900, 000	[5] 879, 100, 000	[5] 940, 500, 000

	1953	1954	1955
Production:			
Portland .... barrels	264, 180, 522	272, 352, 557	297, 453, 321
Prepared masonry .... do	(2)	(2)	16, 518, 671
Natural, slag, and hydraulic lime .... do	[3] 3, 488, 102	[3] 3, 504, 380	941, 072
Total .... do	267, 668, 624	275, 856, 937	314, 913, 064
Capacity used at portland-cement mills .... percent	90. 5	91. 4	94. 3
Shipments from mills:			
Portland .... barrels	260, 878, 535	274, 871, 992	292, 764, 720
Prepared masonry .... do	(2)	(2)	16, 526, 082
Natural, slag, and hydraulic lime .... do	[3] 3, 459, 361	[3] 3, 513, 358	954, 414
Total .... do	264, 337, 896	278, 385, 350	310, 245, 216
Value of shipments [4]	$707, 603, 575	$773, 076, 462	$896, 887, 763
Average value per barrel	$2. 68	$2. 78	$2. 89
Stocks at mills, Dec. 31 .... barrels	19, 414, 334	[5] 16, 611, 889	17, 603, 708
Imports .... do	386, 051	450, 248	5, 219, 700
Exports .... do	2, 550, 788	[5] 1, 859, 012	1, 795, 448
Apparent consumption [6] .... do	262, 173, 159	[5] 276, 976, 586	313, 669, 468
World production (estimated) .... do	[5] 1, 042, 800, 000	[5] 1, 146, 200, 000	1, 277, 500, 000

[1] Includes Puerto Rico and Hawaii, 1946; Puerto Rico only, 1947–55. There has been no production in Hawaii since 1946.
[2] Not included in tabulation until 1955.
[3] Includes masonry cement from natural, slag, and hydraulic lime cement plants.
[4] Value received f. o. b. mill, excluding cost of containers.
[5] Revised figure.
[6] Shipments from domestic mills minus exports.

Domestic portland-cement plants operated at 94 percent of capacity in 1955 compared with 91 percent in 1954. The estimated annual capacity of the portland-cement facilities in the United States and Puerto Rico rose from 298 million barrels at the end of 1954 to 315 million barrels at the end of 1955, an increase of nearly 6 percent.

As indicated in figure 1, regional consumption of portland cement in 1955 followed the general trends established since 1945.

PORTLAND CEMENT

PRODUCTION AND SHIPMENTS

Well over 99 percent of the hydraulic cement produced in 1955 was portland cement. No new plants were put into operation in 1955; but one plant, carried on an inactive (standby) basis in 1954, was dismantled in 1955. The number of active portland-cement plants remained 157 in 37 States and Puerto Rico.

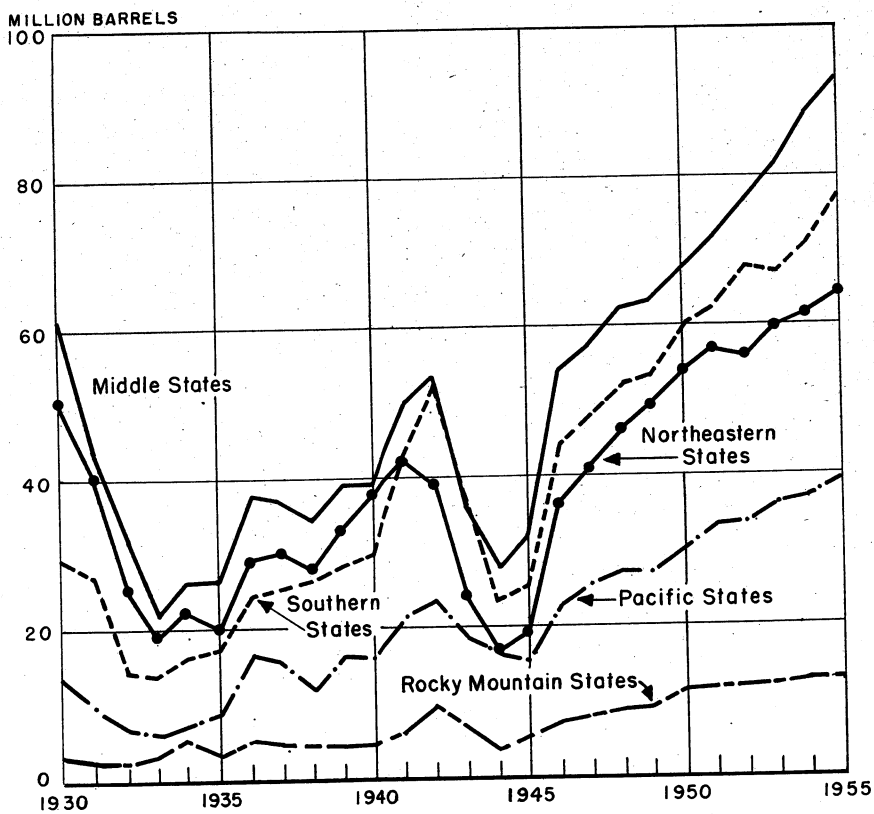

FIGURE 1.—Indicated consumption of portland cement in continental United States, 1930–55, by regions.

TABLE 2.—Finished portland cement produced, shipped, and in stock in the United States, 1954–55, by districts

District	Active plants		Production			Shipments from mills								Stocks at mills on Dec. 31		
			Barrels		Change from 1954 (percent)	1954			1955					Barrels		Change from 1954 (percent)
						Barrels	Value		Barrels	Value		Change from 1954 (percent) in—				
	1954	1955	1954	1955			Total	Average		Total	Average	Barrels	Average value	1954	1955	
Eastern Pennsylvania, Maryland	21	21	37,048,724	39,966,736	+7.9	37,336,814	$101,611,149	$2.72	38,547,246	$113,315,217	$2.94	+3.2	+8.1	[1] 1,950,789	2,736,282	+40.3
New York, Maine	11	11	16,458,513	20,048,810	+21.8	16,470,125	44,286,389	2.69	19,171,285	55,295,479	2.88	+16.4	+7.1	[1] 801,539	1,395,412	+74.1
Ohio	9	9	13,306,570	13,965,839	+5.0	13,076,921	35,929,163	2.75	13,981,909	39,642,957	2.84	+6.9	+3.3	[1] 984,704	838,914	−14.8
Western Pennsylvania, West Virginia	7	7	10,952,648	12,610,983	+15.1	11,269,630	30,223,272	2.68	12,392,137	34,923,402	2.82	+10.0	+5.2	[1] 855,792	915,422	+7.0
Michigan	7	7	16,671,383	18,204,826	+9.2	16,711,710	45,691,867	2.73	18,128,068	52,352,794	2.89	+8.5	+5.9	[1] 1,266,340	1,337,530	+5.6
Illinois	4	4	8,841,848	8,809,655	−0.4	9,109,076	23,147,871	2.54	8,654,735	22,886,351	2.64	−5.0	+3.9	556,437	435,818	−21.7
Indiana, Kentucky, Wisconsin	6	6	16,423,738	17,584,100	+7.1	16,548,046	47,289,781	2.86	17,041,854	47,911,872	2.81	+3.0	−1.7	[1] 968,378	855,152	−11.7
Alabama	8	8	10,996,641	12,160,565	+10.6	11,121,599	28,582,683	2.57	11,782,095	31,517,373	2.68	+5.9	+4.3	681,720	534,760	−21.6
Tennessee	6	6	7,523,507	8,109,659	+7.8	7,569,279	19,734,262	2.61	8,016,859	21,175,825	2.64	+5.9	+1.1	540,158	361,838	−33.0
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	11	11	18,452,202	19,862,501	+7.6	18,552,091	51,283,337	2.76	19,562,251	55,904,000	2.86	+5.4	+3.6	782,165	855,157	+9.3
Iowa	5	5	9,658,123	10,182,382	+5.4	9,858,889	27,044,464	2.74	9,914,977	27,837,413	2.81	+0.6	+2.6	897,893	927,869	+3.3
Eastern Missouri, Minnesota, South Dakota	6	6	12,750,592	13,484,017	+5.8	13,043,450	36,201,230	2.78	13,775,559	39,262,076	2.85	+5.6	+2.5	1,191,237	819,157	−31.2
Kansas	6	6	8,803,007	9,219,533	+4.7	9,076,328	23,874,179	2.63	9,071,747	24,520,533	2.70	−0.1	+2.7	471,828	532,483	+12.9
Western Missouri, Nebraska, Oklahoma, Arkansas	6	6	10,331,058	11,300,575	+9.4	10,285,005	27,758,505	2.70	11,402,340	31,568,337	2.77	+10.9	+2.6	772,817	566,644	−26.7
Texas	13	13	21,541,325	24,241,443	+12.5	21,928,170	56,674,124	2.58	24,038,427	64,820,374	2.70	+9.6	+4.7	[1] 865,556	1,068,572	+23.5
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	9	9	9,286,435	10,558,165	+13.7	9,436,381	29,704,078	3.15	10,570,159	33,910,625	3.21	+12.0	+1.9	625,659	613,665	−1.9
Northern California	5	5	14,389,330	16,142,248	+12.2	14,406,528	43,026,454	2.99	16,030,433	45,256,605	2.82	+11.3	−5.7	[1] 917,864	1,029,679	+12.2
Southern California	6	6	18,209,548	19,307,286	+6.0	18,355,462	55,224,791	3.01	19,053,982	58,537,097	3.07	+3.8	+2.0	[1] 645,610	898,914	+39.2
Oregon, Washington	9	9	7,107,301	7,500,406	+5.5	7,034,301	22,910,458	3.26	7,511,918	24,380,922	3.25	+6.8	−0.3	[1] 713,920	695,446	−2.6
Puerto Rico	2	2	3,600,064	4,193,592	+16.5	3,682,187	9,663,445	2.62	4,116,739	12,506,784	3.04	+11.8	+16.0	42,409	119,262	+181.2
Total	157	157	272,352,557	297,453,321	+9.2	[2] 274,871,992	759,861,502	2.76	[3] 292,764,720	837,526,036	2.86	+6.5	+3.6	[1] 16,532,815	17,537,976	+6.1
Pennsylvania	24	24	42,514,803	46,862,575	+10.2	43,068,234	117,912,299	2.74	45,526,877	132,965,136	2.92	+5.7	+6.6	[1] 2,539,940	3,442,601	+35.5
Missouri	5	5	11,201,697	12,001,304	+7.1	11,379,257	31,425,190	2.76	12,255,346	34,912,186	2.85	+7.7	+3.3	907,430	572,850	−36.9

[1] Revised figure.
[2] Includes portland cement used in making masonry cement.
[3] Does not include 3,596,328 barrels used in making masonry cement.

TABLE 3.—Production, shipments from mills, and stocks at mills of finished portland cement in the United States in 1955, by months[1] and districts, in thousand barrels

District	January	February	March	April	May	June	July	August	September	October	November	December
PRODUCTION												
Eastern Pennsylvania, Maryland	2,944	2,684	3,236	3,306	3,519	3,474	3,383	3,352	3,433	3,770	3,502	3,363
New York, Maine	1,272	997	1,305	1,753	1,934	1,867	1,933	1,975	1,964	1,937	1,639	1,487
Ohio	1,022	772	1,036	1,076	1,284	1,263	1,327	1,307	1,243	1,317	1,154	1,091
Western Pennsylvania, West Virginia	800	645	978	1,044	1,144	1,154	1,224	1,137	1,149	1,267	1,115	953
Michigan	795	746	753	1,611	1,904	1,950	2,024	1,894	1,899	1,771	1,624	1,097
Illinois	634	561	726	813	773	788	800	785	767	777	734	653
Indiana, Kentucky, Wisconsin	1,265	889	1,254	1,438	1,595	1,588	1,637	1,746	1,640	1,705	1,528	1,230
Alabama	975	830	1,034	1,060	1,036	1,017	1,046	1,057	950	1,088	1,046	1,022
Tennessee	561	488	646	600	684	712	733	785	737	766	702	695
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	1,457	1,292	1,609	1,711	1,741	1,703	1,729	1,696	1,653	1,813	1,776	1,709
Iowa	759	550	685	814	926	948	905	973	952	993	757	856
Eastern Missouri, Minnesota, South Dakota	882	684	953	965	1,247	1,323	1,453	1,365	1,331	1,295	1,016	975
Kansas	701	532	721	805	829	785	812	875	786	839	789	747
Western Missouri, Nebraska, Oklahoma, Arkansas	714	668	812	851	1,158	1,090	1,040	1,094	983	1,019	962	856
Texas	1,851	1,657	2,047	1,996	2,091	1,951	2,011	2,243	2,034	2,182	2,108	2,069
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	481	518	579	880	1,010	1,001	1,009	1,096	1,042	1,088	911	760
Northern California	1,049	1,045	1,407	1,465	1,433	1,416	1,386	1,441	1,437	1,448	1,349	1,268
Southern California	1,322	1,402	1,673	1,674	1,692	1,669	1,711	1,797	1,784	1,717	1,344	1,431
Oregon, Washington	370	344	506	636	686	703	804	877	826	773	509	466
Puerto Rico	369	307	380	320	345	360	365	366	348	359	329	347
Total: 1955	20,223	17,611	22,340	24,818	27,031	26,762	27,332	27,861	26,958	27,924	24,894	23,075
1954	17,769	16,895	20,097	21,730	23,279	22,802	25,482	25,698	25,522	25,887	23,826	22,290
SHIPMENTS												
Eastern Pennsylvania, Maryland	1,564	1,659	3,140	3,408	4,076	4,308	3,844	3,657	3,860	3,879	2,770	2,382
New York, Maine	538	541	1,171	1,623	2,231	2,367	2,114	2,189	2,186	2,124	1,274	906
Ohio	450	447	952	1,224	1,294	1,614	1,657	1,708	1,414	1,374	1,058	726
Western Pennsylvania, West Virginia	412	359	802	1,040	1,358	1,520	1,446	1,388	1,337	1,262	892	576
Michigan	565	512	756	1,277	2,087	2,312	2,127	2,310	2,182	1,943	1,278	779
Illinois	264	281	605	837	983	1,011	970	946	887	803	661	405
Indiana, Kentucky, Wisconsin	595	587	1,118	1,404	1,609	1,764	1,798	2,188	1,949	1,801	1,353	875
Alabama	848	800	1,148	1,015	992	1,061	932	1,072	969	1,020	976	948
Tennessee	436	463	610	566	789	871	759	809	776	742	675	519
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	1,263	1,307	1,743	1,667	1,690	1,724	1,638	1,750	1,752	1,848	1,659	1,521
Iowa	212	207	671	845	1,337	1,245	1,085	1,268	1,123	1,070	564	290
Eastern Missouri, Minnesota, South Dakota	452	503	996	1,110	1,310	1,566	1,491	1,781	1,527	1,512	884	644
Kansas	364	339	784	1,014	917	911	893	951	828	851	740	479

See footnote at end of table.

TABLE 3.—Production, shipments from mills, and stocks at mill of finished portland cement in the United States in 1955, by months [1] and districts, in thousand barrels—Continued

District	January	February	March	April	May	June	July	August	September	October	November	December
SHIPMENTS—continued												
Western Missouri, Nebraska, Oklahoma, Arkansas	471	487	922	1,043	1,245	1,300	1,157	1,214	1,094	1,113	808	549
Texas	1,668	1,709	2,241	1,954	2,010	2,119	1,917	2,246	2,035	2,158	2,022	1,960
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	417	380	741	1,024	1,043	1,131	1,022	1,151	1,134	1,131	751	644
Northern California	883	1,015	1,601	1,413	1,449	1,576	1,411	1,695	1,465	1,511	1,241	771
Southern California	1,253	1,532	1,669	1,593	1,652	1,692	1,704	1,922	1,778	1,423	1,385	1,358
Oregon, Washington	325	351	554	624	742	811	810	956	921	733	345	339
Puerto Rico	334	327	380	312	358	357	349	379	326	343	346	308
Total: 1955	13,314	13,806	22,604	24,993	29,172	31,260	29,124	31,580	29,543	28,641	21,682	16,979
1954	11,143	15,202	18,751	23,589	24,911	28,632	27,702	28,887	29,032	27,134	22,766	16,347
STOCKS (END OF MONTH)												
Eastern Pennsylvania, Maryland	3,311	4,295	4,327	4,171	3,542	2,640	2,122	1,774	1,280	1,113	1,803	2,737
New York, Maine	1,717	2,155	2,275	2,377	2,047	1,513	1,269	1,007	733	512	846	1,409
Ohio	1,557	1,878	1,952	1,786	1,764	1,400	1,053	639	454	383	468	827
Western Pennsylvania, West Virginia	1,238	1,518	1,680	1,672	1,442	1,059	821	552	344	338	549	919
Michigan	1,496	1,731	1,727	2,093	1,944	1,606	1,534	1,118	835	674	1,021	1,338
Illinois	911	1,184	1,284	1,230	996	743	542	350	199	151	206	436
Indiana, Kentucky, Wisconsin	1,584	1,839	1,918	1,904	1,828	1,584	1,367	920	559	402	527	855
Alabama	770	761	588	588	584	497	574	515	451	472	496	535
Tennessee	648	658	668	685	553	364	311	258	195	194	203	362
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	967	936	770	797	826	784	851	776	650	591	688	855
Iowa	1,428	1,766	1,759	1,713	1,287	983	778	469	285	194	365	928
Eastern Missouri, Minnesota, South Dakota	1,621	1,793	1,742	1,589	1,520	1,266	1,224	802	598	373	498	819
Kansas	797	990	918	709	609	479	390	309	252	240	271	532
Western Missouri, Nebraska, Oklahoma, Arkansas	1,015	1,178	1,068	867	780	570	442	323	212	118	268	567
Texas	1,049	997	804	846	927	759	853	849	849	873	959	1,069
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	701	910	776	667	655	528	527	472	380	336	497	612
Northern California	1,083	1,112	918	970	955	795	770	516	488	425	533	1,030
Southern California	715	585	588	670	710	687	693	568	574	867	825	899
Oregon, Washington	752	744	697	707	651	543	534	455	360	400	560	688
Puerto Rico	77	57	57	65	52	55	72	59	81	98	81	119
Total: 1955	23,437	27,087	26,516	26,106	23,672	18,855	16,727	12,731	9,779	8,754	11,664	17,536
1954	25,869	27,562	28,905	27,045	25,412	19,674	17,524	14,408	10,909	9,667	10,732	[2] 16,731

[1] Difference between monthly and annual reports not adjusted.
[2] Revised figure.

TYPES OF PORTLAND CEMENT

Over 90 percent of the portland cement produced in the United States in 1955 was types I and II, general use and moderate heat cement; nearly 12 percent of these types was air entrained.

The classification, portland-pozzolan, included 3 plants producing a true portland-pozzolan cement using pozzolanic materials and 7 plants using blast-furnace slag to make portland-slag cement (ASTM definitions). Production of these types of cement more than doubled in 1955.

TABLE 4.—Portland cement produced and shipped in the United States,[1] 1946–50 (average) and 1951–55, by types

Type and year	Active plants	Production (barrels)	Shipments		
			Barrels	Value	
				Total	Average
General use and moderate heat (types I and II):					
1946–50 (average)	151	168, 240, 196	168, 860, 897	$352, 582, 934	$2. 09
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
1953	156	217, 555, 091	215, 103, 044	569, 217, 300	2. 65
1954	157	[2] 255, 672, 888	258, 306, 467	705, 962, 751	2. 73
1955	157	[2] 276, 248, 222	272, 064, 095	768, 519, 723	2. 82
High-early-strength (type III):					
1946–50 (average)	91	6, 178, 639	6, 191, 117	15, 125, 421	2. 44
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
1953	99	7, 949, 035	7, 794, 006	23, 743, 313	3. 05
1954	102	[3] 10, 166, 228	10, 172, 066	31, 778, 662	3. 12
1955	106	[3] 11, 744, 327	11, 458, 692	37, 550, 258	3. 28
Low-heat (type IV):					
1946–50 (average)	4	177, 920	165, 795	363, 806	2. 19
1951	6	900, 624	790, 819	2, 647, 460	3. 35
1952	2	252, 122	272, 062	767, 571	2. 82
1953	2	192, 889	171, 717	507, 290	2. 95
1954	1	84, 205	48, 193	193, 738	4. 02
1955	0				
Sulfate-resisting (type V):					
1946–50 (average)	5	86, 792	96, 211	295, 268	3. 07
1951	3	9, 908	87, 635	342, 689	3. 91
1952	4	99, 229	78, 276	240, 129	3. 07
1953	4	79, 244	89, 631	317, 792	3. 55
1954	7	142, 171	119, 711	433, 400	3. 62
1955	6	65, 316	80, 012	301, 841	3. 77
Oil-well:					
1946–50 (average)	17	1, 714, 896	1, 764, 106	4, 193, 091	2. 38
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
1953	17	1, 861, 003	1, 822, 887	5, 463, 901	3. 00
1954	16	1, 641, 080	1, 665, 422	5, 058, 474	3. 04
1955	16	1, 897, 597	1, 851, 099	6, 428, 898	3. 47
White:					
1946–50 (average)	4	982, 126	971, 730	4, 438, 799	4. 57
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
1953	4	1, 114, 374	1, 091, 016	6, 087, 641	5. 58
1954	4	1, 109, 719	1, 153, 183	6, 412, 844	5. 56
1955	4	[4] 1, 190, 938	1, 204, 587	6, 580, 024	5. 46
Portland-pozzolan:					
1946–50 (average)	5	1, 321, 753	1, 356, 706	2, 847, 272	2. 10
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
1953	6	2, 406, 314	2, 448, 861	6, 440, 686	2. 63
1954	8	[5] 2, 412, 536	2, 251, 005	6, 100, 311	2. 71
1955	10	[5] 4, 906, 213	4, 706, 513	13, 183, 549	2. 80
Air-entrained:					
1946–50 (average)	75	18, 804, 267	18, 774, 646	38, 410, 944	2. 05
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
1953	95	32, 130, 866	31, 474, 609	82, 593, 723	2. 62
1954	99	(6)	(7)	(7)	
1955	99	(6)	(7)	(7)	

See footnotes at end of table.

TABLE 4.—Portland cement produced and shipped in the United States,[1] 1946–50 (average) and 1951–55, by types—Continued

Type and year	Active plants	Production (barrels)	Shipments		
			Barrels	Value	
				Total	Average
Miscellaneous: [8]					
1946–50 (average)	22	850,424	859,010	$2,299,774	$2.68
1951	23	825,745	825,830	2,647,625	3.21
1952	22	900,319	911,200	2,796,013	3.07
1953	21	891,706	882,764	2,891,162	3.28
1954	22	1,123,730	1,155,945	3,921,322	3.39
1955	22	1,400,708	1,399,722	4,961,743	3.54
Grand total:					
1946–50 (average)	151	198,357,013	199,040,218	420,557,309	2.11
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
1953	156	264,180,522	260,878,535	697,262,808	2.67
1954	157	272,352,557	274,871,992	759,861,502	2.76
1955	157	297,453,321	292,764,720	837,526,036	2.86

[1] Including Puerto Rico and Hawaii, 1946; Puerto Rico only, 1947–55. There has been no production in Hawaii since 1946.
[2] Includes 31,203,721 barrels of air-entrained portland cement in 1954 and 31,858,323 barrels in 1955.
[3] Includes 2,650,930 barrels of air-entrained portland cement in 1954 and 3,378,012 barrels in 1955.
[4] Includes a small amount of air-entrained portland cement.
[5] Includes 1,667,368 barrels of air-entrained portland cement in 1954, and 945,062 barrels in 1955.
[6] See footnotes 2, 3, 4, and 5.
[7] Data not available.
[8] Includes hydroplastic, plastic, and waterproofed cements.

CAPACITY OF PLANTS

The estimated annual capacities of all portland-cement plants December 31, 1955, as reported to the Bureau of Mines by producers, was 6 percent greater than that reported December 31, 1954.

Increases in capacity were reported for all except four districts—Illinois, Alabama, Tennessee, and Iowa. Increases of over 1 million barrels were reported for six districts—Eastern Pennsylvania-Maryland, New York-Maine, Ohio, Virginia-Georgia-Florida-Louisiana-South Carolina-Mississippi, Kansas, and Southern California. Texas led all districts, with expansions totaling nearly 4 million barrels.

TABLE 5.—Portland-cement-manufacturing capacity of the United States, 1954–55, by districts

District	Estimated (barrels)		Percent utilized	
	1954	1955	1954	1955
Eastern Pennsylvania, Maryland	40,303,225	42,338,135	91.9	94.4
New York, Maine	18,762,580	20,458,010	87.7	98.0
Ohio	13,815,725	15,009,951	96.3	93.0
Western Pennsylvania, West Virginia	12,023,795	12,495,500	91.1	100.9
Michigan	18,990,688	19,495,000	87.8	93.4
Illinois	9,227,510	8,973,240	95.8	98.2
Indiana, Kentucky, Wisconsin	18,107,000	19,048,000	90.7	92.3
Alabama	13,053,416	13,018,210	84.2	93.4
Tennessee	8,132,000	8,102,000	92.5	100.1
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	19,753,000	21,193,000	93.4	93.7
Iowa	10,668,000	10,453,000	90.5	97.4
Eastern Missouri, Minnesota, South Dakota	13,750,013	14,175,625	92.7	95.1
Kansas	9,578,000	10,661,000	91.9	86.5
Western Missouri, Nebraska, Oklahoma, Arkansas	10,785,987	11,600,000	95.8	97.4
Texas	22,955,000	26,925,400	93.8	90.0
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	11,065,000	11,595,000	83.9	91.1
Northern California	15,225,000	15,753,000	94.5	102.5
Southern California	19,620,000	21,420,000	92.8	90.1
Oregon, Washington	8,460,000	8,785,000	84.0	85.4
Puerto Rico	3,750,000	3,800,000	96.0	110.4
Total	298,025,939	315,299,071	91.4	94.3

The percentage of capacity utilized was greater in all districts except Ohio, Kansas, Texas, and Southern California, where large increases in producing capacities were reported.

Expansions at wet-and-dry-process plants were made without a significant change in the ratio of capacity of wet-process plants to total capacity of the industry—57.3 percent in 1954 and 57.2 in 1955.

The increased total capacity of the industry, without addition of new plants, resulted in a decrease of the smaller plants and a continued increase in the large capacity plants, as shown below in the grouping of cement plants based on their annual capacities.

Number of portland-cement plants in the United States (including Puerto Rico) in 1955, by size groups

Estimated annual capacity, Dec. 31, barrels:	*Number of plants*
Less than 1,000,000	13
1,000,000 to 2,000,000	79
2,000,000 to 3,000,000	49
3,000,000 to 10,000,000	16
Total	157

TABLE 6.—Capacity of portland-cement plants in the United States,[1] Dec. 31, 1953–55, by processes

Process	Capacity, Dec. 31						Percent of capacity utilized			Percent of total finished cement produced		
	Thousand barrels			Percent of total								
	1953	1954	1955	1953	1954	1955	1953	1954	1955	1953	1954	1955
Wet	164,726	169,361	179,911	56.5	56.8	57.1	90.9	92.2	94.6	56.7	57.3	57.2
Dry	127,072	128,665	135,388	43.5	43.2	42.9	90.1	90.4	93.9	43.3	42.7	42.8
Total	291,798	298,026	315,299	100.0	100.0	100.0	90.5	91.4	94.3	100.0	100.0	100.0

[1] Includes Puerto Rico.

The results of the special canvass of future cement-producing capacity in the continental United States, conducted by the Bureau of Mines in December 1955, are shown in table 7.

TABLE 7.—Estimated future annual production capacity of portland cement plants in the United States

(Canvass of December 1955)

Year	Capacity, in million barrels[1]			
	1st quarter, ending Mar. 31	2d quarter, ending June 30	3d quarter, ending Sept. 30	4th quarter, ending Dec. 31
1956	317	331	342	[2] 358
1957	371	374	376	[3] 381
1958	383	384	386	[4] 392

[1] Table does not include capacity of Puerto Rico plants.
[2] 97 percent of 46 million barrels expansion under construction.
[3] 52 percent of 24 million barrels expansion under construction.
[4] None of 11 million barrels expansion under construction.

457676—58——19

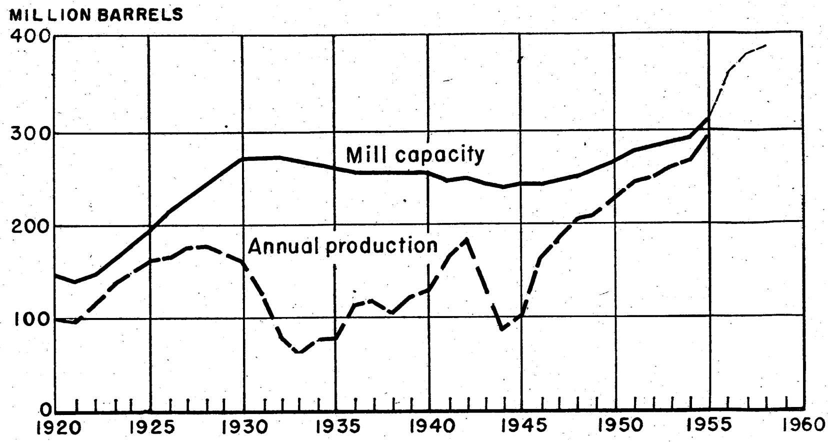

FIGURE 2.—Mill capacity and annual production of portland cement in continental United States, 1920–55.

CLINKER PRODUCTION

Production of clinker—the intermediate product between raw materials and finished portland cement—was 10 percent higher in 1955 than in 1954. The peak production of clinker was in October 1955, and the greatest accumulation of stock was in March. At the end of the year stocks of clinker on hand at plants were over 27 percent greater than those reported at the end of 1954.

TABLE 8.—Production and stocks of portland-cement clinker at mills in the United States in 1955, by months and districts, in thousand barrels

District	January	February	March	April	May	June	July	August	September	October	November	December
PRODUCTION												
Eastern Pennsylvania, Maryland	3,114	2,954	3,336	3,338	3,518	3,390	3,439	3,361	3,413	3,639	3,520	3,545
New York, Maine	1,574	1,364	1,637	1,693	1,729	1,682	1,742	1,637	1,679	1,607	1,644	1,649
Ohio	1,157	997	1,122	1,090	1,256	1,187	1,234	1,245	1,240	1,281	1,176	1,221
Western Pennsylvania, West Virginia	850	870	960	915	1,039	958	979	1,053	1,059	1,093	1,048	1,056
Michigan	1,417	1,189	1,361	1,479	1,632	1,673	1,703	1,649	1,686	1,712	1,607	1,647
Illinois	762	659	743	727	705	727	762	780	755	780	746	746
Indiana, Kentucky, Wisconsin	1,384	1,265	1,462	1,431	1,489	1,411	1,559	1,563	1,567	1,651	1,560	1,446
Alabama	1,041	945	1,021	1,025	1,064	1,055	1,065	1,059	1,000	1,081	1,071	1,076
Tennessee	624	496	673	671	623	693	695	739	674	744	717	718
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	1,514	1,461	1,652	1,640	1,717	1,691	1,694	1,702	1,673	1,717	1,708	1,765
Iowa	780	725	801	767	883	861	915	927	940	916	828	803
Eastern Missouri, Minnesota, South Dakota	1,032	916	1,105	1,113	1,126	1,152	1,183	1,229	1,133	1,206	1,073	1,083
Kansas	730	616	768	747	802	757	791	837	795	810	799	812
Western Missouri, Nebraska, Oklahoma, Arkansas	916	811	900	924	956	922	940	966	972	1,026	976	911
Texas	1,934	1,717	2,034	1,984	2,163	1,989	2,012	2,236	2,094	2,249	2,156	2,218
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	684	639	707	883	966	919	1,013	1,051	1,008	1,080	1,024	1,015
Northern California	1,123	1,040	1,362	1,310	1,403	1,322	1,380	1,398	1,385	1,443	1,322	1,294
Southern California	1,559	1,422	1,739	1,686	1,712	1,661	1,817	1,802	1,800	1,738	1,669	1,752
Oregon, Washington	405	383	593	683	699	657	681	643	674	693	647	643
Puerto Rico	343	298	342	335	344	297	341	355	345	352	327	371
Total: 1955	22,943	20,767	24,318	24,441	25,826	25,004	25,945	26,232	25,892	26,818	25,618	25,771
1954	20,773	18,881	22,023	21,588	21,992	21,125	24,077	24,614	24,132	25,031	23,665	24,029
STOCKS (END OF MONTH)												
Eastern Pennsylvania, Maryland	479	721	769	749	730	587	600	547	504	316	294	442
New York, Maine	750	1,105	1,438	1,379	1,170	987	873	618	402	279	312	496
Ohio	293	474	545	542	485	391	301	215	169	110	128	234
Western Pennsylvania, West Virginia	287	551	591	521	479	337	150	149	128	64	91	244
Michigan	1,267	1,689	2,212	1,993	1,650	1,316	937	641	395	282	238	735
Illinois	189	287	304	218	146	86	48	43	31	34	45	138
Indiana, Kentucky, Wisconsin	392	701	876	869	744	533	454	266	192	126	140	333
Alabama	228	298	255	175	167	166	163	145	156	121	113	154
Tennessee	274	274	286	352	276	246	192	136	55	24	25	39
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	434	602	637	529	488	453	371	344	342	224	125	155
Iowa	177	343	459	417	363	245	253	183	144	68	119	125
Eastern Missouri, Minnesota, South Dakota	359	591	769	935	842	700	456	349	169	91	165	273

TABLE 8.—Production and stocks of portland-cement clinker at mills in the United States in 1955, by months and districts, in thousand barrels—Continued

District	January	February	March	April	May	June	July	August	September	October	November	December
STOCKS (END OF MONTH)—continued												
Kansas	151	222	269	206	178	152	124	84	91	58	69	134
Western Missouri, Nebraska, Oklahoma, Arkansas	296	433	508	581	392	235	152	39	42	62	84	148
Texas	188	220	206	177	216	234	227	194	236	300	303	416
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	487	666	677	642	539	399	396	342	278	263	365	606
Northern California	469	472	439	293	265	183	190	158	118	125	110	148
Southern California	623	638	722	746	729	690	778	775	767	839	1,227	1,429
Oregon, Washington	470	511	602	651	666	621	503	269	122	43	182	355
Puerto Rico	77	84	65	94	126	63	50	57	72	85	101	146
Total: 1955	7,890	10,882	12,629	12,069	10,651	8,624	7,218	5,554	4,413	3,514	4,236	6,750
1954	8,269	10,091	11,947	11,681	10,392	8,585	7,244	6,080	4,720	3,849	3,634	[1] 5,294

[1] Revised figure.

TABLE 9.—Portland-cement clinker produced and in stock at mills in the United States,[1] 1954–55, by processes, in barrels [2]

Process	Plants		Production		Stocks on Dec. 31—	
	1954	1955	1954	1955	1954 [3]	1955 [4]
Wet	94	94	154, 717, 039	169, 647, 029	2, 852, 394	2, 894, 471
Dry	63	63	117, 212, 578	129, 928, 154	2, 441, 723	3, 855, 324
Total	157	157	271, 929, 617	299, 575, 183	5, 294, 117	6, 749, 795

[1] Including Puerto Rico.
[2] Compiled from monthly estimates of producers.
[3] Revised figures.
[4] Preliminary figures.

RAW MATERIALS

The principal raw materials used in the United States for producing portland cement in 1955 were limestone and clay or shale. Since 1943 approximately 70 percent of the output has been made from these materials. Argillaceous limestone (cement rock) or a mixture of cement rock and pure limestone was used for 24 percent of the portland cement made in 1955. Eight portland-cement plants used oystershell in place of limestone.

Blast-furnace slag was used as an ingredient of portland cement at 14 plants. Eight plants, including three of the above, used approximately 350,000 short tons of blast-furnace slag to produce portland-slag cement. The amount of portland cement (including portland-slag cement) made from a mixture of blast-furnace slag and limestone is shown under the last heading in table 10.

TABLE 10.—Production and percentage of total output of portland cement in the United States,[1] 1907–14, 1926, 1929, 1933, 1935, and 1941–55, 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
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
1953	54, 028, 856	20. 5	184, 181, 701	69. 7	5, 097, 256	1. 9	20, 872, 709	7. 9
1954	57, 172, 952	21. 0	190, 611, 040	69. 9	5, 082, 054	1. 9	19, 486, 511	7. 2
1955	71, 764, 313	24. 1	201, 411, 617	67. 7	5, 351, 185	1. 8	18, 926, 206	6. 4

[1] Includes Puerto Rico, 1941–55; Hawaii, 1945–46. There has been no production in Hawaii since 1946.
[2] Includes output of 2 plants using oystershell 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 1952–55 (includes 1 plant that used coquina shell).

TABLE 11.—Raw materials used in producing portland cement in the United States,[1] 1953–55

Raw material	1953	1954	1955
	Short tons	*Short tons*	*Short tons*
Cement rock	14,624,080	15,148,183	19,120,064
Limestone (including oystershell)	55,575,779	57,466,872	61,117,168
Marl	1,291,726	1,298,143	1,331,871
Clay and shale [2]	8,596,483	8,596,740	8,691,825
Blast-furnace slag	1,408,486	1,297,655	1,659,027
Gypsum	1,956,093	2,009,249	2,319,352
Sand and sandstone (including silica and quartz)	888,359	894,757	922,933
Iron materials [3]	410,420	399,283	327,404
Miscellaneous [4]	176,173	168,826	310,506
Total	84,927,599	87,279,708	95,800,150
Average total weight required per barrel (376 pounds) of finished cement	*Pounds* 643	*Pounds* 641	*Pounds* 644

[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

The quantities of fuel of all classes—coal, oil, and natural gas—increased in 1955 compared with 1954—coal 7 percent, oil 29 percent, and natural gas 4 percent.

TABLE 12.—Finished portland cement produced and fuel consumed by the portland-cement industry in the United States,[1] 1954–55, 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)
1954						
Wet	94	156,069,805	57.3	3,847,198	5,327,623	84,536,810
Dry	63	116,282,752	42.7	4,276,524	1,256,216	41,516,268
Total	157	272,352,557	100.0	[3] 8,123,722	6,583,839	[4] 126,053,078
1955						
Wet	94	170,264,929	57.2	4,080,463	6,248,524	91,611,457
Dry	63	127,188,392	42.8	4,647,111	2,257,297	39,790,053
Total	157	297,453,321	100.0	[5] 8,727,574	8,505,821	[6] 131,401,510

[1] Includes Puerto Rico.
[2] Figures compiled from monthly estimates of producers.
[3] Comprises 199,773 tons of anthracite and 7,923,949 tons of bituminous coal.
[4] Includes 48,685 M cubic feet of byproduct gas and 747,296 M cubic feet of coke-oven gas.
[5] Comprises 199,429 tons of anthracite and 8,528,145 tons of bituminous coal.
[6] Includes 54,569 M cubic feet of byproduct gas and 2,961,386 M cubic feet of coke-oven gas.

TABLE 13.—Portland cement produced in the United States,[1] 1954–55, 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)
1954						
Coal	62	[3] 108,237,100	39.7	5,976,308		
Oil	14	[3] 24,860,577	9.1		5,020,575	
Natural gas	23	[3] 35,549,878	13.1			[4] 48,752,885
Coal and oil	20	30,825,722	11.3	1,344,002	1,181,121	
Coal and natural gas	21	35,624,815	13.1	599,942		[5] 33,390,720
Oil and natural gas	9	25,449,654	9.4		304,218	30,860,157
Coal, oil, and natural gas	8	11,804,811	4.3	203,470	77,925	13,049,316
Total	157	272,352,557	100.0	[6] 8,123,722	6,583,839	126,053,078
1955						
Coal	62	[3] 116,034,780	39.0	6,303,628		
Oil	14	[3] 27,821,211	9.3		5,851,248	
Natural gas	21	[3] 38,135,168	12.8			[7] 50,540,495
Coal and oil	20	35,878,491	12.1	1,467,343	1,657,869	
Coal and natural gas	20	35,407,964	11.9	731,620		[8] 31,514,037
Oil and natural gas	11	30,027,700	10.1		883,247	34,244,613
Coal, oil, and natural gas	9	14,148,007	4.8	224,983	113,457	15,102,365
Total	157	297,453,321	100.0	[9] 8,727,574	8,505,821	131,401,510

[1] Includes Puerto Rico.
[2] Figures compiled from monthly estimates of producers.
[3] Average consumption of fuel per barrel of cement produced was as follows: 1954—Coal, 110.4 pounds; oil, 0.2019 barrel; natural gas, 1,371 cubic feet. 1955—Coal, 108.7 pounds; oil, 0.2103 barrel; natural gas, 1,325 cubic feet.
[4] Includes 747,296 M cubic feet of coke-oven gas.
[5] Includes 48,685 M cubic feet of byproduct gas.
[6] Comprises 199,773 tons of anthracite and 7,923,949 tons of bituminous coal.
[7] Includes 2,961,386 M cubic feet of coke-oven gas.
[8] Includes 54,569 M cubic feet of byproduct gas.
[9] Comprises 199,429 tons of anthracite and 8,528,145 tons of bituminous coal.

Sixteen plants purchased no electrical energy and used fuel to generate all the electric energy used at the plants, as well as to operate the kilns and driers. At these plants an average of 1.6 million B. t. u. was used per barrel of cement produced. At 95 plants no electric energy was generated, and an average of 1.2 million B. t. u. was used per barrel of cement. These figures indicate that approximately one-fourth of the fuel used at the 16 plants was consumed in generating power.

TABLE 14.—Electric energy used at portland-cement-producing plants in the United States,[1] 1954–55, 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		
1954								
Wet	28	741,378,118	87	2,522,473,945	3,263,852,063	55.7	156,069,805	20.9
Dry	33	1,467,161,188	57	1,125,486,397	2,592,647,585	44.3	116,282,752	22.3
Total	61	2,208,539,306	144	3,647,960,342	5,856,499,648	100.0	272,352,557	21.5
Percent of total electric energy used		37.7		62.3	100.0			
1955								
Wet	28	801,247,157	88	2,718,899,715	3,520,146,872	54.5	170,264,929	20.7
Dry	34	1,633,990,915	56	1,303,171,918	2,937,162,833	45.5	127,188,392	23.1
Total	62	2,435,238,072	144	4,022,071,633	6,457,309,705	100.0	297,453,321	21.7
Percent of total electric energy used		37.7		62.3	100.0			

[1] Includes Puerto Rico.

TRANSPORTATION

The quantity of portland cement shipped from the plants in bulk continued to increase; it rose from 55 percent in 1950 to 69 in 1954 and 71 in 1955. The percentages shipped by truck and railroad decreased slightly, and shipments by boat increased.

TABLE 15.—Shipments of portland cement from mills in the United States,[1] 1953–55, 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
1953								
Truck	[3]53,402,084	30.7	23,133,403	127,753	--------	23,261,156	76,663,240	29.4
Railroad	116,169,084	66.8	63,012,562	350,725	14,893	63,378,180	179,547,264	68.8
Boat	4,254,315	2.5	392,876	20,450	390	413,716	4,668,031	1.8
Total	173,825,483	100.0	86,538,841	498,928	15,283	87,053,052	260,878,535	100.0
Percent of total	66.6	--------	33.2	0.2	(4)	33.4	100.0	--------
1954								
Truck	[3]61,007,517	32.2	22,588,878	159,284	--------	22,748,162	83,755,679	30.5
Railroad	123,950,364	65.3	61,604,223	297,871	12,757	61,914,851	185,865,215	67.6
Boat	4,820,552	2.5	401,421	29,075	50	430,546	5,251,098	1.9
Total	189,778,433	100.0	84,594,522	486,230	12,807	85,093,559	274,871,992	100.0
Percent of total	69.0	--------	30.8	0.2	(4)	31.0	100.0	--------
1955								
Truck	65,713,354	31.3	21,283,833	121,209	--------	21,405,042	87,118,396	29.7
Railroad	137,328,311	65.4	59,899,634	301,461	18,901	60,219,996	197,548,307	67.5
Boat	6,788,039	3.2	797,151	31,836	--------	828,987	7,617,026	2.6
Used at plant	256,198	0.1	217,031	906	6,856	224,793	480,991	0.2
Total	210,085,902	100.0	82,197,649	455,412	25,757	82,678,818	292,764,720	100.0
Percent of total	71.8	--------	28.1	0.1	(4)	28.2	100.0	--------

[1] Includes Puerto Rico. Does not include interplant shipments.
[2] Includes steel drums and iron and wood barrels.
[3] Includes cement used at mills by producers as follows—1953: 1,306,411 barrels; 1954: 2,955,556 barrels; 1955: 480,991 barrels.
[4] Less than 0.05 percent.

CONSUMPTION

Although shipments to destinations in a State do not equal its consumption during the year covered, shipments afford a fair index of consumption. Shipments were higher into 36 States and the District of Columbia and lower in 12 States in 1955 than in 1954.

TABLE 16.—Destination of shipments of finished portland cement from mills in the United States, 1953–55, by States

Destination	1953 (barrels)	1954 (barrels)	1955 Barrels	1955 Change from 1954 (percent)
Continental United States:				
Alabama	4, 260, 020	3, 954, 507	3, 940, 356	−0. 4
Arizona	2, 422, 223	2, 215, 346	2, 337, 071	+5. 5
Arkansas	1, 772, 135	1, 897, 348	2, 519, 362	+32. 8
California	27, 732, 814	28, 761, 087	31, 643, 181	+10. 0
Colorado	2, 940, 615	3, 279, 171	3, 486, 108	+6. 3
Connecticut [1]	3, 188, 752	3, 264, 089	3, 384, 590	+3. 7
Delaware [1]	891, 978	910, 193	1, 096, 501	+20. 5
District of Columbia [1]	1, 248, 696	1, 323, 125	1, 391, 463	+5. 2
Florida	7, 487, 563	8, 313, 451	8, 945, 736	+7. 6
Georgia	4, 643, 993	4, 447, 570	5, 200, 560	+16. 9
Idaho	985, 580	1, 220, 895	922, 821	−24. 4
Illinois	13, 515, 338	15, 017, 658	14, 670, 230	−2. 3
Indiana	6, 430, 278	6, 756, 519	7, 984, 019	+18. 2
Iowa	5, 025, 264	5, 907, 952	5, 973, 536	+1. 1
Kansas	5, 791, 950	6, 596, 942	7, 248, 175	+9. 9
Kentucky	3, 319, 505	3, 040, 909	3, 639, 822	+19. 7
Louisiana	5, 759, 267	6, 291, 696	7, 339, 674	+16. 7
Maine	907, 788	868, 111	951, 426	+9. 6
Maryland	4, 672, 721	4, 447, 762	4, 881, 833	+9. 8
Massachusetts [1]	4, 351, 196	4, 158, 916	5, 238, 880	+26. 0
Michigan	12, 716, 532	13, 085, 398	13, 893, 512	+6. 2
Minnesota	4, 968, 121	5, 515, 459	5, 827, 326	+5. 7
Mississippi	1, 696, 176	1, 750, 784	1, 886, 883	+7. 8
Missouri	6, 797, 881	7, 570, 836	7, 918, 938	+4. 6
Montana	948, 293	1, 022, 168	950, 571	−7. 0
Nebraska	3, 384, 652	3, 741, 686	3, 485, 162	−6. 9
Nevada [1]	623, 133	852, 651	739, 766	−13. 2
New Hampshire [1]	548, 692	830, 141	1, 157, 178	+39. 4
New Jersey [1]	8, 574, 407	9, 206, 660	9, 334, 931	+1. 4
New Mexico [1]	1, 876, 499	2, 062, 937	1, 994, 584	−3. 3
New York	19, 101, 250	20, 367, 852	19, 400, 037	−4. 8
North Carolina [1]	3, 746, 417	3, 855, 839	4, 414, 777	+14. 5
North Dakota [1]	1, 120, 297	1, 161, 684	1, 057, 389	−9. 0
Ohio	14, 292, 284	16, 033, 134	17, 475, 318	+9. 0
Oklahoma	4, 158, 026	4, 365, 606	4, 788, 814	+10. 0
Oregon	2, 445, 679	2, 089, 482	2, 392, 194	+14. 5
Pennsylvania	15, 229, 467	15, 160, 456	16, 082, 713	+6. 1
Rhode Island [1]	859, 500	689, 556	830, 023	+20. 4
South Carolina	2, 260, 545	2, 071, 459	2, 461, 114	+18. 8
South Dakota	1, 188, 758	1, 115, 853	1, 221, 080	+9. 4
Tennessee	4, 867, 836	4, 702, 127	5, 088, 175	+8. 2
Texas	16, 153, 989	19, 198, 914	20, 781, 619	+8. 2
Utah	1, 342, 755	1, 507, 387	1, 835, 456	+21. 8
Vermont [1]	296, 159	241, 995	293, 672	+21. 4
Virginia	4, 705, 831	4, 495, 388	4, 801, 708	+6. 8
Washington	5, 399, 200	5, 630, 848	5, 594, 728	−. 6
West Virginia	1, 922, 820	2, 306, 293	1, 849, 138	−19. 8
Wisconsin	6, 138, 721	5, 912, 086	6, 185, 706	+4. 6
Wyoming	537, 625	581, 555	578, 738	−. 5
Unspecified	14, 250	27, 684	18, 125	−34. 5
Total continental United States	255, 263, 471	269, 827, 165	287, 134, 719	+6. 4
Outside continental United States [2]	5, 615, 064	5, 044, 827	5, 630, 001	+11. 6
Total shipped from cement plants	260, 878, 535	274, 871, 992	292, 764, 720	+6. 5

[1] Non-cement-producing States.
[2] Direct shipments by producers to foreign countries and to noncontiguous Territories (Alaska, Hawaii, Puerto Rico, etc.), including distribution from Puerto Rican mills.

TABLE 17.—Destination of shipments of finished portland cement from mills in the United States in 1955, by months, in barrels

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Alabama	273,926	250,892	380,053	304,550	318,783	329,351	322,896	386,977	353,811	374,990	332,561	320,593
Arizona	168,606	208,852	266,691	226,310	225,862	196,186	134,189	159,025	201,360	196,519	173,536	179,733
Arkansas	223,123	195,075	328,682	257,355	272,556	252,530	211,149	188,609	162,146	159,687	144,869	123,264
California	1,856,891	2,239,232	2,912,074	2,737,332	2,836,810	2,973,264	2,783,950	3,275,458	2,963,664	2,637,529	2,412,087	1,925,169
Colorado	163,582	112,439	260,825	331,600	331,537	371,372	339,679	353,221	335,159	371,160	275,429	239,584
Connecticut	129,827	129,583	269,273	313,979	386,195	374,351	318,838	329,356	296,457	367,866	246,942	217,378
Delaware	33,873	36,340	75,253	75,866	97,395	138,940	134,536	136,078	110,788	106,029	83,372	68,379
District of Columbia	87,643	65,106	116,046	135,290	134,809	136,259	118,736	121,438	127,777	144,450	111,585	96,341
Florida	778,425	766,618	856,683	756,842	759,248	723,018	731,271	773,589	734,358	705,358	721,015	690,353
Georgia	321,135	321,022	469,473	426,565	456,537	474,457	455,272	491,090	417,431	492,219	443,648	429,639
Idaho	19,785	22,132	70,869	87,930	106,690	108,579	96,673	112,058	105,018	95,825	55,323	41,775
Illinois	491,007	515,826	952,102	1,304,312	1,526,128	1,602,674	1,567,281	1,681,677	1,543,612	1,521,240	1,223,541	740,439
Indiana	218,402	239,261	528,006	702,360	729,674	894,035	878,309	1,072,761	975,917	921,265	561,490	351,439
Iowa	87,662	73,153	345,541	362,282	759,425	760,944	673,780	871,278	796,625	704,503	315,521	132,291
Kansas	247,570	213,715	564,203	844,910	808,399	824,614	794,030	795,191	671,126	630,648	532,800	321,196
Kentucky	116,890	125,541	228,461	276,579	332,886	347,336	390,275	500,413	417,133	417,025	300,675	183,072
Louisiana	447,895	413,368	618,513	554,590	588,774	685,871	554,794	629,970	693,285	728,034	734,197	697,594
Maine	24,192	20,350	93,689	91,697	110,880	103,689	101,073	110,134	123,601	86,811	57,717	37,644
Maryland	228,226	200,774	372,609	458,737	508,817	460,676	475,557	451,360	451,344	569,993	397,243	306,430
Massachusetts	199,026	186,501	394,951	459,233	631,408	580,378	487,819	451,660	472,191	585,939	431,601	357,901
Michigan	481,234	455,349	719,888	1,184,680	1,520,573	1,652,817	1,555,974	1,669,854	1,636,250	1,479,097	996,065	639,151
Minnesota	141,162	135,968	406,062	477,619	761,093	736,926	677,887	726,887	664,897	633,002	285,033	191,198
Mississippi	99,621	113,374	186,475	144,273	176,114	208,159	181,381	256,867	150,751	170,635	143,538	141,012
Missouri	288,988	306,366	636,876	749,251	674,124	865,367	806,130	861,968	800,691	803,380	586,646	444,355
Montana	28,550	21,862	30,601	65,957	96,336	125,047	100,902	113,674	126,843	150,035	54,981	35,749
Nebraska	83,582	81,767	216,962	294,039	479,289	503,775	407,101	418,084	342,398	375,023	206,747	76,135
Nevada	41,606	53,907	65,058	73,015	65,050	72,768	80,888	62,508	61,025	60,676	49,058	51,749
New Hampshire	23,802	21,099	47,154	79,663	129,899	179,114	153,798	164,318	156,691	113,419	48,846	29,336
New Jersey	388,128	403,945	754,576	823,245	991,373	1,020,034	924,346	899,706	923,398	936,444	670,562	601,689
New Mexico	143,498	151,577	179,593	185,738	183,909	194,042	168,247	197,986	153,231	151,302	166,925	120,282
New York	596,302	687,200	1,355,251	1,654,957	2,140,796	2,372,702	2,065,094	2,136,361	2,187,604	2,020,772	1,189,542	992,822
North Carolina	237,368	275,314	385,500	404,121	490,700	451,501	391,868	375,769	371,967	382,939	357,945	288,737
North Dakota	11,317	16,773	67,844	151,375	109,895	145,916	158,354	149,747	142,869	154,702	29,917	11,610
Ohio	515,362	496,046	999,102	1,340,578	1,923,251	2,268,690	2,210,044	2,156,790	1,677,152	1,616,791	1,275,555	840,173
Oklahoma	261,383	312,124	455,277	493,884	419,067	422,779	409,047	415,931	395,629	411,286	424,234	364,486
Oregon	125,505	138,390	181,889	146,922	238,622	248,140	255,491	296,706	258,030	200,611	130,614	177,070
Pennsylvania	588,431	556,160	1,112,274	1,311,090	1,672,919	1,871,119	1,740,301	1,744,414	1,906,570	1,633,632	1,126,405	813,619
Rhode Island	24,152	22,106	71,016	67,710	87,801	97,908	98,571	85,805	89,122	81,686	54,327	41,563
South Carolina	133,295	144,273	189,429	201,830	255,141	224,877	203,553	239,554	244,331	231,169	211,097	182,874
South Dakota	21,729	21,120	76,826	88,942	107,056	125,426	126,777	192,864	202,503	173,293	55,302	29,198
Tennessee	239,529	245,452	380,161	390,465	432,581	464,023	447,576	569,609	529,589	532,979	465,261	390,936
Texas	1,490,274	1,502,366	2,027,166	1,744,780	1,745,176	1,833,052	1,674,583	1,917,069	1,711,507	1,821,387	1,649,208	1,664,649
Utah	42,420	35,125	111,108	172,187	196,767	196,962	177,404	224,031	224,721	215,670	132,907	105,923
Vermont	2,775	4,345	16,353	21,710	40,276	44,927	33,485	29,756	36,400	35,932	15,166	12,684
Virginia	248,346	276,339	403,210	421,909	460,136	474,821	421,109	422,855	448,576	494,739	426,264	302,942
Washington	318,031	345,072	435,334	538,517	560,705	603,036	557,626	664,137	625,068	553,873	254,856	199,410

West Virginia	61,389	61,298	134,134	133,508	167,854	198,433	193,363	208,792	421,062	210,638	157,375	105,648
Wisconsin	181,000	175,345	324,083	472,752	672,163	732,135	703,323	778,216	524,368	663,142	509,834	240,238
Wyoming	19,398	14,959	28,779	46,629	62,889	65,297	64,272	62,977	72,246	68,245	40,991	31,378
Unspecified	1,240	798	19,012	3,383	310	181	381	93	295	258	2,341	0
Continental United States	12,957,103	13,411,599	22,120,990	24,593,048	28,784,678	30,738,498	28,558,983	30,934,671	29,038,587	28,193,847	21,272,694	16,586,830
Outside continental United States [1]	356,897	394,401	483,010	399,952	387,322	521,502	565,017	645,329	504,413	447,153	409,306	392,170
Total	13,314,000	13,806,000	22,604,000	24,993,000	29,172,000	31,260,000	29,124,000	31,580,000	29,543,000	28,641,000	21,682,000	16,979,000

[1] Shipments by producers to foreign countries and to noncontiguous Territories of the United States (Alaska, Hawaii, and Puerto Rico), including distribution from Puerto Rican mills.

Tables 18 and 19 show the destination of shipments of high-early-strength portland cement. Statistics on shipments of this type III portland cement were collected on an annual basis in 1955 for the first time and showed that New York, New Jersey, Pennsylvania, and Michigan were the largest consumers of such cement.

TABLE 18.—Destination of shipments of high-early-strength cement from mills in the United States,[1] 1955, by States

Destination	1955 (barrels)	Destination	1955 (barrels)
Continental United States:		Continental United States—Continued	
Alabama	398,830	New Jersey [2]	1,399,452
Arizona	1,280	New Mexico [2]	57,103
Arkansas	20,328	New York	1,053,742
California	75,056	North Carolina [2]	173,606
Colorado	8,576	North Dakota [2]	2,868
Connecticut [2]	343,070	Ohio	371,606
Delaware [2]	54,160	Oklahoma	38,956
District of Columbia [2]	88,180	Oregon	3,884
Florida	464,090	Pennsylvania	1,090,335
Georgia	219,623	Rhode Island [2]	90,787
Idaho	4,556	South Carolina	132,769
Illinois	576,176	South Dakota	37,078
Indiana	237,573	Tennessee	36,038
Iowa	175,584	Texas	428,405
Kansas	126,405	Utah	16,711
Kentucky	69,171	Vermont [2]	24,257
Louisiana	75,420	Virginia	225,394
Maine	48,452	Washington	330,387
Maryland	148,914	West Virginia	9,385
Massachusetts [2]	489,515	Wisconsin	51,510
Michigan	1,660,370	Wyoming	5,227
Minnesota	260,693	Unspecified	0
Mississippi	31,400		
Missouri	135,194	Total continental United States	11,388,869
Montana	4,627	Outside continental United States [3]	69,824
Nebraska	24,120		
Nevada [2]	14,015	Total shipped from cement plants	11,458,693
New Hampshire [2]	53,991		

[1] Included in figures of finished portland cement, table 16. These data collected for the first time in 1955.
[2] Non-cement-producing State.
[3] Direct shipments by producers to foreign countries, and to noncontiguous Territories (Alaska and Hawaii).

TABLE 19.—Destination of shipments of high-early-strength cement from mills in the United States in 1955,[1] by months, in barrels

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Alabama	32,158	29,712	33,948	24,192	31,655	29,697	31,712	35,810	34,852	40,535	40,433	34,071
Arizona	0	26	175	0	3	0	560	5	25	130	357	0
Arkansas	1,264	1,074	1,141	1,070	1,831	697	1,743	3,260	2,605	1,743	1,087	2,813
California	7,007	6,406	8,506	8,891	8,299	6,160	5,647	7,715	7,598	3,639	2,492	2,285
Colorado	851	183	1,132	1,046	1,374	696	734	1,439	460	200	28	433
Connecticut	18,359	19,513	30,401	29,270	31,026	32,784	33,315	33,097	31,182	30,347	28,764	24,959
Delaware	3,087	4,904	5,587	4,506	4,475	4,999	3,679	3,309	4,477	5,354	5,024	4,755
District of Columbia	5,438	5,692	7,784	8,580	8,853	7,072	5,593	8,329	6,783	10,225	7,019	6,798
Florida	43,555	42,316	49,718	39,009	41,176	40,535	33,206	37,617	27,884	34,890	35,007	39,104
Georgia	15,648	14,889	19,396	17,479	18,384	21,507	18,993	22,067	19,147	18,476	17,273	16,333
Idaho	870	457	635	689	410	256	241	239	295	299	113	54
Illinois	40,248	35,894	52,897	52,269	64,462	65,756	53,271	45,426	44,804	44,193	32,334	44,550
Indiana	13,215	8,991	14,770	14,743	25,802	34,749	28,091	25,380	21,540	15,855	13,923	21,118
Iowa	10,608	6,480	14,750	13,364	17,605	19,654	16,563	16,729	16,502	15,847	15,623	11,610
Kansas	8,687	7,207	10,939	16,064	10,276	12,009	10,559	11,078	11,368	12,670	7,965	8,063
Kentucky	3,289	4,535	6,816	8,741	14,988	8,439	6,516	7,089	3,266	2,515	1,664	4,707
Louisiana	4,778	2,800	13,441	6,230	7,623	6,744	4,328	4,026	6,444	6,206	7,275	5,513
Maine	2,612	1,927	5,642	2,477	3,190	3,805	4,030	4,938	4,355	6,350	4,756	4,363
Maryland	8,407	9,327	14,677	13,449	13,714	14,232	11,292	13,551	13,636	14,605	11,418	10,582
Massachusetts	28,359	26,247	44,821	41,529	44,423	50,106	46,589	43,335	44,954	43,577	35,961	39,550
Michigan	98,509	103,308	119,654	177,178	178,570	159,091	135,004	154,084	148,523	138,391	120,493	127,328
Minnesota	11,529	10,734	20,765	30,932	32,809	30,147	23,742	21,151	22,330	24,509	19,181	13,180
Mississippi	1,668	2,350	2,813	1,521	2,729	2,229	2,216	2,324	4,075	3,419	2,928	2,768
Missouri	8,816	9,649	13,679	12,334	12,037	16,240	11,984	11,158	11,706	10,101	7,421	10,052
Montana	726	250	361	501	108	25	182	360	493	177	866	578
Nebraska	1,778	1,490	2,706	1,702	2,341	2,924	2,053	3,065	2,138	2,461	1,092	353
Nevada	2,305	4,429	1,048	965	1,039	1,056	734	1,051	420	640	645	75
New Hampshire	2,413	3,752	3,596	4,171	5,024	5,208	5,173	4,968	4,828	4,449	5,812	4,587
New Jersey	96,166	83,393	119,337	115,583	128,094	139,964	124,702	134,816	124,135	119,763	103,450	110,684
New Mexico	3,681	4,376	8,824	3,715	4,701	5,534	4,263	5,993	5,312	3,129	5,327	2,253
New York	59,313	47,974	90,839	101,390	102,063	108,661	87,589	90,539	98,725	86,909	82,234	97,373
North Carolina	11,619	12,303	16,352	16,842	16,467	13,819	15,666	15,010	13,148	14,411	14,105	14,038
North Dakota	60	200	132	75	0	175	25	0	165	350	913	775
Ohio	21,702	23,432	30,674	29,830	28,872	35,725	35,611	37,450	34,206	28,325	28,809	32,855
Oklahoma	3,072	4,445	4,457	3,802	2,750	2,366	2,840	2,590	4,975	2,067	3,151	1,856
Oregon	114	163	388	103	165	255	190	789	311	561	364	282
Pennsylvania	58,376	53,541	87,748	91,543	101,716	109,392	103,343	114,101	103,220	100,920	83,058	82,380
Rhode Island	5,948	4,155	9,417	6,196	7,482	9,179	6,404	8,015	9,185	8,062	7,414	8,714
South Carolina	10,870	9,315	9,656	9,525	8,836	9,896	8,555	10,631	11,499	15,017	15,067	13,931
South Dakota	1,870	1,126	2,314	2,469	3,062	3,597	3,969	4,039	3,144	5,176	3,345	2,910
Tennessee	2,843	3,573	4,557	4,216	3,412	3,011	2,314	2,444	2,469	2,102	2,009	2,878
Texas	34,213	42,460	47,397	32,472	29,905	34,019	31,595	35,264	38,557	31,198	36,878	34,844
Utah	3,475	2,704	2,667	1,176	1,066	950	811	1,055	920	525	389	974
Vermont	665	992	775	1,536	2,721	3,602	3,053	2,540	2,367	1,422	1,878	2,067

See footnote at end of table

TABLE 19.—Destination of shipments of high-early-strength cement from mills in the United States in 1955, by months, in barrels—Con.

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Virginia	14, 440	16, 546	20, 190	16, 595	19, 537	22, 788	18, 343	16, 654	19, 809	24, 136	20, 182	16, 211
Washington	18, 155	21, 674	23, 153	28, 828	33, 143	35, 973	20, 992	45, 282	36, 248	26, 089	18, 499	26, 678
West Virginia	732	700	664	905	967	350	634	780	537	1, 200	851	2, 225
Wisconsin	3, 262	2, 787	4, 251	5, 661	5, 685	5, 850	4, 659	2, 957	5, 078	6, 069	2, 732	2, 513
Wyoming	362	0	273	926	1, 065	635	187	574	532	449	99	123
Unspecified	591	0	0	0	177	363	53	153	492	0	0	301
Continental United States	727, 713	700, 401	985, 863	1, 006, 290	1, 086, 112	1, 122, 921	973, 548	1, 054, 276	1, 011, 724	969, 683	857, 708	897, 447
Outside continental United States [2]	1, 287	2, 599	1, 137	5, 710	21, 888	1, 079	15, 452	11, 724	1, 276	1, 317	1, 292	553
Total	729, 000	703, 000	987, 000	1, 012, 000	1, 108, 000	1, 124, 000	989, 000	1, 066, 000	1, 013, 000	971, 000	859, 000	898, 000

[1] These data collected for the first time in 1955.
[2] Shipments by producers to foreign countries and to noncontiguous Territories (Alaska and Hawaii).

STOCKS

Stocks of finished portland cement and clinker at portland-cement plants were slightly lower for the first 10 months of 1955 than during the corresponding months of 1954. During November and December stocks of both finished portland cement and clinker were increased to above the 1954 figures; stocks on hand on December 31, 1955, were 10 and 27 percent higher, respectively, than on December 31, 1954.

TABLE 20.—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, 1951–55

		Dec. 31 (barrels)	Range			
			Low		High	
			Months	Barrels	Month	Barrels
1951	Cement	18,064,421	October	7,162,000	March	23,250,000
	Clinker	4,728,745	do	3,544,000	April	8,194,000
1952	Cement	15,932,203	do	6,546,000	March	26,622,000
	Clinker	5,384,885	November	4,329,000	do	10,833,000
1953	Cement	19,272,008	October	10,049,000	May	25,247,000
	Clinker	5,349,274	November	4,022,000	March	9,895,000
1954	Cement	[2] 16,532,815	October	9,667,000	do	28,905,000
	Clinker	[2] 5,294,117	November	3,634,000	do	11,947,000
1955	Cement	17,537,976	October	8,754,000	February	27,087,000
	Clinker	6,749,795	do	3,514,000	March	12,629,000

[1] Includes Puerto Rico. [2] Revised figure.

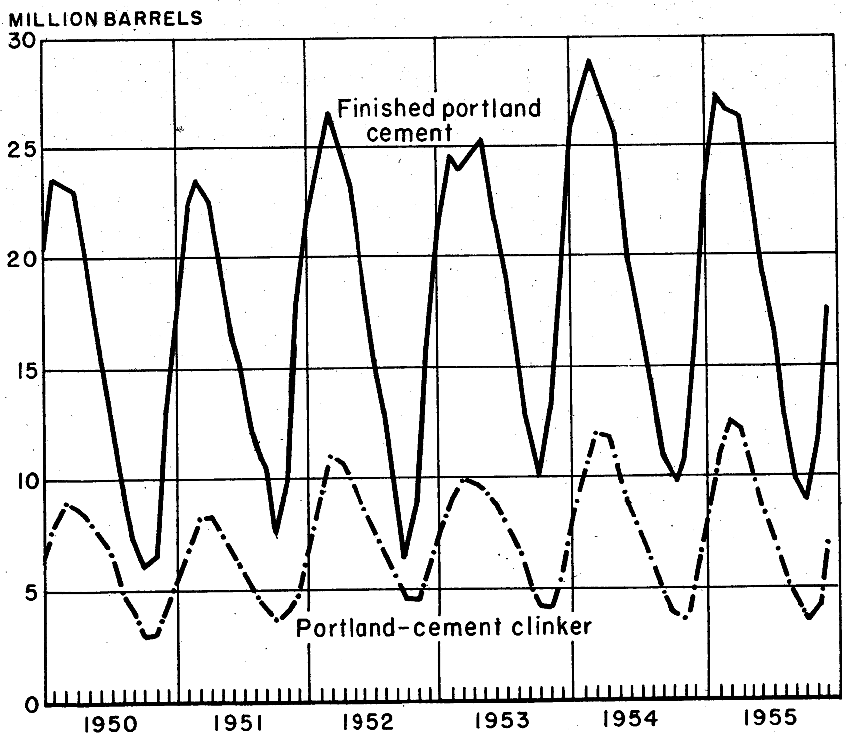

FIGURE 3.—End-of-month stocks of finished portland cement and portland-cement clinker, 1950–55.

PREPARED MASONRY CEMENTS

PRODUCTION AND SHIPMENTS

At the request of representatives of the cement industry, statistics on prepared masonry cements were collected on a monthly basis beginning in 1955. In former years adjustments were made in the shipment reports of portland cement, and masonry-cement shipments were not included in the cement tabulations. However, at many plants some of the clinker produced was processed directly into prepared masonry cement and did not appear in the tabulations of portland cement produced or shipped.

Prepared masonry cements were included in the cement tabulations in 1955. Prepared masonry cements made at the natural- and slag-cement plants were included with production and shipment figures of these classes of hydraulic cements in former years, but in 1955 all masonry cements from both portland and other hydraulic cement plants were grouped into one set of tabulations.

The cement tabulations in this chapter cover only the production from cement-producing companies and do not include statistics on prepared masonry cements made by companies who purchased portland cement for reprocessing.

Masonry cements were produced at 114 portland-cement plants, 3 natural-cement plants, and 2 slag-cement plants. Tables 21 and 22 show production and shipments by districts for 1954–55 and by months of 1955, respectively.

Statistics on prepared masonry cements were reported in many different weight barrels, ranging from 250 to 300 pounds per barrel. For uniformity all were converted to equivalent 376-pound barrels before inclusion in these tabulations.

Prepared masonry cements are sold under proprietary names, and considerable latitude is permitted in the ratio of the constituents.

TABLE 21.—Prepared masonry cement produced and shipped in the United States,[1] 1954–55, by districts

District	Active plants		Production		Shipments from mills					
	1954	1955	Barrels		1954			1955		
			1954	1955	Barrels	Value	Average	Barrels	Value	Average
Eastern Pennsylvania, Maryland	10	17	2,077,779	2,259,747	2,044,851	$6,377,852	$3.12	2,287,417	$7,884,156	$3.45
New York, Maine	7	12	589,370	1,108,567	572,712	1,958,915	3.42	1,119,358	3,730,065	3.33
Ohio	8	8	783,131	916,021	764,909	2,626,622	3.43	931,810	3,322,967	3.57
Western Pennsylvania, West Virginia	6	7	852,341	923,994	875,632	2,995,836	3.42	928,745	3,282,089	3.53
Michigan	5	5	1,416,003	1,596,366	1,406,859	4,800,934	3.41	1,610,332	5,695,606	3.54
Illinois	4	4	533,873	724,524	539,232	1,679,503	3.11	742,363	2,145,170	2.89
Indiana, Kentucky, Wisconsin	6	5	1,870,569	2,002,738	1,829,165	7,244,957	3.96	2,057,744	6,455,040	3.14
Alabama	6	7	552,751	1,925,276	576,573	1,745,014	3.03	1,938,520	6,832,671	3.52
Tennessee	5	5	704,554	779,616	711,109	2,195,246	3.09	794,994	2,497,287	3.14
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	9	9	1,102,821	1,385,442	1,148,057	4,009,999	3.49	1,397,445	4,951,616	3.54
Iowa	4	4	453,323	544,433	458,451	1,578,284	3.44	514,966	1,701,574	3.30
Eastern Missouri, Minnesota, South Dakota	5	5	243,018	407,867	268,746	938,102	3.49	363,943	1,288,445	3.54
Kansas	6	6	274,862	406,430	292,966	979,300	3.34	382,523	1,333,504	3.49
Western Missouri, Nebraska, Oklahoma, Arkansas	5	5	335,854	332,594	338,615	1,168,959	3.45	277,375	997,888	3.60
Texas	10	10	612,080	838,754	652,075	2,038,293	3.13	817,253	2,728,253	3.34
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	6	5	284,526	317,704	278,650	1,088,887	3.91	313,280	1,289,533	4.12
Northern California	1	1	4,264	2,200	3,329	15,693	4.71	2,798	10,192	3.64
Southern California	1	0	25,495		25,478	89,642	3.52			
Oregon, Washington	5	4	55,791	46,398	43,625	184,438	4.23	45,216	196,512	4.35
Puerto Rico										
Total	109	119	12,772,405	16,518,671	12,831,034	43,716,476	3.41	16,526,082	56,342,568	3.41
Pennsylvania	14	21	2,373,787	2,529,446	2,351,850	7,548,182	3.21	2,562,701	9,003,906	3.51

[1] These data shown for the first time in 1955. Figures for 1954 from portland-cement plants only; 1955 from all cement plants (portland, natural, and slag).

TABLE 22.—Production and shipments from mills of prepared masonry cement in the United States in 1955,[1] by months and districts, in thousand barrels

District	January	February	March	April	May	June	July	August	September	October	November	December
PRODUCTION												
Eastern Pennsylvania, Maryland	118	150	205	199	250	240	212	170	194	175	165	180
New York, Maine	60	57	72	90	108	114	116	104	121	98	116	51
Ohio	18	52	69	98	119	100	66	98	74	90	68	63
Western Pennsylvania, West Virginia	51	34	67	100	96	112	107	89	121	66	70	71
Michigan	61	51	188	139	171	149	152	133	106	198	100	139
Illinois	57	14	45	66	61	65	65	67	66	31	40	39
Indiana, Kentucky, Wisconsin	112	206	163	132	203	245	144	163	150	189	170	118
Alabama	58	84	57	74	71	35	74	38	68	53	75	25
Tennessee	42	52	77	40	81	78	82	74	80	63	65	54
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	91	87	156	90	132	110	129	118	130	118	113	102
Iowa	39	44	55	32	67	13	52	33	45	31	58	34
Eastern Missouri, Minnesota, South Dakota	59	41	21	36	25	33	5	15	22	35	21	96
Kansas	39	37	30	7	39	11	46	31	47	22	51	32
Western Missouri, Nebraska, Oklahoma, Arkansas	63	60	2	38	7	19	22	6	3	9	20	63
Texas	56	73	64	60	77	81	67	96	49	80	90	61
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	11	18	24	40	25	35	28	17	26	23	31	37
Northern California	----	----	----	2	----	----	----	----	----	----	----	----
Southern California	21	31	34	----	----	----	----	----	----	----	----	----
Oregon, Washington	----	2	----	4	3	6	6	4	----	1	6	14
Puerto Rico	----	----	----	----	----	----	----	----	----	----	----	----
Total	956	1,093	1,329	1,247	1,535	1,446	1,373	1,256	1,302	1,282	1,259	1,179
SHIPMENTS												
Eastern Pennsylvania, Maryland	112	112	236	181	250	257	215	219	237	206	137	116
New York, Maine	41	46	89	88	123	133	115	120	129	110	80	56
Ohio	33	31	88	78	98	112	96	105	96	87	61	48
Western Pennsylvania, West Virginia	33	32	87	79	106	116	107	112	117	88	64	47
Michigan	73	68	122	140	167	174	155	180	175	154	106	97
Illinois	22	27	63	49	73	75	65	71	67	59	45	33
Indiana, Kentucky, Wisconsin	94	98	198	164	205	220	192	216	221	197	144	112
Alabama	52	62	88	64	61	58	54	61	56	58	54	58
Tennessee	46	52	73	64	71	80	73	77	76	71	61	52
Virginia, Georgia, Florida, Louisiana, South Carolina, Mississippi	93	93	136	117	126	128	114	120	124	129	113	103
Iowa	16	16	61	43	53	52	44	56	45	39	26	21

Eastern Missouri, Minnesota, South Dakota	10	11	36	24	35	45	40	44	42	39	24	15
Kansas	16	15	40	24	32	35	35	50	40	37	34	24
Western Missouri, Nebraska, Oklahoma, Arkansas	21	20	38	30	28	24	14	21	22	21	20	18
Texas	54	51	73	67	80	78	74	81	71	69	62	62
Colorado, Arizona, Wyoming, Montana, Utah, Idaho	17	14	28	34	31	36	29	30	28	24	23	22
Northern California	--	--	--	--	--	--	--	--	--	--	--	--
Southern California	25	28	39	--	--	--	--	--	--	--	--	--
Oregon, Washington	2	2	3	5	5	5	5	5	5	4	2	2
Puerto Rico	--	--	--	--	--	--	--	--	--	--	--	--
Total	760	778	1,498	1,251	1,544	1,628	1,427	1,568	1,551	1,392	1,056	886

[1]Prepared masonry statistics compiled by months for the first time in 1955.

TABLE 23.—Destination of shipments of prepared masonry cement from mills in the United States,[1] 1955, by States

Destination	1955 (barrels of 376 pounds)	Destination	1955 (barrels of 376 pounds)
Continental United States:		Continental United States—Continued	
Alabama	1,318,942	New Hampshire [2]	49,046
Arizona	10,147	New Jersey [2]	506,230
Arkansas	118,947	New Mexico [2]	76,753
California	859	New York	1,104,288
Colorado	218,806	North Carolina [2]	792,023
Connecticut [2]	102,106	North Dakota [2]	47,143
Delaware [2]	26,486	Ohio	1,250,006
District of Columbia [2]	238,894	Oklahoma	210,169
Florida	886,792	Oregon	2,104
Georgia	326,097	Pennsylvania	1,103,627
Idaho	12,543	Rhode Island [2]	24,180
Illinois	767,088	South Carolina	376,975
Indiana	539,647	South Dakota	47,810
Iowa	198,086	Tennessee	482,123
Kansas	187,462	Texas	731,463
Kentucky	328,490	Utah	19,590
Louisiana	119,021	Vermont [2]	25,413
Maine	47,654	Virginia	693,445
Maryland	407,739	Washington	37,657
Massachusetts [2]	247,916	West Virginia	170,250
Michigan	1,297,778	Wisconsin	552,592
Minnesota	361,480	Wyoming	27,390
Mississippi	115,632	Unspecified	34,464
Missouri	137,159		
Montana	26,590	Total continental United States	16,501,213
Nebraska	93,802	Outside continental United States [3]	24,869
Nevada [2]	309		
		Total shipped from cement plants	16,526,082

[1] These data collected for the first time in 1955.
[2] Non-cement-producing State.
[3] Direct shipments by producers to foreign countries and to Alaska.

TABLE 24.—Destination of shipments of prepared masonry cement from mills in the United States in 1955,[1] by months, in barrels

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Alabama	9,473	8,406	13,530	10,309	8,905	7,372	7,850	7,647	8,312	7,589	7,409	8,422
Arizona	844	681	650	860	1,268	1,166	510	2,302	937	453	637	160
Arkansas	8,645	6,461	11,527	8,704	12,011	10,092	8,001	10,437	10,333	12,567	11,057	9,049
California	24,315	27,358	37,304	73	0	73	209	38	43	188	49	16
Colorado	11,899	10,519	18,261	27,431	18,194	23,989	19,592	20,526	19,043	15,545	16,400	17,811
Connecticut	4,757	5,089	9,086	6,754	11,187	12,770	11,229	11,069	10,601	8,952	6,023	4,690
Delaware	1,202	1,437	3,044	1,906	2,942	2,567	3,093	2,345	2,481	2,893	1,442	1,130
District of Columbia	16,975	10,910	24,642	19,458	26,325	24,941	24,216	18,605	26,376	21,667	13,737	10,957
Florida	66,510	70,455	84,392	75,751	75,098	71,809	67,921	74,908	71,798	71,985	75,348	74,846
Georgia	24,761	25,974	37,305	28,115	27,409	31,398	26,783	31,049	28,360	28,287	23,565	25,506
Idaho	479	211	1,208	1,083	1,164	1,488	1,395	1,637	1,770	1,196	811	263
Illinois	28,409	33,317	66,432	58,527	81,159	80,084	70,695	82,247	79,359	71,241	51,544	40,279
Indiana	19,879	23,188	56,713	43,436	51,399	60,455	51,902	57,155	60,840	47,576	39,454	25,080
Iowa	4,369	4,694	26,829	14,660	21,148	20,939	17,350	25,197	16,991	15,123	11,836	7,062
Kansas	9,051	8,404	23,839	13,436	17,624	18,053	15,386	20,952	17,661	17,185	15,261	10,706
Kentucky	12,993	13,871	30,766	24,388	32,885	32,103	33,934	37,779	38,033	31,745	25,549	14,968
Louisiana	6,537	6,677	12,410	8,795	12,028	12,009	6,320	9,428	10,284	14,640	10,943	8,938
Maine	1,254	594	2,728	3,749	4,449	6,025	5,449	5,327	5,800	5,938	3,472	2,887
Maryland	24,001	23,879	43,966	37,787	43,902	41,933	35,588	35,854	40,057	38,849	24,207	18,041
Massachusetts	9,051	12,332	21,072	17,771	26,392	29,527	25,150	28,863	29,190	23,598	15,802	11,405
Michigan	59,916	55,976	101,427	116,498	132,099	143,237	121,729	145,365	134,734	120,713	82,664	80,573
Minnesota	10,929	10,432	36,068	26,847	33,882	39,777	32,836	40,860	36,260	32,140	14,981	17,186
Mississippi	7,823	7,883	11,746	7,935	9,366	10,791	9,136	10,551	11,180	11,038	8,276	10,042
Missouri	5,173	5,827	15,221	9,839	12,463	12,539	12,437	12,574	16,890	15,097	12,545	6,659
Montana	1,466	1,027	1,609	2,584	2,720	3,260	2,425	2,985	3,164	2,647	1,242	1,486
Nebraska	2,515	2,869	11,470	10,862	10,581	9,339	8,594	10,113	9,147	9,267	8,060	1,286
Nevada	570	902	982	28	74	20	29	30	47	32	14	19
New Hampshire	1,380	1,596	4,038	3,504	5,306	6,224	5,484	6,434	6,466	4,791	2,823	2,055
New Jersey	22,879	23,626	50,390	38,508	57,791	53,839	47,429	48,813	58,847	43,365	30,144	26,716
New Mexico	4,773	4,471	7,014	2,581	9,794	6,959	8,053	9,327	3,180	6,998	6,866	3,621
New York	40,345	45,122	95,125	90,758	128,049	138,537	108,283	116,719	123,670	105,928	65,066	52,395
North Carolina	44,101	55,358	82,672	66,153	69,019	70,175	68,392	65,274	73,883	66,041	67,600	49,558
North Dakota	692	1,302	5,056	2,634	17,608	18,318	5,031	4,549	5,538	8,348	1,979	1,754
Ohio	45,710	40,890	106,566	101,252	114,206	146,789	132,479	148,656	134,921	121,653	80,080	70,378
Oklahoma	12,425	13,609	21,714	16,535	19,546	19,125	14,683	28,412	17,438	13,749	16,195	17,045
Oregon	345	60	548	94	108	385	101	222	237	241	180	59
Pennsylvania	43,003	39,447	114,554	94,213	130,012	136,420	120,544	123,850	129,419	101,728	72,349	54,591
Rhode Island	1,054	1,065	2,436	2,436	2,265	3,251	2,442	1,838	3,174	2,317	1,285	758
South Carolina	26,587	27,649	39,410	28,544	31,767	29,974	30,182	31,395	27,254	32,348	28,780	34,142
South Dakota	1,267	1,408	6,307	4,597	4,886	8,126	5,223	6,334	5,107	5,194	1,455	587
Tennessee	23,371	24,858	46,743	40,546	46,153	49,677	43,550	51,789	50,299	42,819	35,441	28,156
Texas	49,517	47,523	68,130	62,277	68,079	69,812	65,483	69,089	62,544	59,270	54,841	58,216
Utah	656	641	1,452	1,974	2,189	2,383	1,594	1,513	2,338	2,078	1,430	1,507

See footnotes at end of table.

TABLE 24.—Destination of shipments of prepared masonry cement from mills in the United States in 1955,[1] by months in barrels—Continued

Destination	January	February	March	April	May	June	July	August	September	October	November	December
Vermont	488	809	1,680	2,165	2,646	2,746	2,759	3,663	3,288	2,615	1,538	1,137
Virginia	41,005	40,673	74,712	54,977	72,239	67,682	65,210	60,388	63,781	67,073	48,958	36,503
Washington	1,552	1,531	2,175	3,933	4,206	4,292	4,538	4,119	4,154	3,602	1,728	2,139
West Virginia	4,462	5,850	16,866	14,618	17,466	20,140	17,826	17,946	19,890	15,199	13,039	6,983
Wisconsin	17,659	18,288	43,073	38,131	55,517	60,056	52,191	43,468	57,717	49,651	36,924	25,009
Wyoming	690	272	1,374	1,375	1,812	1,719	785	12,636	820	1,514	457	162
Unspecified	1,557	1,713	77	149	4,376	154	2,678	4,147	3,334	3,195	1,701	2,318
Continental United States	759,314	777,134	1,496,339	1,249,950	1,541,714	1,624,539	1,424,699	1,566,424	1,546,990	1,387,868	1,053,187	885,256
Outside continental United States[2]	686	866	1,661	1,050	2,286	3,461	2,301	1,576	4,010	4,132	2,813	744
Total	760,000	778,000	1,498,000	1,251,000	1,544,000	1,628,000	1,427,000	1,568,000	1,551,000	1,392,000	1,056,000	886,000

[1] These data collected for the first time in 1955.
[2] Shipments by producers to foreign countries.

NATURAL, SLAG, AND HYDRAULIC LIME CEMENTS

Natural cement was produced by three plants in the United States during 1955. These represent the last stand of the original cement industry in the United States, which had 76 plants in 1899. They are now almost entirely replaced by portland-cement plants. Slag cement (formerly referred to as pozzolan cement) was produced by 2 plants in 1955 and hydraulic lime at 1 plant; 4 of the 6 plants mentioned also produced masonry cements. In addition, a fourth natural cement plant sold no natural cement; it used its entire productive capacity for making masonry cement. Production and shipments of these masonry cements are included in the section, Prepared Masonry Cements, where they are combined with masonry cements prepared at portland-cement plants.

Owing to the small number of producers of these special hydraulic cements, only a summary table can be shown. Quantities in table 25 are shown in equivalent barrels of 376 pounds, as reports from producers show barrels of various weights ranging from 250 to 340 pounds.

TABLE 25.—Natural, slag, and hydraulic lime cements produced, shipped, and in stocks at mills in the United States,[1] 1946–50 (average) and 1951–55

Year	Production		Shipments		Stocks on Dec. 31 (barrels)
	Active plants	Barrels	Barrels	Value	
1946–50 (average)	9	3,259,510	3,257,646	$7,257,961	163,654
1951	9	3,449,463	3,475,423	9,832,956	159,485
1952	8	3,401,684	3,447,390	9,751,837	113,777
1953	8	3,488,102	3,459,361	10,340,767	142,326
1954	8	3,504,380	3,513,358	13,214,960	[2] 79,074
1955	6	941,072	954,414	3,019,159	65,732

[1] Includes natural masonry cements through 1954.
[2] Revised figure.

Production in 1955 decreased 1 percent, and shipments increased nearly 2 percent. Producers of these cements reported consumption of 17,651 short tons of coal and 143,726,000 cubic feet of gas.

The 7 producing plants reported an estimated annual capacity on December 31, 1955, of 1,235,158 equivalent 376-pound barrels. Raw materials used during 1955 in producing cements at these plants were 173,957 short tons of slag and 207,428 tons of other materials, principally shale, lime, and cement rock.

PRICES

The average net realization of all shipments from cement plants in 1955 was $2.89 compared with $2.78 per barrel in 1954.

Portland-cement prices increased in the first quarter of 1955 to $2.83 from $2.80 of the final quarter of 1954. Prices increased in the second quarter to $2.86 and in the final quarter of 1955 to $2.87 per barrel.

Prices of high-early-strength portland cement increased progressively during 1955 from $3.24 in the first quarter to $3.27, $3.29, and $3.30 in the final quarter.

Average mill values of cement in bulk are shown in table 26.

TABLE 26.—Average mill value per barrel, in bulk, of cement in the United States,[1] 1946–50 (average) and 1951–55

	Portland cement	Natural, slag, hydraulic lime cements	Prepared masonry cement [2]	All classes of cement [3]
1946–50 (average)	$2.11	$2.17	$2.42	$2.11
1951	2.54	2.77	3.05	2.55
1952	2.54	2.76	3.05	2.54
1953	2.67	2.93	3.22	2.68
1954	2.76	3.18	3.50	2.78
1955	2.86	3.16	3.41	2.89

[1] Includes Puerto Rico and Hawaii, 1946; Puerto Rico only, 1947–55.
[2] Includes masonry cements made at portland-, natural-, and slag-cement plants.
[3] Includes shipments of masonry for 1955 only.

The composite wholesale price index of portland cement f. o. b. destination, according to the Bureau of Labor Statistics index (1947–49=100), was 131.4 in 1955 compared with 126.6 in 1954.

FOREIGN TRADE [4]

Imports.—Imports of hydraulic cement rose to a peak of over 5 million barrels in 1955 compared with less than one-half million barrels for each of the preceding 3 years. Canada and Mexico supplied nearly 1 million barrels, and imports from Europe increased more than 3.5 million barrels. Nearly 2 million barrels entered through the Florida customs district. It was reported that much of the European cement was shipped into the Midwest areas of the United States to relieve local shortages.[5]

TABLE 27.—Hydraulic cement imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Barrels	Value	Year	Barrels	Value
1946–50 (average)	362,177	$953,869	1953	386,051	$1,265,821
1951	921,953	3,162,960	1954	450,248	[1] 1,762,708
1952	475,986	1,397,239	1955	5,219,700	[1] 14,354,412

[1] Due to changes in tabulating procedures by the U. S. Department of Commerce data known to be not comparable to years before 1954.

[4] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.
[5] Engineering News Record, Imported Cement: Vol. 155, No. 5, Aug. 4, 1955, p. 84.

TABLE 28.—Roman, portland, and other hydraulic cement imported for consumption in the United States, 1953–55, by countries [1]

[U. S. Department of Commerce]

Country	1953		1954		1955	
	Barrels	Value	Barrels	Value	Barrels	Value
North America:						
Canada	11,548	$51,105	67,588	$280,989	724,101	$2,663,631
Dominican Republic					149,364	347,498
Mexico			7,250	17,013	266,907	585,769
Total	11,548	51,105	74,838	298,002	1,140,372	3,596,898
South America: Colombia					56,331	208,016
Europe:						
Belgium-Luxembourg	187,245	524,552	194,596	621,069	1,468,341	4,088,744
Denmark	750	1,559			24,580	65,312
Finland					12,899	49,500
France	152	1,281	51	1,746	2,588	17,612
Germany, West	98,678	275,888	52,053	185,159	1,230,608	3,208,697
Netherlands					1,759	7,642
Portugal					2,990	6,273
Sweden	17,573	35,854	22,498	43,063	428,820	865,153
United Kingdom	10,578	61,958	14,103	88,637	27,476	118,968
Yugoslavia	10,554	52,411	12,919	66,767	109,506	328,551
Total	325,530	953,503	296,220	1,006,441	3,309,567	8,756,452
Asia:						
Israel					52,497	148,574
Japan					1,186	2,584
Total					53,683	151,158
Africa: French Morocco			500	3,433		
Grand total	337,078	1,004,608	371,558	[2] 1,307,876	4,559,953	[2] 12,712,524

[1] Excludes "white, nonstaining, and other special cement."
[2] Due to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not comparable to years before 1954.

Exports.—Exports of hydraulic cement were almost the same in 1955 as in 1954. Shipments to Canada, the West Indies, and the Central and South American countries showed little change, despite the large shipments of European cement to the American continents. Exports to both Canada and Mexico increased slightly, although imports from these countries increased from a few thousand barrels to nearly 1 million, just about equaling the export figures. Cement was exported to the western Provinces of Canada and imported from the eastern Provinces.

TABLE 29.—Hydraulic cement exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Barrels	Value	Percent of total shipments from mills
1946–50 (average)	4,967,422	$15,892,869	2.5
1951	2,932,787	9,963,721	1.2
1952	3,174,405	11,148,535	1.2
1953	2,550,788	9,347,169	1.0
1954	[1] 1,859,012	[1] 6,651,790	1.0
1955	1,795,448	7,066,918	1.0

[1] Revised figure.

TABLE 30.—Hydraulic cement exported from the United States, 1953–55, by countries of destination

[U. S. Department of Commerce]

Country	1953		1954		1955	
	Barrels	Value	Barrels	Value	Barrels	Value
North America:						
Bermuda	7,425	$27,450	1,762	$5,956	425	$2,210
Canada	1,207,296	4,519,410	639,046	2,493,150	743,671	3,032,905
Central America:						
British Honduras	3,900	13,692	2,312	8,707	2,382	9,527
Canal Zone	710	4,211	1,632	7,257	1,582	7,042
Costa Rica	9,577	36,046	40,000	96,649	4,125	34,213
El Salvador	2,508	19,655	1,416	10,561	760	4,880
Guatemala	1,326	8,878	660	6,621	926	7,714
Honduras	32,973	89,627	31,759	80,136	11,461	38,191
Nicaragua	8,064	30,808	4,637	18,829	5,906	31,911
Panama	1,452	10,204	692	4,817	1,785	9,791
Mexico	278,368	1,152,740	209,046	900,025	213,438	985,760
West Indies:						
British:						
Bahamas	12,252	54,790	13,895	57,872	14,774	64,926
Barbados	500	2,480	500	2,474	1,380	7,038
Jamaica	2,055	6,214	505	2,299	1,847	13,241
Leeward and Windward Islands	2,634	9,367	2,430	10,910	5,149	17,188
Trinidad and Tobago	4,133	20,133	3,474	16,164	5,347	25,917
Cuba	447,584	1,254,473	[1] 395,856	[1] 1,008,034	216,349	574,153
Dominican Republic	2,214	12,256	400	1,510		
French West Indies	8,601	26,420	8,997	25,975	15,203	43,353
Haiti	73,628	193,655	131,585	367,016	269,068	775,060
Netherlands Antilles	76,710	195,650	55,692	166,870	3,550	9,685
Total	2,183,910	7,688,159	[1] 1,546,296	[1] 5,291,832	1,519,128	5,694,705
South America:						
Argentina	800	5,488				
Bolivia	2,916	13,723	2,916	12,980	725	4,083
Brazil	7,270	29,944	12,385	57,649	18,388	85,265
Chile	2,533	23,840	264	2,978	1,359	17,804
Colombia	11,663	76,875	15,385	98,650	13,060	85,606
Ecuador	4	104	8,250	28,875	625	2,817
Paraguay	382	2,815				
Peru	10,063	47,322	3,511	16,965	13,422	42,085
Surinam	32,638	78,995	5,937	12,655	201	1,481
Venezuela	239,264	1,043,017	213,918	873,266	163,752	745,475
Total	307,533	1,322,123	262,566	1,104,018	211,532	984,616
Europe:						
Belgium-Luxembourg	528	4,279	761	7,264	1,416	19,809
France	137	2,491	293	1,490	821	7,591
Italy	13	153	187	2,328		
Norway	82	5,359	32	1,850	100	500
Spain	864	5,012	250	1,020	884	4,432
Other Europe	565	6,347	35	107	144	1,553
Total	2,189	23,641	1,558	14,059	3,365	33,885
Asia:						
Bahrein			425	2,403		
Indonesia	5,424	27,014	4,000	16,600	18,635	92,097
Iraq	11,327	53,195	250	1,220	3,434	17,136
Israel and Palestine	596	4,357	[2] 313	[2] 1,281	[2] 132	[2] 665
Japan	1,382	22,247	422	9,075	1,990	46,832
Korea, Republic of	132	1,203	2,235	9,298	6,692	35,942
Kuwait	2,500	9,930	13,759	53,216	5,506	20,219
Malaya	197	934	2,250	10,748	2,000	9,992
Philippines	4,271	42,059	2,255	22,253	1,863	18,596
Saudi Arabia	18,631	92,695	8,485	47,240	1,000	4,230
Other Asia	1,270	10,279	232	2,636	2,486	17,035
Total	45,730	263,913	34,626	175,970	43,738	262,744

See footnotes at end of table.

TABLE 30.—Hydraulic cement exported from the United States, 1953–55, by countries of destination—Continued

[U. S. Department of Commerce]

Country	1953		1954		1955	
	Barrels	Value	Barrels	Value	Barrels	Value
Africa:						
British East Africa					796	$3,744
Federation of Rhodesia and Nyasaland	[3] 750	[3] $3,809				
Liberia	450	1,562	6,479	$25,986	8,953	38,569
Nigeria	148	734	1,554	8,100	250	1,225
Tunisia	502	2,414				
Other Africa	672	5,860	963	6,190	492	4,671
Total	2,522	14,379	8,996	40,276	10,491	48,209
Oceania:						
Australia	375	1,574	1,682	10,966	1,330	15,854
New Zealand	8,113	29,814	3,025	11,677	5,332	20,867
Other Oceania	416	3,566	263	2,992	532	6,038
Total	8,904	34,954	4,970	25,635	7,194	42,759
Grand total	2,550,788	9,347,169	[1] 1,859,012	[1] 6,651,790	1,795,448	7,066,918

[1] Revised figure.
[2] Israel.
[3] Northern Rhodesia.

TECHNOLOGY

A revised edition of a classic portland-cement reference book was published during 1955.[6] Called by one reviewer "the best compendium and digest of research on portland cement and its constituents, at least in the English language," the book was designed to help the cement manufacturer in the control of the production and quality of his product.

Further studies were made of the three principal oxide constituents of portland-cement clinker: Lime, alumina, and silica. Study of the reactions when these ternary cement components were burned was extended to the commercial process of cement manufacture.[7]

The hydration of portland cement continued to arouse general interest as well as speculation. The apparent importance of the hydrated silicate ions as the bond or cementing agency in concrete was discussed.[8] Studies of the heat of hydration were conducted in Italy, Germany, and New Zealand.[9] The structure of cement pastes and hardened cements was investigated in Germany, Russia, and England.[10]

[6] Bogue, R. H., The Chemistry of Portland Cement: Reinhold Publishing Corp., 1955, 793 pp.
[7] Dahl, L. A., New Study on Reactions in Burning Cement Raw Materials: Rock Products, vol. 58, No. 5, May 1955, pp. 71, 72, 106, 108, and 112; vol. 58, No. 6, June 1955, pp. 102, 104, 106, and 134; vol. 58, No. 7, July 1955, pp. 78, 82, 84, 86, 98, 100, 102.
[8] Rockwood, Nathan C., Rocky's Notes: Rock Products, vol. 58, No. 8, August 1955, pp. 49, 138.
Iler, Ralph K., The Colloid Chemistry of Silica and Silicates: Cornell University Press, Ithaca, N. Y., 1955, p. 324.
Rockwood, Nathan C., Prospective Chemistry of Cement and Concrete, Part XI, A Bit on the Chemistry of the Element Silicon: Rock Products, vol. 58, No. 1, January 1955, pp. 100, 101; Part XII, The Real Character of Portland Cement and Concrete: Rock Products, vol. 58, No. 8, August 1955, pp. 150, 152, 168–170, 172.
[9] Building Science Abstracts (London), vol. 28, No. 1, January 1955, p. 6; vol. 28, No. 2, February 1955, p. 37; vol. 28, No. 6, June 1955, p. 164.
[10] Building Science Abstracts (London), vol. 28, No. 9, pp. 260, 262.
American Ceramic Society, vol. 38, No. 10, October 1955, p. 173.

The European practice of using vertical-shaft kilns was discussed in the light of relatively low labor costs and high fuel costs.[11] Lignite was employed successfully in a shaft kiln in Australia,[12] where raw material was nodulized for kiln feed.[13] The burning techniques in German practice were described.[14] Although shaft kilns had been used extensively in France, a representative of the French Portland Cement Association stated that most of its members were replacing shaft kilns with horizontal rotary kilns.

The thermal efficiency of rotary kilns was studied in several countries. In Germany an investigation was carried out to analyze the thermal consumption in kilns with and without waste-heat boilers under German operating conditions, where half to two-thirds of the production costs of cement comprised expenditures for fuel and power.[15] In Norway radioisotopes were used to study material transport in rotary kilns to determine length of time the charge remained in various sections of the kilns.[16] The performance and development of a rationalized rotary kiln system in the United States was described by its inventor. The advantages of a segmented or quadrated kiln, with its accompanying greater exposure of material to the hot gases, were reported to be unbelievable.[17] Plans for the installation of the first "double-pass" Lepol kiln were announced.[18] The nonaqueous process proposed by J. C. Witt to conserve fuel continued to arouse interest in the press.[19] A patent was issued on apparatus for processing hot cement clinker and reclaiming waste heats with heat exchangers.[20]

Some important chemical and economic aspects in the choice of portland-cement raw-material sources were discussed in relation to expansion of residential areas into rural areas.[21] The diversity of raw materials for making cement was indicated by the use of anhydrite (calcium sulfate) in England [22] and limestone, feldspar, and an unidentified white slurry in another plant.[23] The method of calculating material balance used by the Puerto Rico Cement Corp., in producing various types of cement was described.[24]

---

[11] Clausen, C. F., Men or Fuel? Why European Cement Practices Are Different: Rock Products, vol. 58, No. 2, February 1955, pp. 78–82, 84.

[12] Iron and Coal Trades Review, Use of Lignite in Cement Making: Vol. 171, No. 4554, July 22, 1955, p. 200.

[13] Gottlieb, Steven, Cement Can Be Made Efficiently in a Shaft Kiln: Rock Products, vol. 58, No. 8, August 1955, pp. 122, 126, 128, 130, 174, 176.

[14] Spohn, Everhard, Modern Cement Shaft Kiln Has Low Installation Cost: Rock Products, vol. 58, No. 9, September 1955, pp. 58–60, 62, 65, 67.

[15] Cement, Lime and Gravel, Evaluation of Some Rotary Cement-Kiln Installations With Waste-Heat Boilers: Vol. 29, No. 11, May 1955, pp. 541–550.

[16] Rutle, Johs, Investigation of Material Transport in Wet-Process Rotary Kilns by Radioisotopes: Pit and Quarry, vol. 48, No. 1, July 1955, pp. 120–121, 124–125, 128–129, 132–133, 136.

[17] Azbe, Victor L., Rotary Kiln; Its Performance and Development: Rock Products, vol. 58, No. 2, February 1955, pp. 101, 102, 104, 106, 109, 122; vol. 58, No. 3, March 1955, pp. 82–85, 106, 108; vol. 58, No. 5, May 1955, pp. 77–78, 81–82; vol. 58, No. 6, June 1955, pp. 108, 110, 114, 130; vol. 58, No. 7, July 1955, pp. 58, 60, 62, 64, 102; vol. 58, No. 8, August 1955, pp. 154, 156; vol. 58, No. 9, September 1955, pp. 70, 72, 74; vol. 58, No. 10, October 1955; pp. 118, 120, 122, 124, 138, 140.

[18] Pit and Quarry, Plans for $7 Million Plant at Milwaukee Location Announced by Marquette: Vol. 48, No. 5, November 1955, p. 21.

Pit and Quarry, Marquette's Milwaukee Plant to Feature New Type of Kiln: Vol. 48, No. 6, December 1955, p. 32.

Chemical Engineering, Improved Cement Process Looms: Vol. 62, No. 12, December 1955, p. 103.

[19] Chemical Engineering, Nonaqueous Cement Process: Vol. 62, No. 11, November 1955, pp. 207–208.

[20] Oberg, B. N., and Humes, W. Y. C. (assigned to Monolith Portland Cement Co.), Cooling Method and Apparatus for Processing Cement Clinker: U. S. Patent 2,721,806, Oct. 25, 1955.

[21] Wolfe, John A., What To Look for in Selecting Cement Raw Materials: Rock Products, vol. 58, No. 8, August 1955, pp. 132, 180, 182, 184, 186, 188.

[22] Grindrod, John, Cement Clinker To Be Produced in New British Anhydrite Sulfuric-Acid Plant: Pit and Quarry, vol. 47, No. 9, March 1955, pp. 104–105.

[23] American Ceramic Society, vol. 38, No. 10, October 1955, p. 173.

[24] Vera, Arturo, Jr., Materials Accounting in Processing Portland Cement: Rock Products, vol. 58, No. 4, April 1955, pp. 92, 94.

A cement company in Washington transported crushed limestone 58 miles from its quarry by truck and rail to the plant.[25] The use of conveyor belts up to 1 mile in length was described at 5 cement-plant quarries, in some instances replacing aerial tramways.[26]

Grinding techniques were described at the Brandon, Miss., plant of Marquette Cement Manufacturing Co.,[27] at the Northampton, Pa., plant of the Dragon Cement Co.,[28] at the Davenport, Calif., plant of the Santa Cruz Portland Cement Co.,[29] and at the Bamberton works of the British Columbia Cement Co., Ltd.[30]

Equipment and methods used at the following cement plants were described in articles: Aetna Portland Cement Co., Bay City, Mich.;[31] Huron Portland Cement Co., Huron, Mich.;[32] Dragon Cement Co., Northampton, Pa.;[33] Missouri Portland Cement Co., Sugar Creek, Mo.;[34] and St. Lawrence Cement Co., Villeneuve, Quebec.[35]

The Permanente Cement Co. completed successful tests of pulverized petroleum coke as a kiln fuel.[36] Power for a San Antonio cement plant was supplied by duafuel diesels using natural gas and pilot oil.[37] Single-stage gas turbines were used in the powerplant of a Venezuelan cement plant.[38]

Dust problems in the cement industry were discussed in a paper presented at a symposium in London.[39] A $1,500,000 dust-collecting project was installed by a California cement producer.[40] The methods used by a Dutch company to control its dust problem were described.[41] Descriptions were published of dustless trucks used for bulk transport of cement in New York and Michigan.[42]

---

[25] Lenhart, Walter B., From Aerial Tramway to Truck-Rail Haul With the Opening of New Quarry Rock Products, vol. 58, No. 9, September 1955, pp. 42–44, 47.

[26] Rock Products, Stone Plant Goes Underground: Vol. 58, No. 8, August 1955, p. 57.
Lenhart, Walter B., Dual-Belt Conveyor System Serves Southwestern's Crushing Plant: Rock Products, vol. 58, No. 8, August 1955, pp. 135, 136, 138.
Persons, Hubert C., Mine Limestone 1,500 Ft. Underground for Cement Manufacture: Rock Products, vol. 58, No. 9, September 1955, pp. 76, 78.
Mining Engineering, Mile-Long Conveyor-Belt System Replaces Aerial Tramway at Cement Property: Vol. 7, No. 10, October 1955, p. 909.
Lenhart, Walter B., Long Conveyor From Quarry to Cement Plant Generates Current: Rock Products, vol. 58, No. 11, November 1955, pp. 74–76.

[27] Rock Products, vol. 58, No. 4, April 1955, p. 150.

[28] Nordberg, Bror, Grinding Mill Layout of Dragon Cement Co. Stresses Safety, Simplicity, and Easy Maintenance: Rock Products, vol. 58, No. 8, August 1955, pp. 68–75.

[29] Rock Products, Grinding Media Studies Result in Reduced Cost: Vol. 58, No. 10, October 1955, p. 136.

[30] Haskins, R. E., and McColl, J., Experiments with Wet Cyclone Classifiers at Bamberton Works of B. C. Cement Co.: Canadian Min. and Met. Bull., vol. 48, No. 520, August 1955, pp. 508–513.

[31] Avery, W. M., Aetna Portland Cement Adds Fourth Kiln at Bay City: Pit and Quarry, vol. 47, No. 1, July 1954, pp. 71–74.

[32] Nordberg, Bror, World's Largest Cement Plant Boosts Capacity Again: Rock Products, vol. 58, No. 1, January 1955, pp. 102–116, 124.

[33] Trauffer, Walter E., Dragon's Northampton Plant Sets Records in Efficiency and Economy of Production: Pit and Quarry, vol. 48, No. 1, July 1955, pp. 98–99, 101, 105–108, 113–114, 118, 136.

[34] Thibault, Donald G., Missouri Portland Cement Builds New Dry-Process Plant: Pit and Quarry, vol. 48, No. 1, July 1955, pp. 90–97.

[35] Pit and Quarry, Quebec's New Modern 1,500,000-bbl. Cement Plant: Vol. 48, No. 1, July 1955, pp. 70–75, 78–82, 84, 86–88.
Nordberg, Bror, Swiss Engineers Design Cement Plant With Dust Return Into Firing End of Kiln and Gravity-Flow Packing: Rock Products, vol. 58, No. 8, August 1955, pp. 82–94, 96, 101–102, 104–105, 109, 112, 114, 118.

[36] Cornforth, R. M., and Lee, E. R., Jr., Firing Kilns with Fluid Petroleum Coke: Rock Products, vol. 58, No. 11, November 1955, pp. 98, 103, 120.

[37] Pit and Quarry, Two New Diesels Added to San Antonio Portland's Power Plant: Vol. 47, No. 11, May 1955, pp. 178–180.

[38] Passmore, L. W., Gas Turbines Supply All Power Needs of Venezuela Cement Plant: Rock Products, vol. 58, No. 11, November 1955, pp. 107, 110.

[39] Burke, E., Dust Arrestment in the Cement Industry: Chemistry and Industry (London), No. 42, Oct. 15, 1955, pp. 1312–1319.

[40] Lenhart, Walter B., West Coast Cement Manufacturer Installs Waste-Heat Boilers on Long Dry-Process Kiln: Rock Products, vol. 58, No. 6, August 1955, pp. 76–80.

[41] Van der Leeuw, K. L. A., Dutch Cement Plant Returns Recovered Dust to Firing End of Kiln: Rock Products, vol. 58, No. 10, October 1955, pp. 66–68.

[42] Rock Products, Dustless Truck Loading: Vol. 58, No. 8, August 1955, p. 61.
Rock Products, Bulk-Cement Transporter: Vol. 58, No. 8, August 1955, p. 65.

A new method for rapid analysis of cements with reported high accuracy and precision was announced after trials in Paris.[43]

A proposed specification for slag cement was issued.[44] The included specifications for MgO were discussed in Germany.[45] The shortage of cement in some areas awakened interest in pozzolanic materials to relieve the cement situation.[46]

Refractory cements consisting of about 70 percent calcium aluminates are not included in the tabulations in this chapter. Interest in these products was, however, manifested during the year.[47] A new type of cement consisting of an inhibited solution of phosphoric acid and powdered aluminous material for oil-well drilling was described.[48]

WORLD REVIEW

For the third consecutive year world cement production increased about 100 million barrels. The increase of 20 million barrels in cement production in the United States was overshadowed by a 70-million-barrel increase in European production.

TABLE 31.—World production of hydraulic cement, by countries, 1946–50 (average) and 1951–55, in thousand barrels [1]

[Compiled by Helen L. Hunt]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada (sold or used by producers)	13,087	15,831	17,238	20,697	20,885	23,430
Cuba	1,706	2,240	2,463	2,386	2,468	2,644
Dominican Republic	[2] 270	610	803	762	938	[3] 1,170
Guatemala	193	334	352	393	375	475
Jamaica			440	592	580	575
Mexico	6,702	9,469	9,616	9,803	10,448	12,231
Nicaragua	88	117	111	141	141	170
Panama	[4] 287	440	545	469	451	428
Salvador				211	287	334
Trinidad and Tobago					141	709
United States	201,615	249,472	252,658	267,669	275,857	314,913
Total	223,948	278,513	284,226	303,123	312,571	357,079
South America:						
Argentina	7,980	9,147	9,076	9,710	9,850	10,835
Bolivia	223	229	217	199	193	223
Brazil	6,473	8,537	9,493	11,902	14,523	15,784
Chile	3,201	4,093	4,796	4,468	4,544	4,931
Columbia	2,445	3,799	4,104	5,119	5,640	6,145
Ecuador	258	463	522	534	557	821
Paraguay			23	18	41	70
Peru	1,665	2,111	2,175	2,633	2,832	3,195
Uruguay	1,689	1,765	1,759	1,741	1,741	1,560
Venezuela	1,513	3,641	4,925	5,758	7,112	7,517
Total	25,447	33,785	37,090	42,082	47,033	51,081

See footnotes at end of table.

[43] Building Science Abstracts, vol. 28, No. 9, September 1955, p. 262.
[44] American Society for Testing Materials, Bull. 203, January 1955, pp. 8 and 9.
Rock Products, ASTM Convention Contributes New Knowledge on Cement-Concrete: Vol. 58, No. 9, September 1955, p. 100.
[45] Building Science Abstracts, vol. 28, No. 9, September 1955, p. 263.
[46] Engineering News-Record, Pozzolans in Concrete: Vol. 155, No. 9, Sept. 1, 1955, pp. 10 and 12; vol. 155, No. 10, Sept. 8, 1955, pp. 8, 10.
American Metal Market, Firm Formed at Buffalo To Market Fly Ash: Vol. 62, No. 158, Aug. 16, 1955, p. 13.
Wall Street Journal, Cement Shortage: Vol. 146, No. 81, Oct. 25, 1955, p. 1.
[47] Steel, What It Takes To Make a 3,000-Degree Refractory Cement: Vol. 136, No. 6, Feb. 7, 1955, p. 150.
Metal Industry, New Refractory Product: Vol. 87, No. 8, Aug. 19, 1955, p. 155.
Hansen, W. C., and Livovich, A. F., Factors Influencing the Physical Properties of Refractory Concretes: Bull. Am. Ceram. Soc., vol. 34, No. 9, Sept. 15, 1955, p. 298.
American Ceramic Society, Refractory Cements: Vol. 38, No. 10, October 1955, p. 173.
[48] Barnes, Kenneth B., Dowell Develops Brand-New Cement: Oil Gas Jour., vol. 54, No. 27, Nov. 7, 1955, p. 80.

TABLE 31.—World production of hydraulic cement, by countries, 1946–50 (average) and 1951–55, in thousand barrels [1]—Continued

[Compiled by Helen L. Hunt]

Country	1946–50 (average)	1951	1952	1953	1954	1955
Europe:						
Albania [3]	88	94	100	117	235	340
Austria	4,427	8,648	8,150	8,173	9,510	10,900
Belgium	16,781	25,769	24,104	27,567	25,652	27,493
Bulgaria	2,345	3,723	3,952	4,151	[3] 4,690	5,277
Czechoslovakia	8,895	12,196	12,958	13,603	16,417	18,176
Denmark	4,233	5,775	7,106	7,388	6,737	6,643
Finland	3,172	4,861	4,562	5,494	6,092	5,922
France	31,697	47,639	50,688	53,063	54,939	62,092
Germany:						
East [3]	4,690	9,560	11,670	14,130	15,200	18,170
West	35,778	71,626	75,554	90,160	95,337	110,048
Greece	1,513	2,539	3,495	4,116	5,007	6,620
Hungary [3]	2,345	5,560	6,330	6,450	5,860	7,035
Ireland	2,187	2,498	2,697	2,767	3,471	4,005
Italy	21,096	32,705	39,003	45,910	51,368	62,075
Luxembourg	610	774	668	862	885	921
Netherlands	3,113	4,116	4,767	5,048	5,699	6,455
Norway	3,061	4,116	4,139	4,427	4,597	4,867
Poland	11,258	15,761	15,596	19,343	[3] 20,520	[3] 21,690
Portugal	2,750	3,764	4,263	4,509	4,568	4,568
Rumania	2,814	6,684	8,795	12,313	15,831	11,727
Saar	815	1,372	1,395	1,671	1,618	1,659
Spain	13,404	16,077	17,367	19,091	22,351	21,993
Sweden	9,551	11,932	12,407	13,790	14,453	14,916
Switzerland	5,588	7,710	8,115	9,276	10,618	12,377
U. S. S. R. [3]	39,050	72,700	82,700	94,000	108,500	131,900
United Kingdom	48,888	60,910	66,337	66,824	71,274	74,511
Yugoslavia	6,467	6,796	7,699	7,511	8,168	9,164
Total [3]	286,600	445,900	484,600	541,800	589,600	661,500
Asia:						
Burma	[5] 23	100	240	240	358	352
Ceylon	----------	369	358	375	493	446
China [3]	2,200	7,600	12,000	13,500	27,700	29,300
Hong Kong	281	416	399	375	586	686
India	[6] 11,498	19,067	21,072	22,515	26,021	26,309
Indochina	551	1,243	1,378	1,706	1,489	1,524
Indonesia	[3] 175	[3] 590	803	868	827	[3] 880
Iran	[7] 322	[7] 381	[7] 410	[7] 381	[7] 364	469
Iraq	[5] 217	[8] 440	610	1,038	1,161	1,859
Israel	1,612	2,574	2,615	2,726	3,301	4,104
Japan	13,796	38,393	41,729	51,409	62,591	61,846
Jordan	----------	----------	----------	----------	369	[3] 498
Korea:						
North	[3] 1,170	(9)	(9)	(9)	(9)	(9)
Republic of	94	41	211	258	317	328
Lebanon	1,190	1,777	1,671	1,788	1,964	2,463
Malaya	----------	----------	----------	188	504	639
Pakistan	[4] 2,304	2,973	3,160	3,553	3,969	4,052
Philippines	944	1,812	1,818	1,706	1,818	2,345
Syria	317	375	885	1,313	1,460	1,548
Taiwan (Formosa)	1,349	2,281	2,615	3,049	3,143	3,459
Thailand (Siam)	569	1,829	1,448	1,689	2,228	2,298
Turkey	2,087	2,322	2,691	2,832	3,981	4,814
Total [3]	40,700	85,500	97,000	113,300	147,600	153,700
Africa:						
Algeria	967	2,627	2,844	2,896	3,700	3,840
Angola	----------	----------	----------	170	246	410
Belgian Congo	751	1,202	1,407	1,536	2,117	2,369
Egypt	4,591	6,626	5,553	6,432	7,828	8,039
Ethiopia [3]	40	35	35	60	165	165
French Morocco	1,454	2,210	2,551	3,577	3,835	4,016
French West Africa	305	322	469	352	487	756
Kenya	129	117	193	211	416	768
Madagascar	35	29	----------	----------	----------	----------
Mozambique	229	457	487	510	598	616
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	----------	59	334	369	487	[3] 487
Southern Rhodesia	481	932	1,120	1,519	1,935	2,404
Tunisia	821	1,096	1,220	1,331	1,583	2,252

See footnotes at end of table.

TABLE 31.—World production of hydraulic cement, by countries, 1946–50 (average) and 1951–55, in thousand barrels [1]—Continued

[Compiled by Helen L. Hunt]

Country	1946–50 (average)	1951	1952	1953	1954	1955
Africa—Continued						
Uganda				117	246	293
Union of South Africa	8,150	11,457	11,850	12,448	12,676	13,697
Total	17,953	27,169	28,063	31,528	36,319	40,112
Oceania:						
Australia	5,881	7,247	7,956	9,370	11,222	11,662
New Zealand	1,413	956	1,542	1,642	1,894	2,404
Total	7,294	8,203	9,498	11,012	13,116	14,066
World total (estimate)	601,900	879,100	940,500	1,042,800	1,146,200	1,277,500

[1] This table incorporates a number of revisions of data published in previous cement chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[2] Average for 1947–50.
[3] Estimate.
[4] Average for 1948–50.
[5] Average for 1949–50.
[6] Pakistan included with India through 1947.
[7] Year ended March 20 of year following that stated.
[8] Year ended March 31 of year following that stated.
[9] Data not available; estimate by senior author of chapter included in total.

NORTH AMERICA

Canada.—Canada Cement Co., with seven plants, dominated production in Canada. Five other companies with one plant each operated during 1955.[49] The 1955 production of 23 million barrels approached the annual capacity of 25 million barrels, but shortages of cement were reported in western Canada. Four new companies, financed by European capital, and one American cement company announced plans to build new cement plants in Canada. Expansion of facilities at operating plants and the erection of two plants by operating cement companies made a total expansion program of over 12 million barrels annual capacity.[50]

Costa Rica.—Proposals for establishing a cement plant in Costa Rica were invited by the Ministry of Agriculture and Industries.[51]

Mexico.—The 18 cement plants in Mexico, with an annual capacity of 15 million barrels, produced 12 million barrels of cement in 1955. Information on some operating practices was published.[52] Portland cement was added to the list of items requiring a prior export permit.[53]

[49] Canada Department of Mines and Technical Surveys, Cement in Canada, 1955 (Prelim.): Ottawa, 4 pp.
[50] Pit and Quarry, Canadian Cement a Growing Industry: Vol. 48, No. 4, October 1955, pp. 72, 77. Canadian Cement Firms To Expand Their Output by New or Enlarged Plants: Vol. 48, No. 6, December 1955, p. 32. Saskatchewan Cement Announces Plans To Build $8,000,000 Plant at Regina: Vol. 48, No. 6, December 1955, p. 46.
Engineering News Record, Canadian Cement: Vol. 155, No. 5, Aug. 4, 1955, p. 86.
Western Miner and Oil Review, Canada Cement Co.: Vol. 28, No. 3, March 1955, p. 78.
Trauffer, W. E., Review and Forecast of the Canadian Cement Industry: Pit and Quarry, vol. 48, No. 8, February 1956, pp. 68, 70, 72.
American Metal Market, Manufacturers of Cement Plan Vancouver Expansion: Vol. 62, No. 192, Oct. 4, 1955, p. 9.
Canadian Mining Journal, Inland Cement Co.: Vol. 76, No. 9, September 1955, p. 118.
[51] Foreign Commerce Weekly, Costa Rica To Set Up New Cement Factory: Vol. 54, No. 25, Dec. 19, 1955, p. 11.
[52] Barona de la O, Federico, Mexico Improving Cement Quality: Rock Products, vol. 58, No. 3, March 1955, pp. 64–66.
[53] Foreign Commerce Weekly, Mexico Adds More Items to Prior Export-Control List: Vol. 53, No. 26, June 27, 1955, p. 9.

The National Chamber of Commerce considered several projects for construction of new cement plants.[54]

SOUTH AMERICA

Brazil.—Two cement companies took preliminary steps for establishing new plants in the States of Minas Gerais and Para.[55]

Colombia.—Surveys were made by a French company of possible cement-plant locations in the State of Bolivar.[56]

Ecuador.—The Nation's single cement plant was unable to keep pace with construction. Work continued on the erection of a second plant.[57]

Peru.—Tentative plans were made for 3 new plants to meet the cement demand growing too rapidly for Peru's 2 plants.[58]

EUROPE

Cement production in Europe increased more than 70 million barrels in 1955. Russia, West Germany, Italy, and France were mainly responsible for this record expansion.

Belgium.—Nearly one-half of the 3 million barrels of European cement imported by the United States in 1955 came from Belgium. The Belgium cement industry was able to increase production to meet this large increase in the American market.

Finland.—Two of Finland's largest limestone quarry operators also produced cement. Expansion of the larger plant was limited by poor harbor conditions which prevented direct shipments of cement for export.[59]

Germany, East.—Cement-manufacturing equipment for Bulgaria and Poland was furnished by East Germany.[60]

Germany, West.—Exports of cement to the United States increased from less than 100 thousand barrels to over 1 million barrels in 1955. Production in West Germany increased nearly 15 million barrels to 110 million during 1955. West Germany maintained its position as the largest producer of cement among the free nations of Europe.

Iceland.—A breakwater was built and the foundation for a cement plant was begun near Reykjavik, Iceland. Local fishing interests protested against this project.[61]

Italy.—Although production of cement increased nearly 20 percent in 1955, the high price of cement in Italy (nearly $3 U. S. currency per barrel) limited its export to the Mediterranean countries.[62]

Portugal.—Exports of cement declined more than 60 percent in 1955. The Portuguese Industrial Association appealed to the Minister of

[54] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 4, April 1956, p. 23.
Rock Products, Mexican Cement-Plant Proposals: Vol. 58, No. 8, August 1955, p. 58.
[55] Foreign Commerce Weekly, Cement Plant Planned by Brazilian Firm: Vol. 53, No. 18, May 2, 1955, p. 12.
Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 2, February 1956, pp. 20, 21.
[56] United States Embassy, Bogota, Colombia, State Department Dispatch 167: Aug. 3, 1955, p. 5.
[57] United States Embassy, Quito, Ecuador, State Department Dispatch 128: Oct. 11, 1955, p. 2.
[58] Foreign Commerce Weekly, World Bank Lends $2.5 Million for Cement-Plant Construction in Peru: Vol. 53, No. 18, May 2, 1955, p. 24.
Pit and Quarry, vol. 48, No. 5, November 1955, p. 25.
[59] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 3, March 1956, p. 19.
[60] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 6, December 1955, p. 28.
[61] Pit and Quarry, Iceland's First Cement Plant to Be Built Near Reykjavik: Vol. 47, No. 12, June 1955, p. 93.
[62] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 4, October 1955, p. 32.

457676—58——21

Finance for a reduction of the export duty on cement to assist the industry to recover its lost export markets.[63]

Spain.—The cement-quota allocation procedure was simplified as a step toward gradual lifting of controls.[64] Expansion of cement production at the State-owned plant at Xeralle was authorized,[65] and plans were announced for a new plant at Cieza.

United Kingdom.—The Associated Portland Cement Manufacturers Group was reported to be the largest cement company in the world, with 26 plants in the United Kingdom having a total annual capacity of 42 million barrels.[66] The British cement industry employed 16,000 persons and produced 74 million barrels of cement in 1955.[67]

Building programs in England were slowed to prevent disruption of the economic situation. Both private and municipal building faced rising costs owing to continued expansion of public works and services. The tightening of credit facilities was the first measure taken to curtail excess building programs.[68]

Yugoslavia.—The use of marl as the raw material for the Yugoslav cement plants and the expansions in mechanical equipment for handling the finished product were described.[69]

ASIA

Afghanistan.—The first consignment of machinery for a new cement plant in Afghanistan was shipped from Czechoslovakia to the construction site.

Burma.—Expansion of the nationalized Burma Cement Co. plant at Thayetmyo was announced.[70]

Ceylon.—Plans were announced for the erection of a second cement plant of 500,000 barrels annual capacity at Puttalam, with specified Government guarantees.[71]

India.—The Government of India granted a license for constructing a 500,000-barrel cement plant at Macherla village to supply cement for the Nandikonda irrigation project.[72] Plans were announced for a State-owned plant of 600,000 barrels annual capacity at Bhadravati and for expanding the Andhra Cement Co. plant at Vijayawada.[73]

Indonesia.—Construction was begun on the second cement plant in Indonesia, at Gresik. During 1955 imports of cement from the Soviet Bloc displaced those from Japan, the previous largest supplier.[74]

Iran.—An English firm contracted to supply the machinery for a proposed 1 million barrel cement plant at Doroud, 250 miles southwest of Tehran.[75]

Iraq.—In addition to expansion of the capacity of the only operating cement plant in Iraq, construction continued on erection of three

---

63 Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 4, April 1956, p. 24.
64 United States Embassy, Madrid, Spain, State Department Dispatch 966: July 1, 1955, p. 7.
65 United States Embassy, Madrid, Spain, State Department Dispatch 345: Oct. 21, 1955, p. 4.
66 Cement, Lime, and Gravel, Largest Cement Manufacturer in the World: Vol. 30, No. 1, July 1955, p. 3.
67 Cement, Lime, and Gravel, Cement Employment: Vol. 30, No. 3, September 1955, p. 162.
68 United States Embassy, London, England, State Department Dispatch 696: Sept. 27, 1955, p. 14.
69 Commercial Information, Cement in Yugoslav Export: Vol. 8, No. 10, October 1955, pp. 17–19.
70 Rock Products, Burma Cement Bids: Vol. 58, No. 4, April 1955, p. 63.
71 Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 3, February 1956, pp. 21–22.
72 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, pp. 40–41.
73 Foreign Commerce Weekly, Cement Factory in India to Increase Annual Production: Vol. 53, No. 23, June 6, 1955, p. 25.
74 United States Embassy, Djakarta, Indonesia, State Department Dispatch 227: Oct. 11, 1955, p. 6.
75 South African Mining and Engineering Journal, Cement-Plant Contract: Vol. 67, No. 3284, Jan. 20, 1956, p. 13.

private cement plants at Mosul, Samawa, and Hindiya. The Development Board received bids for constructing 2 plants, 1 at Mosul and the other at Sarchinar, to provide low-heat cement for the Dokan and Derbendi-Khan Dams.[76]

Israel.—The first shipment of portland cement to the United States from Israel was delivered to Bridgeport, Conn., in August 1955. The cargo originated at the Neshei Portland Cement Works, Ltd., Haifa, the largest of Israel's three cement plants.[77]

Korea.—Construction of a million-barrel cement plant was begun at Mungyong, and $8 million project of the United Nations Korean Reconstruction Agency. Rehabilitation and expansion of South Korea's only cement plant at Samchok were completed, raising it to 500,000-barrel annual capacity.[78]

Pakistan.—A committee appointed by the Government of Pakistan found that Karachi-plant cement was below British Standard Specifications due to the inferior limestone used. A better grade limestone was substituted to improve the quality of the cement.[79] American firms were invited to help finance a second plant with 1-million-barrel capacity at Karachi.[80]

Philippines.—A strong effort was made to increase cement production in the Philippines. The Government-owned company, the Cebu Portland Cement Co., operated its new plant at Bacnotan and its rehabilitated plant at Naga with coal from its mines in Cebu. The privately owned Rizal Cement Co. doubled the capacity at its Binangotan plant. Total annual capacity of the industry was increased to 3 million barrels. During the expansion construction period, cement was imported principally from Japan and Formosa. Plans were considered for another plant near Manila.[81]

Taiwan (Formosa).—Despite continued increase in cement production, critical shortages of cement for construction work on the Island developed. Plans for further increase in capacity at its 3 plants were announced by the Taiwan Cement Corp., and 5 or more small plants were planned to improve the situation.[82]

Thailand.—The Siam Cement Co., Thailand's only producer, began expanding its plants from 2 million to 3 million barrels annual capacity. An agreement was reached for the purchase of German equipment for a new plant (500,000 barrels capacity) to supply cement for irrigation projects.[83]

Turkey.—Nearly 5 million barrels of cement was produced from Turkey's 7 plants in 1955. Plans were announced for two more plants, one in Adana and the other in Bartin, with an additional 1.5 million barrels capacity.[84]

---

[76] Pit and Quarry, Iraq Plans Two Cement Plants To Supply Material for Dams: Vol. 48, No. 5, November 1955, p. 28.
Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 6, December 1955, p. 28.

[77] Rock Products, Israel Cement to U. S.: Vol. 58, No. 12, December 1955, p. 122.

[78] Pit and Quarry, $8,000,000 Cement Operation Being Built by U. N. in Korea: Vol. 48, No. 6, December 1955, p. 46.
Foreign Commerce Weekly, Cement Plant in Korea Under Construction: Vol. 54, No. 26, Dec. 26, 1955, p. 21.

[79] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 3, March 1956, p. 19.

[80] Pit and Quarry, American Financing Sought for Pakistan Cement Plant: Vol. 47, No. 12, June 1955, p. 24.

[81] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 6, December 1955, pp. 29–30.

[82] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 4, April 1956, pp. 24–25.

[83] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 2, February 1956, p. 23.

[84] Chemical Age (London), Turkish Cement Production: Vol. 73, No. 1888, Sept. 17, 1955, p. 58.

AFRICA

Belgian Congo.—Announcement was made of the formation of a new company to produce near Lake Kivu.[85]

Eritrea.—The Ethiopian Red Sea Cement Factory S. A. was formed to construct and operate a cement plant.[86]

Nigeria.—Construction of a 600,000-barrel cement plant was begun at Nkalagu. Machinery was ordered from F. L. Smidth & Co.[87]

Rhodesia and Nyasaland, Federation of.—The Salisbury Portland Cement Co., Ltd., began preliminary construction of a cement plant at Salisbury. The major items for the plant were ordered.[88] The oldest cement company in Rhodesia installed an all-welded, automatically controlled, Polysius grate kiln, which incorporated the latest technique of double-passing the hot gases through the nodules in the grate chambers.[89] Announcement was made of the formation of the Shamva Lime & Cement Co., interested in cement-plant possibilities near Salisbury.[90]

Tanganyika.—Following investigations by the Tanganyika Department of Geological Survey, which revealed suitable deposits of raw materials for making cement, the Government of Tanganyika invited tenders for establishing a cement plant at Wazo Hill.[91]

Union of South Africa.—Expansion of the Anglo-Alpha Cement plants at Roodepoort and Ulco was proposed to alleviate shortages in Natal and South-West Africa.[92]

OCEANIA

Australia.—Gippsland Industries, Ltd., opened a plant of 500,000 barrels annual capacity at Port Fairy. Australian Portland Cement, Ltd., ordered a rotary kiln for installation at its Geelong plant.[93]

New Zealand.—Two new cement companies formed in 1955 announced plans to erect plants at Westport and Waitomo. Suspension of imports duties was in effect during the entire year as a result of shortages in cement for construction.[94]

---

85 South American Mining and Engineering Journal, Congo Cement Plan: Vol. 67, No. 3289, Feb. 24, 1956, p. 233.
86 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 40.
87 Rock Products, African Cement Plant: Vol. 58, No. 7, July 1955, p. 34.
Chemical Age (London), Nigerian Cement Plant: Vol. 73, No. 1883, Aug. 13, 1955, p. 334.
88 Pit and Quarry, Salisbury Portland Cement Building 120,000-Ton Plant: Vol. 48, No. 4, October 1955, p. 91.
89 South African Mining and Engineering Journal, Cement Development: Vol. 66, No. 3242, Apr. 2 1955, p. 179.
90 Rock Products, New Lime Co.: Vol. 58, No. 3, March 1955, p. 55.
91 South African Mining and Engineering Journal, Projected Cement Industry of Tanganyika: Vol. 66, No. 3274, Nov. 12, 1955, p. 375.
92 South African Mining and Engineering Journal, Increased Cement Production: Vol. 66, No. 3273, Nov. 5, 1955, p. 323.
93 Mining and Geological Journal, Record Brick and Cement Production: Vol. 6, No. 1, March 1956, p 26.
94 Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 4, April 1956, p. 23.

Chromium

By Wilmer McInnis [1] and Hilda V. Heidrich [2]

UNITED STATES consumption of chromite in 1955, an alltime high, was 41 percent of the estimated world output. Metallurgical uses of chromite almost doubled those of 1954, and the refractory and chemical uses were 55 and 19 percent, respectively, higher than in the previous year. Stocks of chromite at consumers' plants decreased 12 percent during the year and at the end of 1955 were equivalent to a 8.4-month supply.

Although the Government continued to purchase domestically produced chrome ore and concentrate at incentive prices, production in 1955 was 6 percent below 1954 and comprised only 8 percent of the total United States supply. World production of chrome ore and concentrate reached 3.9 million short tons, the second highest in history. Turkey continued to be the world major producer (18 percent), followed by the Philippines (17 percent).

The United States imported chrome ore and concentrate from 13 countries in 1955, but 91 percent of the total was from the Philippines, Turkey, Rhodesia, and South Africa.

Prices of most foreign chromite increased in 1955 from $2 to $7 per long dry ton, and prices of chromium metal and several chromium ferroalloys also increased.

Research on the beneficiation and utilization of subgrade domestic chrome ores was continued. The work on methods of utilizing the chromium value in laterites was encouraging.

TABLE 1.—Salient statistics of chromite in the United States,[1] 1946–50 (average) and 1951–55, in short tons

	1946–50 (average)	1951	1952	1953	1954	1955
Domestic production (shipments)	1,902	7,056	21,304	58,817	163,365	153,253
Imports for consumption	1,182,652	1,429,020	1,708,969	2,226,631	[2] 1,471,037	1,827,960
Total new supply	1,184,554	1,436,076	1,730,273	2,285,448	1,634,402	1,981,213
Exports	2,583	2,030	1,531	1,166	864	1,341
Consumption	819,258	1,212,480	1,185,460	1,335,755	913,973	1,583,983
Consumers' stocks Dec. 31	540,761	637,453	754,299	1,015,878	1,267,817	1,109,924
World production	2,100,000	3,100,000	3,700,000	[2] 4,300,000	3,600,000	3,900,000

[1] Including Alaska.
[2] Revised figure.

[1] Commodity specialist.
[2] Statistical assistant.

DOMESTIC PRODUCTION [3]

In spite of increased demand and continued incentive prices, domestic chromite production (mine shipments) in 1955 was 6 percent less than in 1954. During 1955 chromite was shipped from 163 mines (31 less than in 1954), of which 113 were in California, 47 in Oregon, and 1 each in Montana, Washington, and Alaska. The decrease in operating mines was believed to have been due largely to exhaustion of some small chromite deposits. Over 77 percent of the chromite produced was derived from the American Chrome Co. Mouat chrome mine in Stillwater County, Mont. Ore from this mine was concentrated to about 39 percent Cr_2O_3 with a chrome-iron ratio of 1.5 : 1. Concentrate comprised 89 percent of all domestic shipments. The average grade of ore and concentrate shipped, on a dry-weight basis, was 40.3 percent Cr_2O_3.

Two small lots of chromite shipped late in 1955 from Fred W. Wagner, Jr., Chrome Cliff mine in Okanogon County, Wash., were the first chromite shipments from Washington in over a decade.

TABLE 2.—Chromite production (mine shipments) in the United States,[1] 1951–55, by States, in short tons, gross weight

State	1951	1952	1953	1954		1955	
				Shipments	Value	Shipments	Value
Alaska				2,953	$208,257	7,082	$625,340
California	6,302	14,713	26,512	30,661	2,285,250	22,105	1,834,277
Montana			26,089	123,096	4,132,475	118,703	3,718,882
Oregon	754	6,591	6,216	6,655	537,928	5,341	463,514
Washington						22	1,706
Total	7,056	21,304	58,817	163,365	7,163,910	153,253	6,643,719

[1] Including Alaska.

Government Participation.—Virtually the entire output of domestic chromite was purchased by the Government at incentive prices. A small quantity of chromite produced in California was sold for refractory use; all other shipments from California and those from Washington and Oregon were sent to the Grants Pass, Oreg., depot for sale to the Government under terms of the purchase program for domestic chromite. According to General Services Administration, on December 31, 1955, 101,634 long dry tons had been accepted at the depot since inception of the program in August 1951. The purchase program was amended in February 1955 to require that each seller, participating and possessing records involving transactions related to the program, allow authorized representatives of the United States Government, access to pertinent records and documents for purposes of examination. These requirements are to be in effect for 3 years after termination of the amended program.

[3] Differences between 1954 production figures as compiled by the Bureau of Mines and Bureau of Census are due primarily to exclusion by the Bureau of Census of production in Alaska, and quantities from mining operations of less than $500 value in the United States and to the crediting of concentrate to the State where milled instead of the State in which the ore originated.

Output by American Chrome Co. from the Mouat mine in Stillwater County, Mont., was delivered to Government stockpile under terms of an individual contract negotiated in 1952 for the delivery of 900,000 short tons of concentrate over an 8-year period. Chromite production from the Star Four mine on Red Mountain in Alaska was also delivered to the Government under terms of an individual contract made in 1953 for 13,000 tons of ore. This contract was terminated by mutual agreement during the latter half of the year after about 8,900 long tons had been delivered of which over 6,000 tons was delivered in 1955.

Under terms of another Government contract, Pacific Northwest Alloys, Inc., upgraded a quantity of low-grade chromite concentrate (stockpiled near Coquille, Oregon, by the Government during World War II) to a low-chromium, low-carbon ferrochromium. Electrostatic and electromagnetic methods were used to produce a clean chromite concentrate before shipment to the company plant at Mead, Wash., where the ferrochromium was produced.

Defense Minerals Exploration Administration received 5 applications for assistance in chromite exploration in 1955; 1 was approved, and 4 were either withdrawn or denied. Under the DMEA program the Government would grant assistance to legal entities on approved projects for the exploration of chromite within the United States, its Territories or possessions, on a participating basis to the extent of 50 percent of the approved exploration cost, with repayment to the Government from income on future production.

TABLE 3.—Chromite shipped from mines in the United States, from before 1880 through 1955

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	1953	58,817
1918	92,322	1944	45,629	1954	163,365
1919	5,688	1945	13,973		
1920	2,802	1946	4,107	Total 1947–54	255,946
				1955	153,253
Total 1914–20	206,800	Total 1939–46	357,994	Grand total	1,252,351

[1] Annual totals published separately in Minerals Yearbooks, 1947–50.

CONSUMPTION AND USES

Following the high level of industrial activity, chromite consumption in 1955 increased 73 percent over 1954 and was 19 percent above the previous high, established in 1953. Substantial increase in consumption was reported throughout the year, and the fourth quarter was 20 percent higher than the first. Compared with 1954, the metallurgical industry used 98 percent more chromite, the refractory industry 55 percent more, and the chemical industry 19 percent more. Of the 1.6 million short tons of chromite consumed in 1955, the metallurgical industry used 64 percent, of which 81 percent was metallurgical-grade ore, 11 percent chemical-grade, and 8 percent refractory-grade: the refractory industry consumed 27 percent, and the chemical industry used 9 percent. Chromite consumed during the year was reported to contain an average of 43 percent chromic oxide (Cr_2O_3), an increase of 1 percent over the 1954 average. Table 4 shows quantities and average chromic oxide content by grades of ore consumed.

As in past years, chromite consumption in 1955 was largely confined to six adjoining States (New York, Ohio, Pennsylvania, Maryland, West Virginia, and New Jersey), where it was used principally in making ferroalloys, refractories, and chemicals. In addition, a small quantity of chromite was added directly to steel.

TABLE 4.—Consumption of chromite and tenor of ore used by primary consumer groups in the United States, 1946–50 (average) and 1951–55, 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)
1946–50 (average)	387,690	47.9	298,004	34.1	133,564	44.8	819,258	42.1
1951	573,075	48.1	440,771	34.7	198,634	44.3	1,212,480	42.6
1952	676,624	47.1	387,085	33.8	121,751	44.4	1,185,460	42.9
1953	742,822	46.3	441,155	33.6	151,778	44.5	1,335,755	42.7
1954	502,278	46.3	278,324	34.3	133,371	44.6	913,973	42.4
1955	993,653	46.5	431,407	34.4	158,923	44.8	1,583,983	43.0

United States consumption of chromium alloys and metal in 1955 increased 46 percent over consumption in 1954. Ferrochromium, which averaged 66.4 percent chromium, comprised 71 percent of the total. The remainder included ferrochromium-silicon, exothermic chromium additives, and several other chromium alloys. The quantities of chromium alloys and metal consumed are given in table 5.

Chrome ores fall into three industrial-use categories, parallel to the general grade designations—metallurgical, refractory, and chemical. These categories are determined largely by variations in composition of the mineral chromite. For metallurgical use, lump ore containing 48 percent chromic oxide with a chrome-iron ratio of 3:1 was preferred, but all three grades were used in producing chromium ferroalloys. In refractories (where resistance to high temperature is important), hard, lumpy chromite, rich in alumina and chromic oxide and low in iron oxide was standard. Chromite averaging about 44 percent chromic oxide and low in silica, with a chrome-iron ratio of about 1.6 : 1 was used in producing chromium chemicals. Specifications for the purchase of the three types of chromite for the National Stockpile are given in table 6.

Metallurgical Uses.—Of the 300,600 short tons of chromium alloys and chromium metal consumed in 1955, almost two-thirds went into the production of stainless steel in the forms of high- and low-carbon ferrochromium, ferrochromium-silicon, chromium metal, and exothermic ferrochromium-silicon, chromium metal, and exothermic ferrochromium (including low- and high-carbon chrom-X, and chrom

TABLE 5.—Consumption of chromium alloys and chromium metal, in the United States, 1952–55 by major end uses

	Chromium products consumed (gross weight, short tons)			Percent consumed in—				
	Ferrochromium [1]	Other [2]	Total	Stainless steels	High-speed steels	Other alloy steels	High-temperature alloys	Other uses
1952 [3]	189,792	69,224	259,016	63.3	0.4	30.3	4.1	1.9
1953	208,106	76,242	284,348	63.2	.4	31.0	3.7	1.7
1954	149,632	56,756	206,388	67.3	.4	26.4	3.6	2.3
1955	215,152	85,408	300,560	65.8	.5	28.5	3.3	1.9

[1] Including chromium briquets.
[2] Comprises exothermic chromium additives, chromium metal, ferrochrome-silicon alloys, and miscellaneous chromium alloys.
[3] End-use data for earlier periods not available.

TABLE 6.—Chromite purchase specifications for National Stockpile in 1955

[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, mum maxi-	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-R, May 28, 1953, covers refractory-grade chromium ore that is suitable for the production of all chromium-type refractories. Based on ore originating in Philippine Islands and Cuba, although material from other sources of the same chemical composition may be purchased. Material shall consist of lump ore, of which not more than 20 percent (by weight) shall pass a U. S. Standard Sieve No. 12 (Tyler Standard Sieve mesh No. 10).
[4] Specification P-65, June 1, 1949, covers chromium ore intended for the manufacture of chromium chemicals.

sil-X, etc.). Only high- and low-carbon ferrochromium was reported used in the production of high-speed tool steels, but all chromium alloys and chromium metal were reported used in making other alloy steels; these steels accounted for 28.5 percent of the total consumption during the year. Chromium metal was used mostly in the production of high-temperature alloys, but small quantities also were reported to have been used in the production of stainless and other alloy steel and other special products. End uses of chromium alloys and chromium metal are given in table 7.

Refractory Uses.—Chrome brick, chrome-magnesite brick, chrome mortar, plastic chrome ramming mix, and magnesite chrome brick were used principally in ferrous and nonferrous metal smelters and refineries. A large quantity was used in lining basic open-hearth and

TABLE 7.—End uses of individual chromium ferroalloys and chromium metal in the United States, 1955 in percent

Alloy	Stainless steel	High-speed steels	Other alloy steels	High-temperature alloys	Other uses
Low-carbon ferrochromium	84.2	0.3	10.0	5.3	0.2
High-carbon ferrochromium	52.6	1.5	41.8	1.4	2.7
Chromium briquets			28.2	6.8	65.0
Chromium metal	1.5		8.0	81.2	9.3
Exothermic ferrochromium-silicon (chrom Sil-X)	.1		97.5		2.4
Exothermic ferrochromium (low and high-carbon chrom-X, etc.)	.2		98.4	.2	1.2
Ferrochromium-silicon (chrome silicide)	90.2		9.1	.5	.2
Other chromium alloys			24.0		76.0

electric steel furnaces. Because of their neutral quality, chrome refractories are preferred for use at the juncture between basic bottoms and acid roofs. At nonferrous smelters they were used in copper-anode furnaces and converter linings. Chrome refractory shapes shrink less than magnesite refractories but tend to spall if temperature fluctuates rapidly. Consequently chrome and magnesite frequently are mixed to form refractories combining the desired properties of each.

Kaiser Aluminum & Chemical Corp. began constructing a basic refractories plant at Columbiana, Ohio, at an estimated cost of $4 million when completed. It was reported that plant production will be divided among the high-magnesia periclase, periclase chrome, and chrome-periclase types of brick.[4]

Chemical Uses.—Estimates indicate that about 38 percent of the chromium chemicals used in 1955 went into the manufacture of pigments, 21 percent in electroplating and other metal treatment, 18 percent in leather tanning, 3 percent in textiles, 3 percent in direct chemical uses, and 17 percent in various miscellaneous uses, such as the production of chromium metal by the aluminothermic process. Lead chromates, chrome oxide green (crystalline chromic oxide), and zinc chromate comprised the bulk of the pigments produced and were used in paints, printing inks, linoleum, plastics, rubber, and other products. Chrome oxide green was reduced to metal by the aluminothermic process.

Chromium's properties which include superior hardness, acid and alkali resistance, high meltingpoint, good heat conductivity, resistance to wear, and good adherence to most other metals have made it one of the metals most desirable for surface coating. It was used extensively in ornamental electroplating both for appearance and surface protection. Porous or channel and hard chromium electroplating was used for special industrial applications. Hard-chromium-plated crankshafts were reported to have gained greater acceptance, even though they were difficult to plate because of complications created by design.[5]

A process consisting of a special chromic-acid-type bath with automatic regulation of catalyst concentration whereby crackfree chro-

[4] American Metal Market, Construction Work on Kaiser's Columbiana Plant to Start Soon: Vol. 62, No. 62, March 1955, p. 9.
[5] Diesel Power, Chromium for Crankshafts: Vol. 33, No. 8, August 1955, pp. 40–43.

mium is plated directly on steel was reported to have emerged from the pilot-plant stage early in the year.[6]

The use of chromate coatings (consisting essentially of insoluble trivalent chromium compounds and somewhat soluble hexavalent chromium compounds) for corrosion inhibition on zinc, and cadmium-coated metals, aluminum, and magnesium was described.[7]

Chromium compounds were also used extensively in tanning leather, in making textile finishes, in laboratory reagents, and in various other applications.

STOCKS

Chromite stocks at consumers' plants decreased 157,893 short tons during 1955 and at the year end were 12 percent lower than at the end of 1954. Metallurgical- and chemical-grade ore stocks decreased 22 and 18 percent, respectively, but refractory-grade stocks increased 22 percent compared with the previous year-end stocks. Stocks of all grades at the end of the year were equivalent to an 8.4-month supply, based on the 1955 consumption rate, compared with stocks at the end of 1954 of a 16.6-month supply based on the 1954 consumption rate.

Although consumption of ferrochromium alloys and metal in 1955 was almost twice that in the preceding year, stocks at producers' and consumers' plants increased 1 and 45 percent, respectively, compared with those at the end of 1954. High-carbon ferrochromium and ferrochromium-silicon comprised the largest gains in consumers' stocks.

TABLE 8.—Stocks of chromite at consumers' plants, December 31, 1951–55, in short tons

Grade	1951	1952	1953	1954	1955
Metallurgical	305, 134	364, 013	607, 724	803, 889	628, 244
Refractory	247, 673	269, 933	259, 896	257, 451	313, 189
Chemical	84, 646	120, 353	148, 258	206, 477	168, 491
Total	637, 453	754, 299	1, 015, 878	1, 267, 817	1, 109, 924

PRICES

Prices quoted by E&MJ Metal and Mineral Markets at the end of 1955 were $2 to $7 higher per long dry ton than at the beginning of the year, except for South African (Transvaal) ore grading 48 percent Cr_2O_3, which was $1 a ton lower. Refractory-grade chromite prices were not quoted.

Virtually all chromite produced in the United States and Alaska was sold to the Government, either under the purchase program or under individual contracts. The base price provided by the purchase program was $115 per long dry ton for lump ore grading 48 percent Cr_2O_3, with a chrome-iron ratio of 3 : 1, and $110 per ton for fines and concentrate of the same grade.

[6] Steel, Crackless Chromium Foils Corrosion: Vol. 136, No. 20, May 16, 1955, p. 122.
[7] Materials and Methods, Chromate Coatings: Vol. 42, No. 3, September 1955, pp. 118–119.

TABLE 9.—Price quotations for various grades of foreign chromite in 1955

[E&MJ Metal and Mineral Markets]

Source	Cr_2O_3 (percent)	Cr-Fe ratio	Price per long ton [1]	
			Jan. 1	Dec. 31
Pakistan	48	3:1	$43-$44	$49 -$50
Rhodesian [2]	48	[3] 3:1	43- 44	45 - 46
Do	48	2.8:1	40- 41	42 - 43
Do	48		32- 33	33 - 35
South African (Transvaal)	48		32- 33	31 - 32
Do	44		22- 23	23.50- 24.50
Turkish	48	[4] 3:1	46- 47	52 - 53
Do	46	[4] 3:1	43- 44	49.50- 51

[1] Quotations are on a dry basis, subject to penalties if guarantees are not met, f. o. b. cars, east coast ports.
[2] Prices reported for Rhodesian ores are based on long-term contracts.
[3] Lump ore.
[4] Lump and concentrate.

E&MJ Metal and Mineral Markets quoted prices for ferrochromium in carlots f. o. b. destination continental United States at the end of 1955 as follows: High-carbon ferrochromium (4–9 percent carbon, 65–69 percent chromium) 26–25 cents a pound of contained chromium, an increase of 1.5 cents per pound from the previous year-end price; and low-carbon (0.01 percent carbon) ferrochromium 32.75 cents a pound of contained chromium (a decrease of 1.75 cents a pound). Commercial-grade electrolytic chromium metal (99 percent minimum) and 97-percent-grade aluminothermic chromium was increased from $1.16 to $1.25 a pound in September 1955. Chromium metal containing 9–11 percent carbon was increased to $1.34 a pound during the year.

FOREIGN TRADE [8]

Imports.—Of the United States imported chromite from 13 countries in 1955, 91 percent was from the Philippines, Turkey, Federation of Rhodesia and Nyasaland, and Union of South Africa combined; 4 percent was from North America; Oceania supplied 2 percent; and 3 percent came from other Eastern Hemisphere countries. Imports during the year were 24 percent higher than in 1954 and were the highest in any year except 1953, when over 2,226,000 short tons was shipped into the country. Of total imports, metallurgical grade comprised 53 percent, refractory grade 35 percent, and chemical grade 12 percent. The average chromic oxide content of all chromite imported was 41.8 percent, metallurgical averaging 46.3 percent, refractory 34 percent, and chemical 43.8 percent. All 13 countries shipped metallurgical-grade ore, but Turkey was by far the largest single source, supplying 42 percent of the total. Federation of Rhodesia and Nyasaland supplied 33 percent and Union of South Africa 12 percent. Refractory ore came chiefly from the Philippines (81 percent) and Cuba (9 percent). All chemical ore originated in the Union of South Africa.

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

Chromium-metal imports totaled 268 short tons, of which 142 tons was from West Germany, 84 tons from United Kingdom, and the remainder from France.

Imports of ferrochromium (average chromium content, 64 percent) totaled 30,300 short tons valued at $8,011,602. High-carbon ferrochromium comprised 20,163 tons, of which Canada supplied 11,067 tons, Union of South Africa 5,341 tons, Japan 1,778 tons, Sweden 1,658 tons, and France 319 tons. Low-carbon ferrochromium (less than 3 percent carbon) was imported from Federation of Rhodesia (2,170 tons), France (4,055 tons), Yugoslavia (1,890 tons), Norway (1,099 tons), Sweden (695 tons), Union of South Africa (223 tons), and West Germany (5 tons). Imports of sodium chromates and bichromates totaled 1,059 tons, all from Union of South Africa.

Exports.—As in past years, United States exports of chromite were small, totaling 1,341 tons that originated abroad but processed domestically; Canada received 1,318 tons and the remainder was shipped to Colombia and the Philippines.

Ferrochromium (all grades) totaling 4,693 tons valued at $2,266,579 was exported to 10 countries in 1955; 89 percent went to Canada, 7 percent to United Kingdom, 1 percent to Mexico, and 3 percent to Colombia, Chile, Argentina, Norway, Austria, Japan, and Belgian Congo combined. Twenty-four countries imported a total of 6,015 tons of sodium chromate and sodium bichromate, valued at $1,370,303, from the United States during the year. Chromic acid exports totaling 701 tons valued at $373,580 went to 16 countries.

Although exports of chromium metal were not separately classified, it is believed that the bulk of the 6 tons, valued at $15,164, exported under the classification "metal and chrome-bearing alloys in crude form and scrap", was metal.

Tariff.—Chrome ore and concentrate were duty free in 1955. The Tariff Act of 1930, as modified by various trade agreements or other methods, imposed the following duties on imports of chromium products from nations signatory to the agreements: Ferrochromium containing 3 percent carbon or over, 5/8 cent per pound of contained chromium; ferrochromium containing less than 3 percent carbon, chromium metal, chromium carbide, ferrochromium-silicon and chrome silicide, chromium nickel, and chromium vanadium, 12½ percent ad valorem; alloys of two or more of the metals barium, boron, columbium, strontium, tantalum, thorium, vanadium, zirconium, calcium, titanium, and uranium containing chromium, 20 percent ad valorem, except that the tariff was 25 percent ad valorem for those alloys containing uranium; chromic acid and chromic oxide and other chrome colors, 12½ percent ad valorem.

The tariff rate on chromium alloys from nonsignatory countries was as follows: High-carbon ferrochromium, 2½ cents per pound of contained chromium; low-carbon ferrochromium and chromium metal, 30 percent ad valorem; chromium-cobalt-tungsten, chromium-tungsten, and ferrochromium-tungsten, 60 cents per pound of contained tungsten plus 25 percent ad valorem; all other chromium products, 25 percent ad valorem.

TABLE 10.—Chromite imported for consumption in the United States, 1954–55, by countries and 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	
1954												
North America: Cuba							37,579	13,795	$828,997	37,579	13,795	$828,997
Europe:												
Greece							55	23	1,300	55	23	1,300
Turkey				[1] 305,612	[1] 141,589	[1] $11,960,972				[1] 305,612	[1] 141,589	[1] 11,960,972
Total				[1] 305,612	[1] 141,589	[1] 11,960,972	55	23	1,300	[1] 305,667	[1] 141,612	[1] 11,962,272
Asia:												
India							16,855	6,851	276,973	16,855	6,851	276,973
Iran				1,120	537	41,500				1,120	537	41,500
Pakistan				9,552	4,412	363,965				9,552	4,412	363,965
Philippines				46,719	21,510	1,279,484	434,621	138,976	5,766,765	481,340	160,486	7,046,249
Total				57,391	26,459	1,684,949	451,476	145,827	6,043,738	508,867	172,286	7,728,687
Africa:												
Rhodesia, Federation of, and Nyasaland				245,213	114,024	8,076,888	19,516	8,764	416,025	264,729	122,788	8,492,913
Sierra Leone [2]				3,016	1,206	88,193				3,016	1,206	88,193
Union of South Africa	[1] 201,582	[1] 88,288	[1] $2,178,716	[1] 101,931	[1] 45,594	[1] 1,605,377	17,874	7,441	200,562	[1] 321,387	[1] 141,323	3,984,655
Total	[1] 201,582	[1] 88,288	[1] 2,178,716	[1] 350,160	[1] 160,824	[1] 9,770,458	37,390	16,205	616,587	[1] 589,132	[1] 265,317	12,565,761
Oceania: New Caledonia [3]				29,792	15,568	1,110,820				29,792	15,568	1,110,820
Grand total 1954	[1] 201,582	[1] 88,288	[1] 2,178,716	[1] 742,955	[1] 344,440	[1] 24,527,199	526,500	175,850	7,490,622	[1] 1,471,037	[1] 608,578	[1] 34,196,537
1955												
North America												
Canada				244	116	9,484				244	116	9,484
Cuba				9,408	3,707	238,050	57,570	20,378	1,173,616	66,978	24,085	1,411,666
Guatemala				595	286	28,410				595	286	28,410
Total				10,247	4,109	275,944	57,570	20,378	1,173,616	67,817	24,487	1,449,560

Europe:												
Greece				1,398	793	50,544	56	27	1,600	1,454	820	52,144
Turkey				409,777	188,822	13,193,000				409,777	188,822	13,193,000
Yugoslavia				3,360	1,176	72,000	5,846	2,485	155,700	9,206	3,661	227,700
Total				414,535	190,791	13,315,544	5,902	2,512	157,300	420,437	193,303	13,472,844
Asia:												
India				26,549	12,196	625,066	16,591	6,736	249,437	43,140	18,932	874,503
Iran				2,063	963	55,743				2,063	963	55,743
Pakistan				6,377	2,924	226,503				6,377	2,924	226,503
Philippines				43,998	21,303	1,092,229	512,967	168,779	6,863,273	556,965	190,082	7,955,502
Total				78,987	37,386	1,999,541	529,558	175,515	7,112.710	608,545	212,901	9,112,251
Africa:												
Rhodesia, Federation of, and Nyasaland				320,907	150,705	8,482,752	12,891	5,564	250,315	333,798	156,269	8,733,067
Union of South Africa	219,742	96,324	2,452,342	116,834	52,417	1,533,288	29,531	12,430	342,755	366,107	161,171	4,328,385
Total	219,742	96,324	2,452,342	437,741	203,122	10,016,040	42,422	17,994	593,070	699,905	317,440	13,061,452
Oceania: New Caledonia				31,256	15,270	757,612				31,256	15,270	757,612
Grand total 1955	219,742	96,324	2,452,342	972,766	450,678	26,364,681	635,452	216,399	9,036,696	1,827,960	763,401	37,853,719

[1] Revised figure.
[2] Assumed source; classified in import statistics under "British West Africa."
[3] Assumed source; classified in import statistics under "French Pacific Islands."

TABLE 11.—Chromite ore and concentrate exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Domestic [1]		Foreign [2]	
	Short tons	Value	Short tons	Value
1946–50 (average)	2,583	$82,710	10,298	$350,576
1951	2,030	144,248	15,199	569,670
1952	1,531	73,137	21,265	1,152,941
1953	1,166	56,393	6,071	251,525
1954	864	50,371	427	7,611
1955	1,341	75,656	2,950	86,986

[1] Material of domestic origin, or foreign material that has been ground, blended or otherwise processed in the United States.
[2] Material that has been imported and subsequently exported without changing its form.

Duties paid on imports from all countries were: Chrome brick and shapes, 25 percent ad valorem; sodium chromate and bichromate, 1¾ cents per pound; and potassium chromate and bichromate, 2¼ cents per pound.

TECHNOLOGY

The mineral chromite, basically a combination of the oxides of chromium, iron, aluminum, and magnesium within the chemical formula (Fe, Mg)O. $(Cr, Al, Fe)_2O_3$, was the only source of chromium in 1955. Chromite was mined by both underground and opencut methods. Most of the ore mined was sufficiently high grade to be marketed without beneficiation, except for hand picking. In beneficiating the lower grade ores, gravity concentration, heavy-medium separation, spiral concentrators, and flotation were employed. Beneficiation of ore from the Mouat mine near Nye, Mont., was described as being a gravity method that has a specially built settling classifier consisting of "hindered-settling devices which automatically control the velocity of an upward flow of water through a bottom construction plate to produce the desired sorting condition." [9]

The Bureau's continued research on beneficiation of low-grade chrome ores was directed mainly toward direct smelting and flotation concentration. Research on ore from the Seiad Creek areas, in Siskiyou County, Calif., grading 18–23 percent Cr_2O_3, indicated that a plus-45-percent concentrate could be made. Direct smelting of the raw ore gave good recoveries of chromium and iron, but the resulting product was subgrade. Work on Cuban laterites indicated that a concentrate grading about 35 percent Cr_2O_3, with a recovery of about 65 percent of the chromium in the ore, could be made by flotation. Bureau work on exploration and utilization of chromite in the John Day area, Grant County, Oreg., was prepared for publication.

Bureau of Mines research on electric smelting of low-grade chromite concentrate, demonstrating the feasibility of producing chromium ferroalloys, was prepared for publication. Chromium ferroalloys were produced in an electric furnace. High-carbon ferrochromium and ferrochromium-silicon were made by direct reduction of chromite.

[9] Mining World, Redesigned Classifiers Iron Out Tough Chromate Separation Problem: Vol. 17, No. 4, April 1955, pp. 36–40, 60.

Low-carbon ferrochromium was made mostly from ferrochromium-silicon.

Chromium metal was produced by electrolytic and aluminothermic processes. High-carbon ferrochromium ground to pass a 20-mesh screen was used in the electrolytic process that was briefly described [10] as consisting of leaching the ground ferrochromium in a mixture of reduced anolyte (chromium-alum mother liquor and makeup sulfuric acid) at near boiling, cooling, filtering and conditioning at high temperatures to convert to the nonalum-forming modification, which is then cooled rapidly to precipitate iron sulfate that is separated from the mother liquor by filtration before re-solution occurs. The mother liquor is aged several days until the alum-forming modification is complete and then filtered and washed, with the filtrate going to the leach circuit and the chromium-alum crystals being dissolved in hot water and filtered before entering the electrolytic circuit.

In the aluminothermic process chrome oxide green is reduced to metal by using aluminum as the reductant.

Several articles on ductile chromium and its alloys were published.[11]

A chromium-boron-nickel cermet layer as thin as 0.002 inch applied to low-strategic alloys and to ingot iron was reported to provide oxidation protection for more than 800 hours at 1,500° F.[12] Chromium plated directly on aluminum and other metals and alloys was reported to be highly ductile.[13] A plant at Huddersfield, England, for electrodeposition of chromium on aluminum and aluminum alloys for use in the construction of aircraft and aircraft equipment was reported to have been opened in September 1955.[14]

WORLD REVIEW

World production of chrome ore and concentrate in 1955 increased 8 percent over 1954 production and was higher than in any year except 1953. The Philippines and Turkey increased production over the previous year 49 and 15 percent, respectively.

Albania.—The chrome mine at Bulshil was reported to be fully mechanized. Albania has no other chrome mines. Production in 1955 was 25 percent greater than in the previous year.[15]

Argentina.—The principal chrome deposits in Argentina were reported [16] to be in the Province of Cardoha in a 120-kilometer area and in the Province of Mendoza, zone of Vspollota. The ore is low grade, averaging 15 to 30 percent Cr_2O_3. Production in 1955 was too small to be included in the world table.

British Columbia.—An important chromite discovery on a tributary of Blue River in British Columbia, with representative samples containing 42 percent chromic oxide and 15 percent iron, was reported.[17]

[10] Carosella, M. C., and Mettler, J. D., The First Commercial Plant for Electrowinning of Chromium: Metal Progress, vol. 69, No. 6, June 1956, pp. 51–56.
[11] Metal Progress, Ductility of Chromium at Room Temperature: Vol. 67, No. 6, June 1955, pp. 206, 208.
Metal Industry, Ductility of Chromium: Vol. 86, No. 3, January 1955, p. 51.
Metal Progress, Workability of Chromium Alloys: Vol. 67, No. 6, June 1955, pp. 152, 154.
[12] Moore, D. G., and Cuthill, J. R., Protection of Low-Strategic Alloys With a Chromium-Boron-Nickel Cermet Coating: Ceramic Bull. vol. 34, No. 11, November 1955, pp. 375–382.
[13] Topelian, P. J., New Chrome Plating Process Deposits Highly Ductile Coatings: Iron Age, vol. 176, No. 15, October 1955, pp. 99–101.
[14] Chemical Age (London), Chromium Deposits on Aluminum: Vol. 73, No. 1889, September 1955, p. 669.
[15] Mining World, vol. 17, No. 7, June 1955, p. 78.
[16] Mining World, vol. 17, No. 2, February 1955, p. 75.
[17] Mining Magazine, vol. 93, No. 5, November 1955, p. 285.

TABLE 12.—World production of chromite, by countries,[1] 1946–50 (average) and 1951–55, in short tons [2]

(Compiled by Pearl J. Thompson)

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	1,469					
Cuba	135,225	87,154	68,132	77,205	80,011	81,745
Guatemala	476	1,254	116	441	146	320
United States	1,902	7,056	21,304	58,817	163,365	153,253
Total	139,072	95,464	89,552	136,463	243,522	235,318
South America:						
Argentina					(3)	
Brazil	[4] 1,109	2,663	2,920	3,942	2,108	[5] 3,000
Total	[4] 1,109	2,663	2,920	3,942	[5] 4,800	[5] 3,000
Europe:						
Albania [5]	24,000	50,000	57,000	[6] 61,000	129,000	[6] 161,000
Greece	6,441	27,925	35,452	40,520	29,549	37,635
Portugal	250	36	119	6	23	
U. S. S. R.[5] [7]	450,000	600,000	600,000	600,000	600,000	600,000
Yugoslavia	96,865	109,833	118,192	139,950	137,216	139,119
Total [1] [5]	580,000	800,000	800,000	900,000	900,000	1,000,000
Asia:						
Afghanistan	[8] 854	83				
Cyprus (exports)	10,286	13,948	14,867	9,115	10,080	9,599
India	47,921	18,706	[9] 40,530	72,543	50,968	[5] 72,000
Iran		9,728	22,046	23,657	23,406	[5] 17,000
Japan	17,439	45,134	51,975	41,418	36,138	29,050
Pakistan	(10)	19,848	19,040	25,760	24,527	31,808
Philippines	222,275	368,801	599,121	614,086	442,230	659,310
Turkey	312,941	682,793	889,466	1,005,883	619,001	710,253
Total [7]	611,716	1,159,041	1,637,045	1,792,462	1,206,350	[5] 1,529,000
Africa:						
Egypt	120			231	584	926
Sierra Leone	14,236	18,139	26,312	27,277	21,011	22,110
Rhodesia and Nyasaland, Fed. of: Southern Rhodesia	236,406	330,987	355,679	463,028	442,506	449,202
Union of South Africa	418,614	600,763	639,366	798,562	706,935	597,368
Total	669,376	949,889	1,021,357	1,289,098	1,171,036	1,069,606
Oceania:						
Australia	465	1,545	1,565	3,070	5,536	
New Caledonia	71,494	97,876	118,809	134,032	93,645	50,790
Total	71,959	99,421	120,374	137,102	99,181	50,790
World total (estimate) [1]	2,100,000	3,100,000	3,700,000	4,300,000	3,600,000	3,900,000

[1] In addition to countries listed, Bulgaria and Rumania 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. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[3] Data not available; estimate by s nior author of chapter included in total.
[4] Exports.
[5] Estimate.
[6] Data from Economic Survey for Europe 1954 and 1955 (United Nations).
[7] Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.
[8] Average for 1949–50.
[9] Does not include 23,813 tons of low-grade ore accumulated from production from 1943 through 1948.
[10] Pakistan included with India.

Cuba.—The Cayo Guan, Cromite, Delta, Conete, and Potosi mines in the Baracoa area of Cuba produced chromite during 1955. The country's production of chromite during the year was slightly higher than in the previous year.

Cyprus.—Chromite production in 1955 decreased compared with 1954 production. Approximately 2,225 tons of lump ore was handpicked and the remainder concentrated mechanically.

India.—The Government of India's policy on the export of chrome ore was rather uncertain during the early part of 1955, but the situation was clarified somewhat by a press release dated June 30 stating that the Government had decided to continue free licensing of chromite during the rest of the year.

Philippines.—Chromite production in the Philippines in 1955 was 7 percent over the previous high reached in 1953. The country was the world's second largest chromite producer in 1955.

Benguet Consolidated Mining Co., operator of Consolidated Mines, Inc., Masinloc property, was the only producer of refractory-grade chromite. The company made great improvements in its property. The initial 75-ton-per-hour heavy-medium plant was increased to 150 tons per hour; and the 36-inch-gage railroad from mine to port was completed, reducing mines-to-port transportation cost.

Important progress was made in developing metallurgical-grade ore deposits. The Acoje Chromite Mining Co. placed its reserves at 1.5 million tons containing about 20–25 percent Cr_2O_3. Further development of the Irahuan chromite property near Puerto Princesa, Palawan Island, resulted in the formation of the Palawan Consolidated Mining Co., which also announced it would develop the Sugod Mercury deposit on Palawan Island. The newly formed company planned to produce 1,500 to 2,000 tons of ore a month by April or May 1956. The importance of Philippine chromite was discussed.[18]

Rhodesia and Nyasaland, Federation.—Chromite production in Rhodesia and Nyasaland in 1955 was only 3 percent below the all-time high of 1953.

Chromium Mining & Smelting Co. of Canada, Ltd., was reported to have acquired the Unseweswe Chrome mines on the Great Dyke in Southern Rhodesia.[19] Ore from the mines is upgraded to a concentrate averaging about 51 percent Cr_2O_3, with a chrome-iron ratio of 2.4 : 1.

The Lourenco Marques railway, completed in May 1955, was expected to relieve chrome producers' dependence upon the Salisbury-Beira railway line.

Turkey.—Production of chrome ore and concentrate in 1955 was 29 percent lower than in the peak production year 1953, but the country continued to be the world's largest producer of chromite.

A shortage of truck tires and parts was reported to have doubled the cost of transporting Turkish chromite from mine to port.[20] The Turkish Government was said to have reduced the duty on chrome exports from 5 percent to 1 percent.[21]

[18] Mining World, Chromite Importance Will Grow With New Discoveries and Two Big Mines: Vol. 17, No. 10, September 1955, p. 65.
[19] South African Mining and Engineering (Johannesburg) Journal, Canadian Firm Buys S. R. Chrome Mine: Vol. 66, Part 1, No. 3242, April 1955, p. 193.
[20] Metal Bulletin (London), Turkish Costs: No. 4013, July 1955, p. 24.
[21] Mining World, Turkey: Vol. 17, No. 2, February 1955, p. 74.

TABLE 13.—Exports of chromite from Turkey, 1946–50 (average) and 1951–55, by countries of destination, in short tons [1] [2]

(Compiled by Corra A. Barry)

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	1,923	-----	2,240	-----	-----	1,120
United States	177,924	392,694	468,463	516,577	224,037	434,014
Europe:						
Austria	20,373	39,101	43,771	38,455	31,281	35,842
Belgium	86	-----	55	-----	-----	667
France	20,429	30,080	43,411	20,286	20,224	27,476
Germany, West	3,734	42,800	54,863	25,374	69,568	72,410
Greece	-----	-----	-----	-----	-----	-----
Hungary	774	110	-----	-----	-----	-----
Italy	4,719	6,768	7,744	2,470	5,897	5,077
Netherlands	-----	304	8,299	4,700	7,883	3,797
Norway	11,665	8,569	15,826	23,830	8,063	-----
Spain	447	1,224	-----	1,764	661	8,257
Sweden	21,631	14,133	17,820	24,413	12,125	2,205
Switzerland	11	2,860	17,764	9,060	-----	-----
United Kingdom	8,467	17,592	9,689	14,807	12,419	25,264
Yugoslavia	-----	-----	-----	-----	882	551
Other countries	431	-----	551	1,102	-----	154
Total	272,614	556,235	690,496	682,838	393,040	616,834

[1] Compiled from Customs Returns of Turkey.
[2] This table incorporates a number of revisions of data published in the previous Chromite chapter.

Union of South Africa.—Chromite production in the Union of South Africa in 1955 decreased slightly compared with 1954 output. About 55 percent of its production was exported to the United States.

Clays

By Brooke L. Gunsallus [1] and Eleanor V. Blankenbaker [2]

TOTAL CLAYS sold or used by producers in 1955 increased 13 percent in tonnage compared with 1954. Of the six major classifications of clay—china clay or kaolin, ball clay, fire clay, bentonite, fuller's earth, and miscellaneous clay—only fuller's earth decreased in output in 1955 compared with 1954.

Kaolin sold or used by producers increased 16 percent in tonnage and 14 percent in value; ball clay, 25 and 29 percent; bentonite, 16 and 17 percent; and fire clay, 23 and 26 percent. Miscellaneous clay sold or used by producers increased 10 percent in tonnage but decreased 2 percent in value. Fuller's earth sold or used by producers decreased 2 percent in tonnage but increased 11 percent in value.

TABLE 1.—Salient statistics of clays in the United States, 1954–55

	1954		1955	
	Short tons	Value	Short tons	Value
Domestic clay sold or used by producers:				
Kaolin or china clay	1,873,000	$28,019,179	2,166,400	$31,883,034
Ball clay	328,185	4,168,570	411,354	5,386,777
Fire clay, including stoneware clay	[1] 8,797,265	[1] 33,326,885	10,839,829	42,119,555
Bentonite	1,278,393	14,722,864	1,480,205	17,219,015
Fuller's earth	376,321	6,861,603	369,719	7,620,319
Miscellaneous clays	[1] 29,852,373	[1] 36,185,093	32,974,747	35,432,663
Total sold or used by producers	[1] 42,505,537	[1] 123,284,194	48,242,254	139,661,363
Imports:				
Kaolin or china clay	134,354	[2] 2,158,417	152,396	2,444,785
Common blue and ball clay	25,557	272,214	33,651	[2] 359,143
Bentonite	(3)	(3)	795	30,504
Other clays [4]	4,789	54,643	5,540	[2] 107,055
Total imports	164,700	2,485,274	192,382	2,941,487
Exports:				
Kaolin or china clay	49,199	946,027	49,830	1,017,262
Fire clay	77,913	815,059	109,312	1,358,159
Other clays (including fuller's earth)	[1] 200,860	[1] 6,588,649	247,397	8,515,353
Total exports	[1] 327,972	[1] 8,349,735	406,539	10,890,774

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to years before 1954.
[3] Included in "Other clays."
[4] Includes fuller's earth and Gross-Almerode.

Prices for most clays and clay products in 1955, as shown in trade papers, remained steady.

Imports of kaolin for 1955 increased 13 percent from 1954 and were 7 percent of the total domestic consumption of kaolin.

Imports of ball clay (including common blue and Gross Almerode clays) in 1955 increased 32 percent in tonnage and value.

[1] Commodity specialist.
[2] Literature research clerk.

Exports of kaolin or china clay in 1955 increased 1 percent over 1954; 78 percent was shipped to Canada. Exports of fire clay in 1955 increased 40 percent in tonnage and 67 percent in value. Canada received 73 percent and Mexico 13 percent of the total exports.

CONSUMPTION AND USES

Heavy clay products (building brick, structural tile, sewer pipe, etc.) in 1955 consumed 9 percent more clay than in 1954 and comprised 53 percent of the total clay output, compared with 55 percent in 1954. Clays used in portland and other hydraulic cements in 1955 consumed 19 percent of the total clay output; refractories, 13 percent; lightweight aggregate for use in concrete products, 6 percent; rotary-drilling mud, 1 percent; and paper filler, paper coating, and pottery, less than 1 percent each. The remainder was consumed for a large number of miscellaneous purposes.

The total tonnage of clays consumed in 1955 increased 13 percent above 1954, but consumption in many branches of the clay industry using 15,000 short tons or more each decreased.

The increases for some of the more important branches of the clays industry were as follows: Pottery, 25 percent; high-grade tile, 14 percent; paper filler, 25 percent; paper coating, 4 percent; portland and other hydraulic cements, 3 percent; refractories, 34 percent; heavy clay products, 9 percent; lightweight aggregate, 99 percent; rotary-drilling mud, 8 percent; and insecticides and fungicides, 42 percent. Much of the increased consumption of lightweight aggregate may be attributed to expanded coverage. The quantity of clay used in the following branches decreased: Filtering and decolorizing oils (raw and activated earths), 6 percent; other filtering and clarifying, 10 percent; and filler (other than paper), 23 percent.

CHINA CLAY OR KAOLIN

Domestic kaolin sold or used in 1955 increased 16 percent compared with 1954 and reached an alltime high of over 2 million short tons.

Nine States shipped kaolin in 1955, the same as in 1954. Georgia, the principal producing State, continued to hold its place in 1955, with 69 percent of the total United States output; South Carolina was second, with 18 percent. Both Georgia and South Carolina in 1955 reported substantial increases compared with 1954, the former 14 percent and the latter 17 percent.

As has been the pattern for the previous several years, the paper, rubber, refractories, and pottery industries were the principal kaolin consumers. Paper consumed 51 percent of the total—26 percent for coating and 25 percent for filling. Refractories consumed 14 percent, rubber 12 percent, and pottery 7 percent. The remaining 16 percent was consumed for a wide variety of purposes, including cement, high-grade tile, fertilizers, chemicals, insecticides, paint filler or extender, and linoleum. All large consumers showed increases in 1955 compared with 1954.

TABLE 2.—Clay sold or used by producers in the United States in 1955, 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	Tota
Pottery and stoneware:							
Whiteware, etc	131,726	263,501					395,227
Stoneware, including chemical stoneware	1,394	264	21,882				23,540
Art pottery and flower pots	9,703	9,999	40,564			48,582	108,848
Total	142,823	273,764	62,446			48,582	527,615
Tile, high-grade	34,447	62,061	184,289			65,214	346,011
Kiln furniture: Saggers, pins, and stilts	4,068	12,880	12,868				29,816
Architectural terra cotta	2,500		14,646			482	17,628
Paper:							
Filler	546,436						546,436
Coating	571,681						571,681
Total	1,118,117						1,118,117
Rubber	257,223		2,928				260,151
Linoleum	34,778		8,467			2,522	45,767
Paints: Filler or extender	35,369		42			380	35,791
Portland and other hydraulic cements	29,521			746		9,024,898	9,055,165
Refractories:							
Firebrick and block	270,245	14,258	4,141,024			7,359	4,424,173
Bauxite, high-alumina brick	1,100		44,858				45,958
Fire-clay mortar	11,651	2,252	175,299			2,031	191,233
Clay crucibles	657		3,203				3,860
Glass refractories	17,132	15,906	9,313				42,351
Zinc retorts and condensers			37,335				37,335
Foundries and steelworks	2,802	528	955,310	419,152		11,406	1,389,198
Other refractories		1,320	149,740			298	151,358
Total	303,587	34,264	5,516,082	419,152		21,094	6,285,466
Heavy clay products: Building brick, paving brick, drain tile, sewer pipe, and kindred products		10,560	4,909,978			20,561,270	25,490,521
Miscellaneous:							
Rotary-drilling mud			2,262	595,471	47,231	39,392	684,356
Filtering and decolorizing oils (raw and activated earths)				182,587	[1] 59,380		241,967
Other filtering and clarifying				126,728	8,747		135,475
Artificial abrasives	155					897	1,052
Absorbent uses (oily floors, etc.)	2,175				136,664	9,658	148,497
Asbestos products	669						669
Chemicals	8,590		102,225	6,750		19,076	136,641
Enameling		1,784		411			2,195
Fertilizers	9,736				1	5,254	14,991
Filler (other than paper or paint)	5,080	15,491	11,703	2,056	1,339	1,482	37,151
Insecticides and fungicides	39,712		874	16,466	91,039	3,843	151,934
Plaster and plaster products	7,689						7,689
Concrete admixture, sealing dams, etc				2,304			2,304
Lightweight aggregates				948		3,092,583	3,093,531
Other uses	130,161	550	11,019	126,586	25,318	78,120	371,754
Total	203,967	17,825	128,083	1,060,307	369,719	3,250,305	5,030,206
Grand total:							
1955	2,166,400	411,354	10,839,829	1,480,205	369,719	32,974,747	48,242,254
1954	1,873,000	328,185	[2] 8,797,265	1,278,393	376,321	[2] 29,852,373	[2] 42,505,537

[1] Comprises the following: Mineral oils, 55,251 tons; vegetable oils, 4,129 tons.
[2] Revised figure.

TABLE 3.—Kaolin sold or used by producers in the United States, 1954–55, by States

State	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1954						
Alabama and Florida	32,983	$594,162			32,983	$594,162
California	(1)	(1)	(1)	(1)	29,928	288,641
Georgia	1,228,125	19,734,987	76,740	$790,919	1,304,865	20,525,906
North Carolina	20,822	391,469			20,822	391,469
South Carolina	307,953	3,974,367	19,306	56,010	327,259	4,030,377
Utah	80,176	1,603,520			80,176	1,603,520
Other States [2]	64,335	471,892	42,560	401,853	76,967	585,104
Total	1,734,394	26,770,397	138,606	1,248,782	1,873,000	28,019,179
1955						
California	(1)	(1)	(1)	(1)	31,835	335,651
Georgia	1,391,031	22,494,678	101,952	881,090	1,492,983	23,375,768
North Carolina	21,429	357,647			21,429	357,647
Pennsylvania	38,823	211,230			38,823	211,230
South Carolina	366,014	4,621,208	17,388	47,390	383,402	4,668,598
Other States [2]	125,072	2,258,393	104,691	1,011,398	197,928	2,934,140
Total	1,942,369	29,943,156	224,031	1,939,878	2,166,400	31,883,034

[1] Included with "Other States."
[2] Includes States indicated by footnote 1, and Alabama (1955 only), Arkansas (1954–55), Florida (1955 only), Pennsylvania (1954 only), and Utah (1955 only).

The average value of domestic kaolin sold or used as reported to the Bureau of Mines in 1955 was $14.72 per short ton compared with $14.96 in 1954, $14.38 in 1953, and $13.78 in 1952.

No quotations on domestic kaolin have been reported by E&MJ Metal and Mineral Markets since June 1951. In December 1955, Oil, Paint and Drug Reporter quoted prices for Georgia kaolin as follows: Dry-ground, air-floated, 300-mesh, in bags, carlots, f. o. b. plant, $13.50 to $14.50 per short ton; l. c. l., same basis, $35 to $36 per short ton.

Prices for imported china clay in December 1955 were quoted by the Oil, Paint and Drug Reporter as follows: White lump, carlots, ex dock (Philadelphia, Pa., and Portland, Maine), $20 to $35 per long ton; powdered, ex dock, in bags, $50 per net ton; and powdered, l. c. l., ex warehouse, $60 to $65.

TABLE 4.—Georgia kaolin sold or used by producers, 1946–50 (average) and 1951–55, 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
1946–50 (average)	939,445	$12,947,955	$13.78	122,405	$695,375	$5.68	1,061,850	$13,643,330	$12.85
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	1,145,063	17,635,838	15.40	183,192	1,166,355	6.37	1,328,255	18,802,193	14.16
1953	1,170,679	18,606,351	15.89	171,046	1,053,274	6.16	1,341,725	19,659,625	14.65
1954	1,190,681	(1)	(1)	114,184	(1)	(1)	1,304,865	20,525,906	15.73
1955	1,327,211	(1)	(1)	165,772	(1)	(1)	1,492,983	23,375,768	15.66

[1] Figures not available.

Imports of kaolin for 1955 increased 13 percent compared with 1954 and represented 7 percent of the total domestic consumption, the same as in 1954. Over 99 percent of the 1955 imports came from the United Kingdom and the remainder from Canada.

Exports of kaolin or china clay in 1955 increased 1 percent over 1954; 78 percent was shipped to Canada, 7 percent to Mexico, and 3 percent to Italy. Small tonnages also were sent to Central and South America, Europe, and Japan.

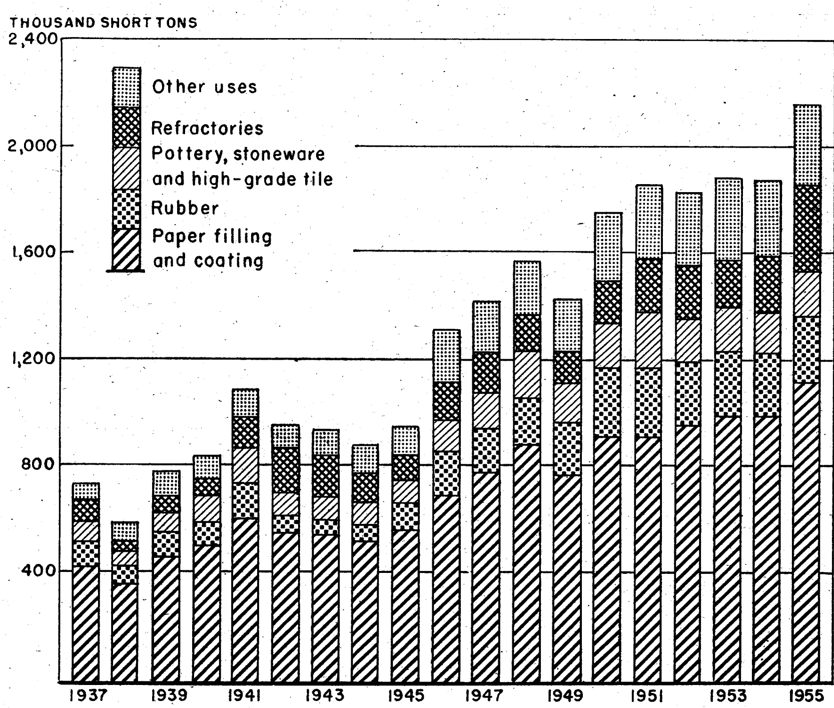

FIGURE 1.—Kaolin sold or used by domestic producers for specified uses, 1937–55.

BALL CLAY

Ball clay sold or used by producers in 1955 increased 25 percent in tonnage and 29 percent in value compared with 1954.

Beginning with 1943 Tennessee has been the largest producer. In 1955 Tennessee production led with 62 percent of the United States total; and Kentucky was second, with 27 percent. Compared with 1954, ball clay production increased 31 percent in Tennessee and 16 percent in Kentucky.

The pottery industry consumed 67 percent of the ball clay produced in 1955, the same as in 1954. Ball clay used in making whiteware, the major use, increased 25 percent. Increases for other important uses were: High-grade tile, 43 percent; refractories, 35 percent; and saggers, pins, and stilts, 19 percent.

Quotations on domestic ball clay have not appeared in E&MJ Metal and Mineral Markets since 1949. In December 1955 the Oil, Paint and Drug Reporter quoted the following prices for Tennessee ball clay: Crushed, in bulk, carlots, f. o. b. plant, $10 per short ton; air-floated, in bags, carlots, f. o. b. plant, $19.50 per short ton; and air-floated, purified, in bags, carlots, f. o. b. plant, $20.50 per short ton. In 1955 the average value per short ton for ball clay, as reported by producers, was $13.10 compared with $12.70 in 1954. In 1955 the average value per short ton was: For Tennessee ball clay, $13.13 compared with $12.84 in 1954; for Kentucky ball clay, $13.43 compared with $13.10 in 1954.

Imports of common blue and ball clays and Gross Almerode clays in 1955 increased 32 percent in tonnage and value compared with 1954. Unmanufactured blue and ball clays represented the major share of imports; the United Kingdom supplied 99 percent of this classification and virtually all the imports of manufactured blue and ball clays. Small tonnages of imports of blue and ball clays came from Canada and West Germany. Imports of Gross Almerode clays, including fuller's earth, from West Germany in 1955, totaled 78 short tons. Exports, if any, are not separately shown in official foreign trade returns.

TABLE 5.—Ball clay sold or used by producers in the United States, 1953–55, by States

State	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1953						
California	463	$2,315			463	$2,315
Kentucky	100,307	972,887	175	$1,750	100,482	974,637
Maryland	19,082	118,570			19,082	118,570
Mississippi	14,913	217,263			14,913	217,263
Tennessee	163,207	2,049,732	2,615	26,150	165,822	2,075,882
Total	297,972	3,360,767	2,790	27,900	300,762	3,388,667
1954						
Kentucky	96,483	1,263,526			96,483	1,263,526
Mississippi	13,859	209,709			13,859	209,709
Tennessee	190,762	2,458,129	3,310	33,100	194,072	2,491,229
Other States	(1)	(1)	(1)	(1)	23,771	204,106
Total	301,104	3,931,364	3,310	33,100	328,185	4,168,570
1955						
Kentucky	111,600	1,498,950			111,600	1,498,950
Maryland	20,640	267,410			20,640	267,410
Tennessee	251,104	3,305,277	2,930	29,300	254,034	3,334,577
Other States	(1)	(1)	(1)	(1)	25,080	285,840
Total	383,344	5,071,637	2,930	29,300	411,354	5,386,777

[1] Includes Maryland (1954 only), New Jersey (1955 only), Mississippi (1955 only), and Oregon. Individual figures combined to avoid disclosing individual company operations.

FIRE CLAY

Fire clay sold or used by producers in the United States increased 23 percent in 1955 compared with 1954 and was the third largest in the history of the industry. A high level of activity in the refractory and construction industries accounted for most of the increase. The three largest producing States—Ohio, Pennsylvania, and Missouri—all showed increases in production in 1955 compared with 1954.

The principal uses of fire clay in 1955 were for refractories manufacture, which consumed 51 percent of the national output, and heavy clay products, which consumed 45 percent. These two uses absorbed 96 percent of the 1955 tonnage, compared with 95 percent in 1954. In 1955 fire clay consumed for refractories increased 33 percent and for heavy clay products 16 percent compared with 1954. About 1 percent was consumed in manufacturing high-grade tile, 1 percent in chemicals, and the remainder in a wide variety of uses.

TABLE 6.—Fire clay, including stoneware clay, sold or used by producers in the United States, 1954–55, by States [1]

State	Sold by producers		Used by producers		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1954						
Alabama	148,081	$314,937	87,650	$671,023	235,731	$985,960
Arizona			2	2	2	2
Arkansas	2,693	16,158	322,601	1,607,658	325,294	1,623,816
California	175,367	[2] 662,687	206,025	[2] 534,257	381,392	[2] 1,196,944
Colorado	169,188	355,017	91,537	294,329	260,725	649,346
Illinois	218,102	442,746	95,577	232,661	313,679	675,407
Indiana	300,896	502,368	73,185	197,676	374,081	700,044
Iowa	6,155	492	21,000	31,500	27,155	31,992
Kentucky	23,014	152,613	174,386	1,163,751	197,400	1,316,364
Maryland	9,096	39,526	37,625	223,132	46,721	262,658
Missouri	337,837	1,072,024	846,416	3,462,259	1,184,253	4,534,283
Nebraska			2,496	2,496	2,496	2,496
Nevada	496	4,468	777	1,165	1,273	5,633
New Jersey	61,032	459,855	[2] 61,856	[2] 276,567	[2] 122,888	[2] 736,422
New Mexico	524	1,731	5,703	14,992	6,227	16,723
New York	899	8,990			899	8,990
Ohio	691,197	2,171,505	1,877,430	5,992,530	2,568,627	8,164,035
Oklahoma			300	3,000	300	3,000
Pennsylvania	469,056	1,459,668	1,393,287	6,934,287	1,862,343	8,393,955
Tennessee			15,437	175,364	15,437	175,364
Texas	45,752	304,890	301,495	1,882,976	347,247	2,187,866
Utah	17,988	60,464	11,700	29,250	29,688	89,714
Washington	(3)	(3)	(3)	(3)	78,187	129,902
West Virginia	(3)	(3)	(3)	(3)	290,256	1,171,495
Other States [4]	46,133	150,917	447,274	[2] 1,414,954	124,964	[2] 264,474
Total	2,723,506	[2] 8,181,056	[2] 6,073,759	[2] 25,145,829	[2] 8,797,265	[2] 33,326,885
1955						
Alabama	(3)	(3)	(3)	(3)	216,289	1,102,776
Alaska			100	800	100	800
Arizona			4	4	4	4
California	139,549	575,211	264,953	720,078	404,502	1,295,289
Colorado	191,768	456,946	69,797	279,449	261,565	736,395
Illinois	257,486	468,459	105,899	279,201	363,385	747,660
Indiana	398,608	697,675	130,702	323,028	529,310	1,020,703
Kentucky	71,445	396,638	270,417	1,919,077	341,862	2,315,715
Maryland	(3)	(3)	(3)	(3)	65,910	228,395
Mississippi			47,000	75,670	47,000	75,670
Missouri	383,471	1,166,997	1,145,788	4,868,027	1,529,259	6,035,024
Montana			1,143	4,572	1,143	4,572
Nebraska			2,495	2,495	2,495	2,495
New Jersey	46,427	440,731	85,240	528,328	131,667	969,059
New Mexico	2,732	9,142	6,625	20,569	9,357	29,711
Ohio	1,047,353	3,589,317	2,181,130	8,529,829	3,228,483	12,119,146
Oklahoma			300	3,000	300	3,000
Pennsylvania	498,670	1,741,154	1,661,795	8,559,300	2,160,465	10,300,454
Tennessee			4,604	52,300	4,604	52,300
Texas	(3)	(3)	(3)	(3)	437,595	1,068,664
Utah	17,207	44,738	17,635	70,540	34,842	115,278
Washington	19,708	21,708	80,989	152,173	100,697	173,881
West Virginia	(3)	(3)	(3)	(3)	406,025	2,277,163
Other States [4]	200,620	656,837	1,488,169	5,465,562	562,970	1,445,401
Total	3,275,044	10,265,553	7,564,785	31,854,002	10,839,829	42,119,555

[1] Includes stoneware clay as follows: 1954—34,705 tons; 1955—62,446 tons.
[2] Revised figure.
[3] Included with "Other States."
[4] Includes States indicated by footnote 3 above and Alaska (1954 only), Arkansas (1955 only), Idaho, Iowa (1955 only), Kansas, Minnesota, Mississippi (1954 only), Montana (1954 only), and Nevada (1955 only).

In 1955 Ohio ranked first in fire-clay output, followed by Pennsylvania, Missouri, Indiana, Texas, West Virginia, California, Illinois, Kentucky, Colorado, and Alabama. These 11 States supplied 91 percent of the total in 1955. The remainder was produced in 16 States. Of the 11 principal producing States, only Alabama reported a decrease in 1955 compared with 1954. Price quotations on fire clay do not appear in trade journals; however, the average value per short ton of fire clay sold by producers, as reported to the Bureau of Mines in 1955, was $3.13, compared with $3 in 1954 and $3.14 in 1953. The average value of all fire clay, including both sales and captive tonnage, was $3.89 in 1955 compared with $3.79 in 1954 and $3.75 in 1953. Quotations on firebrick manufactured from fire clay were reported in December 1955 in E&MJ Metal and Mineral Markets as follows: Missouri, Kentucky, and Pennsylvania, superquality, $114; high heat quality, $107; Ohio firebrick, intermediate grade, $107; second grade, $98 per thousand. These quotations were the same as those quoted in December 1954.

Imports of fire clay are not shown separately in foreign trade statistics. Exports of fire clay in 1955 increased 40 percent in tonnage and 67 percent in value compared with 1954. Canada received 73 percent, Mexico 13 percent, and Japan 9 percent of the total exports. The remainder—5 percent—comprised small tonnages to many destinations in Central and South America, Europe, Asia, and Africa.

BENTONITE

The quantity of bentonite sold or used by producers in 1955 exceeded the previous banner year 1952 by 12 percent. The tonnage increased 16 percent and the value 17 percent compared with 1954. Increased activity in the petroleum and steel industries accounted for most of the additional consumption.

The foundry and petroleum industries consumed 89 percent of the total tonnage in 1955, the same as in 1954, compared with 93 percent in 1953. Rotary-drilling mud consumed 40 percent in 1955 (43 percent in 1954 and 46 percent in 1953); foundry-sand bond, 28 percent (23 percent in 1954 and 27 percent in 1953); and filtering and decolorizing oils and other filtering and clarifying, 21 percent (23 percent in 1954 and 20 percent in 1953). The remaining 11 percent of the national output was used for a wide variety of purposes. Compared with 1954, the tonnage of bentonite used for foundry-sand bond increased 42 percent; for rotary-drilling mud, 9 percent; and for filtering and decolorizing oils, 17 percent. The only major use that declined in tonnage consumed, compared with 1954, was chemicals. Thirteen States reported bentonite production in 1955 compared with 11 in 1954.

The 4 States showing the largest production of bentonite in 1955, in percentage of United States total, were Wyoming, 56 percent (58 percent in 1954); Mississippi, 15 percent (14 percent in 1954); Texas, 10 percent (8 percent in 1954); and Arizona, 8 percent (11 percent in 1954).

TABLE 7.—Bentonite sold or used by producers in the United States, 1953–55, by States

State	1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
Arizona	134,850	$651,752	139,171	$728,326	124,872	$674,309
California	(1)	(1)	3,348	90,004	3,942	66,192
Colorado	(1)	(1)	582	5,339	207	931
Mississippi	189,211	2,028,040	185,554	1,998,052	226,852	2,558,399
Montana					(1)	(1)
Nevada					442	4,420
South Dakota	205,303	2,700,394	(1)	(1)	(1)	(1)
Texas	47,887	670,300	105,744	1,299,380	155,128	1,461,873
Utah	1,738	20,396	2,222	26,620	2,520	30,200
Wyoming	670,756	9,861,321	742,453	9,339,755	825,810	10,721,577
Other States [2]	20,226	248,039	99,319	1,235,388	140,432	1,701,114
Total	1,269,971	16,180,242	1,278,393	14,722,864	1,480,205	17,219,015

[1] Included with "Other States."
[2] Includes States indicated by footnote 1, and Alabama (1953 only), Louisiana (1954–55), North Dakota (1954–55), and Oklahoma (1954–55).

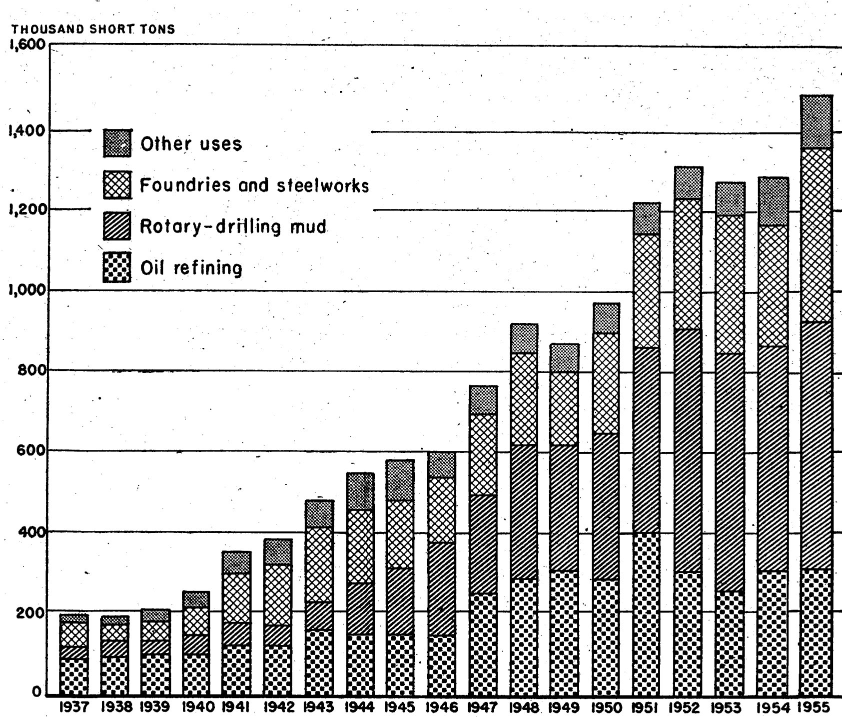

FIGURE 2.—Bentonite sold or used by domestic producers for specified uses, 1937–55

The price of Wyoming bentonite was given in the Oil, Paint and Drug Reporter as follows: 200-mesh, carlots, f. o. b. mines, $14 per short ton. The average value per short ton, as reported by the producers to the Bureau of Mines in 1955, was $11.63 compared with $11.52 in 1954.

Bentonite imported in 1955 comprised 689 short tons from Canada and 106 short tons from Italy.

Bentonite exports are not shown separately in foreign trade statistics but are included under the blanket classification of "Other clays and earths, not especially provided for." It is known, however, that some domestic producers export part of their production to destinations throughout the world.

Arimex Chemical Co. began processing bentonite mined near Sanders, Ariz., at a new $250,000 plant at Gallup, N. Mex., in the fall of 1955.[3] When in full operation, it is said that this plant will prepare and package over 2,000 short tons of bentonite a month.

FULLER'S EARTH

Fuller's earth sold or used by producers decreased 2 percent in tonnage but increased 11 percent in value in 1955 compared with 1954. Although the value was the second highest in the history of the industry, the tonnage sold or used was the smallest since 1949.

Absorbent uses composed 37 percent of the national consumption in 1955 compared with 31 percent in 1954 and 30 percent in 1953. Insecticides and fungicides consumed the second largest quantity in 1955, with 25 percent, compared with 19 percent in 1954 and 17 percent in 1953.

Mineral-oil refining was the third largest consumer, accounting for 15 percent in 1955. The use of fuller's earth by this industry has declined gradually since 1950, when it consumed 40 percent of the total national output. This downward trend is mainly the result of changed methods of mineral-oil refining. Vegetable-oil refining composed only 1 percent of total consumption in 1955 compared with 5 percent in 1954 and 4 percent in 1953; and rotary-drilling mud consumed 13 percent in 1955 compared with 11 percent in 1954 and 12 percent in 1953. The remainder was used in other filtering and clarifying, binders, and other unspecified uses.

All States reporting production of fuller's earth in 1955, except Georgia and Texas, reported increases. Georgia supplied 28 percent of the United States total in 1955.

The average value per short ton of fuller's earth reported sold or used in the United States in 1955 was $20.61 compared with $18.23 in 1954 and $17.47 in 1953. The following quotations on fuller's earth were published in the Oil, Paint and Drug Reporter for December 1955: Powdered, insecticide grade, dried, in bags, carlots, Georgia or Florida mines, $17.50 per short ton; calcined, in bags, carlots, same basis, $20 to $21.75 per short ton; and oil-bleaching grade, 100-mesh, in bags, carlots, $16.50 to $17 per short ton.

Effective January 1, 1955, fuller's earth import statistics were not separately classified but were included under "Other clays." Exports are not given separately in official foreign trade statistics. Reports from the producers to the Bureau of Mines, however, indicated exports of approximately 17,500 short tons in 1955 compared with 12,000 short tons in 1954, 18,000 short tons in 1953, 26,000 short tons in 1952, and 35,000 short tons in 1951. Destinations reported in 1955 included North, Central, and South America, Europe, and Asia.

[3] Mining World, vol. 17, No. 12, November 1955, p. 91.

TABLE 8.—Fuller's earth sold or used by producers in the United States, 1953–55, by States

State	Short tons	Value
1953		
California and Nevada	10,286	$240,587
Florida and Georgia	271,187	5,093,501
Mississippi	12,472	523,044
Tennessee	30,961	427,933
Texas	106,437	1,277,670
Utah	4,494	52,024
Total	435,837	7,614,759
1954		
California and Nevada	(1)	(1)
Florida and Georgia	263,571	$5,244,591
Mississippi	13,920	512,256
Tennessee	27,532	449,480
Texas	(1)	(1)
Utah	2,801	35,400
Other States [2]	68,497	619,876
Total	376,321	6,861,603
1955		
California	14,462	$82,292
Georgia	103,883	2,226,296
Nevada	713	3,565
Tennessee	33,791	473,074
Utah	2,829	35,175
Other States [2]	214,041	4,799,917
Total	369,719	7,620,319

[1] Included with "Other States."
[2] Includes States indicated by footnote 1, and California (1954 only), Florida (1955 only), Mississippi (1955 only), and Texas (1955 only).

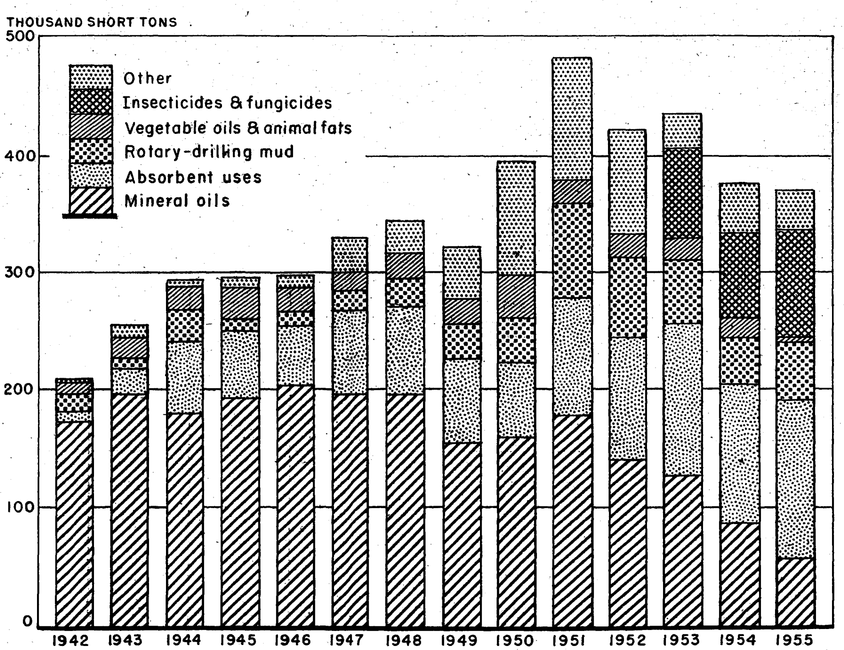

FIGURE 3.—Fuller's earth sold or used by producers for specified uses, 1942–55.

MISCELLANEOUS CLAY

This section presents statistics for the large-tonnage clays and shales—other than those discussed in the preceding pages—used in manufacturing heavy clay products, portland cement, and lightweight aggregate. With these 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.

TABLE 9.—Miscellaneous clay, including shale and slip clay sold or used by producers in the United States, 1954–55, by States

State	Sold by producers [1]		Used by producers [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1954						
Alabama	(3)	(3)	(3)	(3)	1,080,490	$1,126,400
Arizona			114,499	$85,874	114,499	85,874
Arkansas			254,490	555,891	254,490	555,891
California	113,230	$492,142	2,189,243	[4] 2,379,702	2,302,473	[4] 2,871,844
Colorado	56,687	28,558	536,797	319,630	593,484	348,188
Connecticut	61,608	46,206	227,199	238,446	288,807	284,652
Florida	43,983	21,992	174,270	182,770	218,253	204,762
Georgia	7,447	4,841	1,270,930	1,015,645	1,278,377	1,020,486
Idaho	666	500	27,100	13,260	27,766	13,760
Illinois	30,545	79,037	1,682,868	2,728,006	1,713,413	2,807,043
Indiana	328,485	329,297	1,243,503	1,961,375	1,571,988	2,290,672
Iowa	13,914	27,287	841,780	861,580	855,694	888,867
Kansas	30	120	697,352	777,727	697,382	777,847
Kentucky			277,598	415,036	277,598	415,036
Louisiana	(3)	(3)	(3)	(3)	[4] 713,940	[4] 940,940
Maine			26,872	26,872	26,872	26,872
Maryland	(3)	(3)	(3)	(3)	565,009	707,743
Massachusetts			128,998	121,049	128,998	121,049
Michigan	13,838	63,796	1,856,976	1,855,408	1,870,814	1,919,204
Minnesota	370	370	92,292	95,651	92,662	96,021
Mississippi			316,068	334,815	316,068	334,815
Missouri	(3)	(3)	(3)	(3)	743,032	1,324,473
Montana			28,823	22,930	28,823	22,930
Nebraska			161,335	161,335	161,335	161,335
Nevada			4,205	3,154	4,205	3,154
New Hampshire			35,681	35,681	35,681	35,681
New Jersey	(3)	(3)	(3)	(3)	455,456	509,677
New Mexico	1,036	8,288	40,569	58,074	41,605	66,362
New York	863	3,452	1,197,396	1,481,061	1,198,259	1,484,513
North Carolina			1,851,719	2,128,252	1,851,719	2,128,252
North Dakota			35,885	50,620	35,885	50,620
Ohio	783,054	808,575	1,699,797	2,163,868	2,482,851	2,972,443
Oklahoma	(3)	(3)	(3)	(3)	447,913	1,241,478
Oregon	(3)	(3)	(3)	(3)	326,223	368,441
Pennsylvania	163,456	168,419	1,459,298	1,472,667	1,622,754	1,641,086
South Carolina			808,760	671,650	808,760	671,650
South Dakota	(3)	(3)	(3)	(3)	136,217	136,217
Tennessee	35,495	35,495	742,720	629,384	778,215	664,879
Texas	120,740	423,450	1,764,405	2,501,193	1,885,145	2,924,643
Utah	5,926	7,693	86,198	228,485	92,124	236,178
Virginia			704,843	723,292	704,843	723,292
Washington	11,570	41,597	171,571	147,001	183,141	188,598
West Virginia	(3)	(3)	(3)	(3)	296,864	279,044
Wisconsin	(3)	(3)	(3)	(3)	180,233	174,488
Wyoming			201,052	194,332	201,052	194,332
Undistributed [5]	710,373	1,572,757	[4] 4,395,965	[4] 5,379,505	[4] 160,961	[4] 143,361
Total	2,503,316	4,163,872	[4] 27,349,057	[4] 32,021,221	[4] 29,852,373	[4] 36,185,093
1955						
Alabama	1,796	1,616	1,255,725	1,129,576	1,257,521	1,131,192
Alaska			1,012	3,036	1,012	3,036
Arizona			129,567	194,351	129,567	194,351
Arkansas			212,465	288,387	212,465	288,387
California	232,733	563,747	2,172,921	2,684,210	2,405,654	3,247,957
Colorado	(3)	(3)	(3)	(3)	202,459	380,575
Connecticut	96,490	63,741	228,342	250,836	324,832	314,577
Florida	(3)	(3)	(3)	(3)	199,641	205.497
Georgia	(3)	(3)	(3)	(3)	1,356,412	542,608

See footnotes at end of table.

TABLE 9.—Miscellaneous clay, including shale and slip clay sold or used by producers in the United States, 1954–55, by States—Continued

State	Sold by producers [1]		Used by producers [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1955—Continued						
Illinois	49,876	$176,424	1,925,318	$3,054,888	1,975,194	$3,231,312
Indiana	(3)	(3)	(3)	(3)	1,199,989	1,917,307
Iowa	12,808	24,213	866,856	903,292	879,664	927,505
Kansas	(3)	(3)	(3)	(3)	767,662	873,016
Kentucky	(3)	(3)	(3)	(3)	422,237	601,466
Louisiana			651,268	659,099	651,268	659,099
Maine	67	67	32,531	32,531	32,598	32,598
Maryland	8,029	16,058	603,678	753,085	611,707	769,143
Massachusetts			124,832	141,654	124,832	141,654
Michigan	7,381	48,519	1,930,212	1,970,558	1,937,593	2,019,077
Minnesota	46	46	72,954	83,821	73,000	83,867
Mississippi			393,841	395,341	393,841	395,341
Missouri	14,505	27,686	858,637	839,613	873,142	867,299
Montana			33,286	25,400	33,286	25,400
Nebraska			148,340	148,340	148,340	148,340
New Hampshire			35,184	35,184	35,184	35,184
New Jersey	(3)	(3)	(3)	(3)	511,205	573,135
New Mexico	(3)	(3)	(3)	(3)	35,994	78,871
New York	1,466	13,184	1,392,199	1,663,031	1,393,665	1,676,215
North Carolina			2,354,065	1,434,434	2,354,065	1,434,434
North Dakota			50,936	69,436	50,936	69,436
Ohio	197,017	226,664	2,871,913	3,331,579	3,068,930	3,558,243
Oklahoma	(3)	(3)	(3)	(3)	723,856	723,856
Pennsylvania	141,515	50,458	1,679,106	1,850,951	1,820,621	1,901,409
Puerto Rico			136,563	121,753	136,563	121,753
South Carolina			703,090	794,581	703,090	794,581
South Dakota	(3)	(3)	(3)	(3)	157,778	151,123
Tennessee			915,184	309,934	915,184	309,934
Texas	(3)	(3)	(3)	(3)	2,504,236	2,569,385
Utah	10,288	15,162	123,312	321,892	133,600	337,054
Vermont			14,200	14,200	14,200	14,200
Virginia			935,941	873,348	935,941	873,348
Washington	39,223	29,541	225,411	208,385	264,634	237,926
West Virginia			301,408	286,126	301,408	286,126
Wisconsin	1,000	1,050	164,088	164,980	165,088	166,030
Wyoming			209,750	201,944	209,750	201,944
Undistributed [5]	284,990	384,178	8,121,382	8,550,533	324,903	317,872
Total	1,099,230	1,642,354	31,875,517	33,790,309	32,974,747	35,432,663

[1] Purchases by portland-cement companies of common clay and shale: 1954—1,251,753 tons, estimated at $1,256,937; 1955—55,518 tons, estimated at $100,900.
[2] Includes the following: Common clay and shale used by portland-cement companies: 1954—7,220,861 tons, estimated at $6,974,452; 1955—8,963,716 tons, estimated at $8,973,334.
[3] Included with "Undistributed."
[4] Revised figure.
[5] Includes States indicated by footnote 3, and Alaska (1954 only), Delaware, Hawaii, Nevada, Idaho, Oregon (1955 only), Puerto Rico (1954 only), and Vermont (1954 only).

Miscellaneous clay sold or used by producers increased 10 percent in tonnage, but decreased 2 percent in value compared with 1954. As cement production reached an alltime high in 1955, clay used in cement production reached a corresponding alltime high. Miscellaneous clay consumed in the manufacture of heavy clay products increased 8 percent in 1955 compared with 1954. In 1955, 62 percent of the total miscellaneous clay was used in manufacturing heavy clay products and 27 percent in cement, both 2 percent less than in 1954. Captive tonnage—clay produced by mine operators for their own use in manufacturing brick, tile, cement, and lightweight aggregate and marketed for the first time as such—amounted to 99 percent of the miscellaneous clay sold or used in 1955. The quantity of miscellaneous clay used in producing lightweight aggregate for concrete mixtures was shown for the third time in 1955 and composed 9 percent of the total compared with 5 percent in 1954 and 4 percent in 1953.

457676—58——23

The average reported value of miscellaneous clay sold as crude or prepared clay in 1955 was $1.07 compared with $1.21 in 1954 and $1.91 in 1953. Increased activity in the construction industry accounted for most of the gains in the consumption of miscellaneous clay.

Some special types of clay included under the miscellaneous clay classification, however, sold at much higher prices. The value of the captive tonnage was computed from individual estimates that averaged about $1 per short ton. In decreasing order, the following States reported tonnage exceeding 2 million short tons: Ohio, Texas, California, and North Carolina. States reporting over 1 million and less than 2 million tons sold or used by producers were, in decreasing order of output: Illinois, Michigan, Pennsylvania, New York, Georgia, Alabama, and Indiana. Of the States for which data are shown in table 9 for both 1954 and 1955, 30 reported increases and 12 decreases in output in 1955.

HEAVY CLAY PRODUCTS

The data in table 10 are not comparable with past years due to changes in product grouping. Clay consumed in producing structural clay products, as reported in table 2, increased 9 percent in 1955.

The capacity of the South Park, Ohio, lightweight-aggregate plant of the Hydraulic-Press Brick Co. was increased to 500 cubic yards daily to meet growing demand.[4]

The W. S. Dickey Clay Manufacturing Co. announced plans for $1.5 million expansion and modernization for producing vitrified-clay sewer pipe at its plant at Pittsburg, Kans.[5]

A 7-year program of mechanization of the manufacturing operation at National Tile & Manufacturing Co., Anderson, Ind., was completed.[6]

TABLE 10.—Production and shipments of principal structural clay products in the United States, 1955 [1]

Product and unit quantity	Production	Shipments	
		Quantity	Value (thousand dollars)
Brick (building or common and face) .... M standard brick..	7,146,821	7,012,251	212,303
Clay construction products (except brick):			
Structural clay tile except facing .... short tons..	839,945	834,627	10,541
Vitrified clay sewer pipe and fittings .... do....	1,925,352	1,874,383	76,715
Facing tile (structural):			
Ceramic glazed, including glazed brick ..... M brick equiv..	429,979	421,209	28,707
Unglazed and salt glazed M tile (8 by 5 by 12-inch equivalent)..	21,145	20,383	2,935
Clay floor and wall tile and accessories (glazed and unglazed) including quarry tile .... M square feet..	190,672	190,509	104,904

[1] Compiled from information furnished by the Bureau of the Census, U. S. Department of Commerce. Owing to changes in product grouping, data not comparable with those of earlier years.

[4] Brick and Clay Record, vol. 127, No. 5, November 1955, pp. 47–50.
[5] Bulletin, American Ceramic Society, vol. 34, No. 12, December 1955, p. 30.
[6] Ceramic Industry, They've Mechanized at National Tile: Vol. 65, No. 6, December 1955, pp. 68–70.

Operation of the new bisque department of Orange County Tile Co., Huntington Beach, Calif., the first stage in planned expansion of its wall-tile plant, was described.[7]

Gladding, McBean & Co. selected a site near Corona, Calif., to build a plant for manufacturing tile, brick, sewer pipe, terra cotta, and other ceramic products.[8]

The trend toward increased plant modernization and improved manufacturing methods, that began in 1951 in the structural clay products industry, continued through 1955.[9]

REFRACTORIES

The value of clay refractories shipments increased 40 percent in 1955 compared with 1954. The value of fire-clay brick shipments (except superduty) represented 40 percent of the total value in 1954 and 35 percent in 1955; ladle brick, 10 percent in 1954 and 11 percent in 1955; superduty fire-clay brick, 9 percent in 1954 and 8 percent in 1955; and insulating firebrick, 6 percent in both 1954 and 1955. A number of classifications composed the remaining 35 percent in 1954 and 40 percent in 1955, as shown in table 11.

TABLE 11.—Shipments of refractories in the United States, by kinds, 1954–55

[Bureau of the Census]

Product	Unit of quantity	Shipments 1954 Quantity	Shipments 1954 Value (thousand dollars)	Shipments 1955 Quantity	Shipments 1955 Value (thousand dollars)
Clay refractories:					
Fire-clay brick, standard and special shapes, except superduty.	1,000 9-in. equivalent	394, 649	51, 205	495, 859	63, 960
Superduty fire-clay brick and shapes	do	61, 738	11, 891	74, 272	15, 137
High-alumina brick and shapes (50 percent Al_2O_3 and over) made substantially of calcined diaspore or bauxite.[1]	do	15, 818	5, 151	21, 132	7, 138
Insulating firebrick and shapes	do	87, 090	7, 647	54, 178	11, 196
Ladle brick	do	169, 273	12, 915	234, 158	19, 664
Hot-top refractories	do	32, 347	4, 537	50, 679	7, 104
Sleeves, nozzles, runner brick, and tuyères	do	43, 427	6, 993	58, 976	10, 352
Glasshouse pots, tank blocks, feeder parts, and upper structure shapes used only for glass tanks.[1]	Short ton	15, 922	2, 716	18, 362	3, 602
Refractory bonding mortars, air setting (wet and dry types).	do	86, 519	8, 123	72, 604	7, 399
Refractory bonding mortars, except air-setting types.	do			10, 785	1, 021

See footnotes at end of table.

[7] Ceramic Industry, Success Begets Expansion at the Plant: Vol. 65, No. 4, October 1955, pp. 95–96.
[8] Bulletin, American Ceramic Society, vol. 34, No. 3, March 1955, p. 27.
[9] Brick and Clay Record, vol. 126, No. 1, January 1955, pp. 35, 38, 56–60; No. 2, February 1955, pp. 22, 23, 34, 36, 37; No. 3, March 1955, pp. 33, 48–53, 67, 69, 81, 86, 93; No. 4, April 1955, pp. 42, 46, 55, 58–65, 80–81, 88–92; No. 5, May 1955, pp. 17, 20, 66–69; No. 6, June 1955, pp. 39–42, 45, 59, 91; vol. 127, No. 1, July 1955, pp., 32, 33, 36–37, 61–88; No. 2, August 1955, pp. 24, 26, 29–32, 39–42, 46–47, 49–51; No. 3, September 1955, pp. 27, 30, 32, 37–39, 40–48; No. 4, October 1955, pp. 35–37, 44, 72; No. 5, November 1955, pp. 29, 31, 37, 63–66; No. 6, December 1955, pp. 26–30, 42–45.
Ceramic Industry, vol. 64, No. 2, February 1955, p. 44; No. 5, May 1955, pp. 47–48; No. 6, June 1955, pp. 41–42; vol. 65, No. 1, July 1955, pp. 41–42, 77; No. 2, August 1955, pp. 43–44, 81, 112; No. 3, September 1955, pp. 43–44, 81; No. 4, October 1955, pp. 51–52, 95–96; No. 6, December 1955, pp. 39–40.
Ceramic Age, vol. 65, No. 1, January 1955, pp. 27, 29; No. 3, March 1955, pp. 9–11; No. 4, April 1955, p. 16; No. 5, May 1955, pp. 22–23; No 6, June 1955, pp. 22, 24; vol. 66, No. 1, July 1955, pp. 22–23; No. 2, August 1955, pp. 22–24; No. 3, September 1955, pp. 22–23; No. 4, October 1955, p. 48; No. 5, November 1955, pp. 5, 38–39, 42; No. 6, December 1955, pp. 9, 44, 46.

TABLE 11.—Shipments of refactories in the United States, by kinds, 1954–55—Con.

Product	Unit of quantity	Shipments 1954 Quantity	Shipments 1954 Value (thousand dollars)	Shipments 1955 Quantity	Shipments 1955 Value (thousand dollars)
Clay refractories—Continued					
Plastic refractories and ramming mixes [1]	Short ton	92,613	5,125	139,357	9,232
Refractory castables (hydraulic setting)	do	70,511	6,095	80,736	7,279
Insulating refractory castables (hydraulic setting).	do			12,212	1,363
Ground crude fire clay, high-alumina clay, and silica fire caly.[2]	do	(5)	(5)	740,205	7,284
Clay kiln furniture, radiant heater elements, potters' supplies, and other miscellaneous refractory items.			6,688		5,128
Other clay refractory materials sold in lump or ground form.					3,762
Total clay refractories			[4] 129,086		180,621
Nonclay refractories:					
Silica brick and shapes	1,000 9-in. equivalent.	226,402	37,875	328,414	55,563
Magnesite and magnesite-chrome (magnesite predominating) brick and shapes (excluding molten cast).	do	31,351	18,939	53,153	32,093
Chrome and chrome-magnesite (chrome ore predominating) brick and shapes.	do	35,783	18,773	54,101	28,771
Graphite and other crucibles, retorts, stopper heads, and other shaped refractories.	Short ton	9,980	5,522	12,721	7,925
Mullite brick and shapes made predominantly of kyanite, sillimanite, andalusite, or synthetic mullite (excluding molten cast).	1,000 9-in. equivalent.	(5)	22,958	3,928	4,505
Extra-high alumina brick and shapes made predominantly of fused bauxite, fused or dense-sintered alumina.	do			2,127	3,810
Silicon carbide brick and shapes made substantially of silicon carbide.	do			4,943	9,282
Zircon and zirconia brick and shapes made predominantly of these materials.	do			757	1,524
Forsterite, pyrophyllite, molten-cast, and other nonclay brick and shapes.					7,323
Nonclay refractory bonding mortars, air setting (wet and dry types).	Short ton	76,686	7,961	75,199	7,320
Nonclay refractory bonding mortars, except air-setting types.	do			36,721	2,707
Nonclay plastic refractories and ramming mixes (wet and dry types).	do	98,867	8,252	202,509	17,704
Nonclay refractory castables (hydraulic setting)	do		7,341	5,075	542
Other nonclay refractory materials sold in lump or ground form.[6]					8,969
Total nonclay refractories			127,621		188,038
Grand total refractories [3]			[4] 256,707		368,659

[1] Does not include mullite or extra-high-alumina refractories. These products included with mullite and extra-high-alumina brick and shapes in the nonclay refractories section.
[2] Represents only ground crude fire clay and high-alumina clay material produced and shipped by manufacturers, who also produced and shipped other types of refractories.
[3] Data for dead-burned magnesia and magnesite excluded to avoid duplication, since an indeterminate quantity of these materials was shipped to refractory producers for incorporation into the refractory products covered in this report (such as magnesite brick and shapes).
[4] Does not include value of shipments of ground crude fire clay, high-alumina clay, and silica fire clay.
[5] Data not available.
[6] In addition, the Bureau of Mines, U. S. Department of the Interior, reports that 1,521,000 tons of dead-burned dolomite (refractory lime), valued at $21,961,000, was sold by producers in 1954 and 2,129,000 tons, valued at $31,425,000, in 1955.

The Harbison-Walker Refractories Co. opened a new plant at Leslie, Md., to produce silica brick. The site was chosen because of its proximity to a supply of high-quality raw material and to large markets in Baltimore and Philadelphia.[10]

A firebrick specialty company in western Pennsylvania was able to increase labor productivity 83 percent by modernization.[11]

TECHNOLOGY

The First National Conference on Clays and Clay Technology (title changed to Clays and Clay Minerals in subsequent conferences), sponsored by the University of California in cooperation with a group of national and State agencies and societies, was held in Berkeley, Calif., in 1952. The proceedings of this conference were published in 1955. Selected papers from this volume were of special interest to the clay industries.[12]

The Second National Conference on Clays and Clay Minerals, sponsored by the Committee on Clay Minerals of the National Academy of Sciences–National Research Council, the University of Missouri, and the State Geological Survey of Kansas, was held at Columbia, Mo., in October 1953. The proceedings of this conference were published in 1954. Selected papers from this volume were of special interest to the clay industry.[13]

---

[10] American Metal Market, vol. 62, No. 73, September 1955, p. 9.
Iron Age, vol. 176, No. 12, September 1955, p. 74.
Manufacturers Record, vol. 121, No. 12, December 1955, p. 16.
Pit and Quarry, vol. 48, No. 4, October 1955, p. 19.
Iron and Steel Engineer, vol. 32, No. 10, October 1955, p. 131.

[11] Hall, R. S., Modernization of a Refractory Specialty Company: Bull. Am. Ceram. Soc., vol. 34, No. 8, August 1955, pp. 248–250.

[12] Pask, J. A., and Turner, M. D., Clays and Clay Technology: California Div. of Mines, Dept. of Nat. Res., San Francisco, Calif., Bull. 169, 1955, 326 pp.
Kerr, P. F., Formation and Occurrence of Clay Minerals: Pp. 19–32.
Brindley, G. W., Structural Mineralogy of Clays: Pp. 33–44. Identification of Clay Minerals by X-ray Diffraction Analysis: Pp. 119–129.
Davis, L. E., Electrochemical Properties of Clays: Pp. 47–53.
Lewis, D. R., Ion Exchange Reactions of Clays: Pp. 54–69.
Barshad, Isaac, Adsorptive and Swelling Properties of Clay-Water System: Pp. 70–77.
MacEwan, D. M. C., Interlamellar Sorption by Clay Minerals: Pp. 78–86.
Johnson, A. L., Particle Size Distribution in Clays: Pp. 89–92.
Kelley, W. P., Interpretation of Chemical Analyses of Clays: Pp. 92–94.
Osthaus, B. B., Interpretation of Chemical Analyses of Montmorillonites: Pp. 95–100.
Grim, R. E., Petrographic Study of Clay Materials: Pp. 101–104.
Dodd, C. G., Dye Adsorption as a Method of Identifying Clays: Pp. 105–111.
Nahin, P. G., Infrared Analysis of Clays and Related Minerals: Pp. 112–118.
Bates, T. F., Electron Microscopy as a Method of Identifying Clays: Pp. 130–150.
Rowland, R. A., Differential Thermal Analysis of Clays and Carbonates: Pp. 151–164.
Henry, E. C., Clay Technology in Ceramics: Pp. 257–266.
Larsen, D. H., Use of Clay in Drilling Fluids: Pp. 269–281.
Wyllie, M. R. J., Role of Clay in Well-Log Interpretation: Pp. 282–305.
Johnston, Norris, Role of Clay in Oil Reservoirs: Pp. 306–313.
Milliken, T. H., Oblad, A. G., and Mills, G. A., Use of Clays as Petroleum Cracking Catalysts: Pp. 314–326.

[13] Swineford, Ada, and Plummer, Norman, Clays and Clay Minerals: Nat. Acad. Sci.–Nat. Res. Council, Pub. 327, 1954, 498 pp.
Keller, W. D., Westcott, J. F., and Bledsoe, A. O., The Origin of Missouri Fire Clays: Pp. 7–46.
Murray, H. H., Genesis of Clay Minerals in Some Pennsylvanian Shales of Indiana and Illinois: Pp. 47–67.
Powers, M. C., Clay Diagenesis in the Chesapeake Bay Area: Pp. 68–80.
Grim, R. E., and Johns, W. D., Clay Mineral Investigation in the Northern Gulf of Mexico: Pp. 81–103.
Roy, Rustum, The Application of Phase-Equlibrium Data to Certain Aspects of Clay Mineralogy: Pp. 124–140.
Williams, F. J., Elsley, B. C., and Weintritt, D. J., The Variations of Wyoming Bentonite Beds as a Function of the Overburden: Pp. 141–151.
Marshall, C. E., Multifunctional Ionization as Illustrated by the Clay Minerals: Pp. 364–385.
Foster, M. D., The Relation Between "Illite," Beidellite, and Montmorillonite: Pp. 386–397.
Thomas, H. C., and Gaines, G. L., Jr., The Thermodynamics of Ion Exchange on Clay Minerals. A Preliminary Report on the System Montmorillonite–Cs–Sr: Pp. 398–403.
Van Olphen, H., Interlayer Forces in Bentonite: Pp. 418–438.
Hauser, E. A., and Colombo, Umberto, Colloid Science of Montmorillonites and Bentonites: Pp. 439–461.
Buessem, W. R., and Nagy, Bartholomew, The Mechanism of the Deformation of Clay: Pp. 480–491.

The volume of the Proceedings of the Third National Conference on Clays and Clay Minerals, sponsored by the Committee on Clay Minerals of the National Academy of Sciences-National Research Council and The Rice Institute in October 1954, was published during 1955. Selected papers from this volume were of special interest to the clay industry.[14]

The comprehensive research program described in the Clays chapter of Minerals Yearbook, 1954, sponsored by the Expanded Shale, Clay, and Slate Institute, Washington, D. C., at the University of Toledo, Toledo, Ohio, and Kansas State College, Manhattan, Kans., made progress in 1955.[15] A program to determine ultimate deflection, plastic flow of concrete, and internal fibre stress of full-size rigid frame members made from lightweight concrete was initiated at Southern Methodist University, Dallas, Tex. Five members of this institute sponsored precast and masonry expanded-shale concrete houses in the Federal Civil Defense Administration's atomic tests in 1955 at Yucca Flat, Nev. This institute also printed two information sheets—Workability Is Easy, and What About Deflection?

The National Clay Pipe Manufacturers, Inc., in 1955 continued research that was begun in 1952.[16] Research, using plastisols as a point of accomplished progress, included a study of other materials applicable to jointing techniques that will permit practical and economical assembly of clay pipe in trenches. This project was assigned to Battelle Memorial Institute, Columbus, Ohio. Another project, using the facilities of the NCPMI, will provide performance data, based on laboratory tests on vitrified clay pipe when used for sanitary sewers, and will establish standardized tests to compare present and potential jointing techniques.

The School of Engineering, North Carolina State College, began an industrial experimental program aimed at helping small manufacturers unable to support research work of their own. Projects underway included a pilot plant to produce ceramic articles in a new-type shuttle kiln. Blueprints of the pilot plant were to be made available.[17]

---

14 Milligan, W. O., Clays and Clay Minerals: Nat. Acad. Sci.-Nat. Res. Council, Pub. 395, 1955, 573 pp.
Bates, T. F., and Comer, J. J., Electron Microscopy of Clay Surfaces: Pp. 1–25.
Taggart, M. S., Jr., Milligan, W. O., and Studer, H. P., Electron Micrographic Studies of Clays: Pp. 31–64.
Jonas, E. C., The Reversible Dehydroxylization of Clay Minerals: Pp. 66–72.
Hathaway, J. C., Studies of Some Vermiculite-Type Clay Minerals: Pp. 74–86.
Stone, R. L., and Rowland, R. A., DTA of Kaolinite and Montmorillonite Under Water-Vapor Pressures Up to Six Atmospheres: Pp. 103–116.
Mielenz, R. C., Schieltz, N. C., and King, M. E., Effect of Exchangeable Cation on X-Ray Diffraction Patterns and Thermal Behavior of a Montmorillonite Clay: Pp. 146–173.
Nahin, P. G., Swelling of Clay Under Pressure: Pp. 174–185.
White, W. A., Water Sorption Properties of Homoionic Montmorillonite: Pp. 186–204.
Foster, M. D., The Relation Between Composition and Swelling in Clays: Pp. 205–220.
Woodward, L. A., Variations in Viscosity of Clay-Water Suspensions of Georgia Kaolins: Pp. 246–259.
Whitehouse, U. G., and Jeffrey, L. M., Peptization Resistance of Selected Samples of Kaolinitic, Montmorillonitic, and Illitic Clay Minerals: Pp. 260–281.
Coleman, N. T., and McAuliffe, Clayton, H-Ion Catalysis by Clays: Pp. 282–289.
Davis, L. E., Ion Pair Activities in Bentonite Suspensions: Pp. 290–295.
Foster, W. R., Savins, J. G., and Waite, J. M., Lattice Expansion and Rheological Behavior Relationships in Water-Montmorillonite Systems: Pp. 296–316.
Allen, V. T., Relation of Porosity and Permeability to the Origin of Diaspore Clay: Pp. 389–401.
Mathers, A. G., Weed, S. B., and Coleman, N. T., The Effect of Acid and Heat Treatment on Montmorillonoids: Pp. 403-412.
Hauser, E. A., The Colloid Science of Important Clay Minerals: Pp. 442–472.
Norton, F. H., Flow Properties of the Kaolinite-Water System: Pp. 549–556.

15 Expanded Shale, Clay, and Slate Institute, Letter to the Bureau of Mines: Feb. 13, 1956.

16 National Clay Pipe Manufacturers, Inc., Letter to the Bureau of Mines: May 14, 1956.

17 Ceramic Age, vol. 66, No. 6, December 1955, p. 9.

Formulas for calculating the value of clay deposits were explained in detail to enable plant owners to compute value when buying, selling, or evaluating holdings.[18] The results of tests on the magnetic extraction of ferruginous particles from ground clay were described. A two-stage firing process for grog production, treatment of hard-fired grog by magnetic separators, and treatment of raw clay by magnetic separators were discussed.[19] The drying of clay products was presented in nontechnical language.[20] The use of dehumidifying equipment to achieve uniformity of clay casting and drying in a region where extreme dampness makes control difficult was described.[21] Equipment for investigating and controlling bisque strength, shrinkage, porosity, and permeability was described. Special attention was given to casting-slips.[22] Armour Research Foundation, Illinois Institute of Technology, Chicago, announced development of a novel process for coating a wide variety of substances by feeding powdered ceramic material through a simple flame gun.[23]

The flowsheet for producing kaolin from initial discovery through test drilling, laboratory analysis, mining, beneficiation, and packaging was described.[24]

Production of kaolin cracking catalyst was begun, under licenses from Houdry Processing Corp., by the Minerals & Chemicals Corporation of America, Menlo Park, N. J., at Attapulgus, Ga. The catalyst was a pelleted type for use in the moving-bed catalytic units of mineral-oil refineries. Tests showed that pelleted-type kaolin catalyst produced large yields of high-octane gasoline. This new type of catalyst was expected to sell at a substantially lower price than synthetic (silica-alumina) catalysts.

The development of machine coating in the paper industry made it necessary to operate at much higher speeds and resulted in changes in the specifications for kaolin used as a coater. Clay particles of relatively flat plates and 2 microns or less in particle size are required. Clay slurry for coating must contain 60 to 70 percent solids, compared with 35 to 40 percent required previously.[25]

The dispersion of kaolin suspension in various organic liquids was studied, and a report on the results was published.[26] Because of considerable interest in the use of certain polyelectrolytes as flocculating agents for finely divided solids in aqueous suspension and as aggregating agents for soils, the Massachusetts Institute of Technology, Soil Stabilization Laboratory, conducted fundamental research on absorption by kaolinite.[27] It was stated that thermal expansion and differential thermal analysis assisted in explaining low shrinkage and high strength of some clays. The difference between plastic and

---

18 Brick and Clay Record, vol. 126, No. 6, June 1955, pp. 46–47; vol. 127, No. 2, August 1955, pp. 45, 70.

19 Forbes, D., Beneficiation of Fire Clays by Magnetic Separation: Refractories Jour. (London), vol. 31, No. 3, March 1955, pp. 115–117.

20 Seanor, J. G., Practical Aspects of Clay Product Drying: Brick and Clay Record, vol. 126, No. 1, January 1955, pp. 48–51; No. 2, February 1955, pp. 47–50, 70; No. 3, March 1955, pp. 73–77; No. 4, April 1955, pp. 66–69.

21 Fitzcharles, W. N., and Rohrs, M. K., Air Conditioning Assures Production of Vitreous China Plumbing Fixtures: Ceram. Ind., vol. 64, No. 5, May 1955, pp. 87, 112.

22 Weintritt, D. J., and Perricone, A. C., Testing Equipment for Laboratory and Production Control: Ceram. Ind., vol. 65, No. 2, August 1955, pp. 86–89.

23 Ceramic Industry, New Ceramic Coating Process Uses Flame Gun: Vol. 64, No. 6, June 1955, p. 35.

24 Ceramic Age, Modern Prospecting, Testing and Research at Florida Kaolin-Mining Operation: Vol. 66, No. 5, November 1955, pp. 10–12.

25 Albert, C. G., Requirements of Modern Paper Clay: Min. Eng., vol. 7, No. 10, October 1955, pp. 941–943.

26 Folkers, C. L., and Welch, P. A., Clay-Particle Dispersion in Organic Media: Jour. Am. Ceram. Soc., vol. 38, No. 12, December 1955, pp. 454–461.

27 Michaels, A. S., and Morelos, O., Polyelectrolytic Absorption by Kaolinite: Ind. Eng. Chem., vol. 47, No. 9, September 1955, pp. 1801–1809.

nonplastic kaolins was explained in terms of crystalline shape and geometric perfection.[28]

Some methods of controlling the manufacture of fire clay refractories by the stiff-mud process were described.[29] A dense refractory brick with high load-carrying capacity at high temperatures was developed from carefully sized flint fire clay.[30] A study of problems involved in the various stages of kiln-furniture production was reported. The process of forming setters was followed through design, modeling, moldmaking, casting, and firing.[31]

The problems of high-temperature mechanical application and the role of ceramic coatings and cermets in jets, reactors, and missiles were discussed.[32] Ceramic coatings for engine parts to be operated at very high temperatures and other applications were discussed.[33] Electro Refractories & Abrasives Corp., Buffalo, N. Y., announced development of a new silicon carbide refractory that will permit more efficient firing of ceramic materials at temperatures up to 3,000° F.[34]

Studies showed that the high-temperature centrifuge may become an important tool for liquid-phase studies in refractories systems. A rotating-type induction furnace was used to demonstrate application of the high-temperature centrifuge.[35] A review of the progress of development of superrefractory materials, concerning which little was known before 1945, and possible lines of future research were presented. The three major classes discussed were ceramic oxides, carbides, and cermets; intermetallics; and refractory elements and alloys. Properties of 25 of these materials were given in a table.[36]

Estimated costs of various combinations of fusion flux blocks and clay flux blocks in a typical glass-container tank were given. It was suggested that a large percentage of clay-flux blocks could be used in glass-tank design. The blocks are low in cost, dimensionally accurate, and of relatively low thermal conductivity.[37] Thermal-shock-resisting refractories were filling a definite need, notably in the aircraft industry. New applications were being developed in the combustion of fuel, metallurgical industries, and nuclear engineering.[38]

Bleaching clay deposits of the Sanders-Defiance Plateau district, northeastern Arizona, were an important commercial source of activated bentonite. The stages of alteration of vitric tuff to bentonite were traced by field observation, microscopical examination, and

---

[28] Koenig, J. H., and Lyons, S. C., Correlation of Kaolinite Crystal Shape With Particle Size and Some Effects on Ceramic Behavior: Ceram. Age, vol. 66, No. 1, July 1955, pp. 8–14.

[29] Lesar, A. R., and McGee, T. D., Quality Control as Applied to Stiff Mud Manufacture: Bull. Am. Ceram. Soc., vol. 34, No. 12, December 1955, pp. 409–411.

[30] West, R. R., Secondary Expansion of a Flint Fire Clay: Bull. Am. Ceram. Soc., vol. 34, No. 9, September 1955, pp. 283–286.

[31] Shaw, C. F., Design and Production of Kiln Furniture for Fine China: Bull. Am. Ceram. Soc., vol. 34, No. 3, March 1955, pp. 88–91.

[32] Butler, G. M., Jr., Jets, Reactors, Missiles Need Ceramic Parts: Ceram. Ind., vol. 64, No. 3, March 1955, pp. 70–74, 101.

[33] Ceramic Industry, High-Temperature Coatings Beat the Heat: Vol. 64, No. 6, June 1955, pp. 98–99.

[34] Ceramic Age, vol. 65, No. 5, May 1955, p. 22.

[35] Birch, R. E., High-Temperature Centrifuge for Separation of the Liquid Phase From Refractories, part 1, Background Studies: Jour. Am. Ceram. Soc., vol. 38, No. 9, September 1955, pp. 323–328.
Derge, Gethard, and Shegog, Jack, part II, Centrifuging Tests: pp. 329–330.

[36] Long, R. A., Superrefractory Materials: Metals Progress, vol. 68, No. 3, September 1955, pp. 123–128, 190.

[37] Duggan, J. J., The Use of Clay Flux Blocks: Bull. Am. Ceram. Soc., vol. 34, No. 3, March 1955, pp. 85–87.

[38] Hummel, F. A., Ceramics for Thermal Shock Resistance: Ceram. Ind., vol. 65, No. 5, November 1955, pp. 73–75, 104.

X-ray analysis.[39] The corrosion-prevention quality of pastes made from bentonite and certain metallic salts was demonstrated.[40]

The drying of clay-sewer pipe by the room method at the Los Nietos, Calif., plant of Pacific Clay Products Co. was described.[41] The results of studies of efflorescence on different types of brick piers were discussed.[42] It was predicted that the trend toward decreased use of clay products in construction would continue unless lightweight fabricated clay-products units were developed to save on-site labor and construction time.[43]

Clay Sewer Pipe Association, Columbus, Ohio, announced development of a new root-proof, infiltration-proof, vitrified clay pipe.[44]

Patents issued during 1955 covered the use of bentonite in mold compositions for precision casting,[45] as drilling mud,[46] as a nonadhesive to prevent transfer of undried ink from one surface to another during printing,[47] and in a device to indicate when frozen food packages have reached a temperature that will cause deterioration of the contents.[48]

The slurring qualities of bentonite were said to be improved by admixing a small percentage of sodium, potassium, or calcium permanganate.[49] Bentonite and fuller's earth were suggested as absorbents in refining waxes[50] as fillers in animal feeds,[51] and as absorbents for organic solutions containing uranium and rare-earth fission products.[52]

The resistance of metal surfaces to high temperatures was said to be improved by coating with a mixture of a resin, alkali-metal silicate, and a siliceous material. Bentonite or kaolin are suitable siliceous materials.[53] Bentonite or kaolin also was used in formulas for ceramic lining parts in rockets and jet engines to resist high-temperature and high-velocity gases.[54] A slurry of bentonite, plastic fire clay, and pyrophyllite was used to coat hot stainless-steel ingots before rolling.[55] The manufacture of catalysts suitable for polymerizing hydrocarbons was described.[56] For some purposes fuller's earth can replace part of the kaolin. The corrosiveness of liquefied petroleum gases was reduced materially by treatment with lead or zinc mercaptides

---

[39] Kiersch, G. A., and Keller, W. D., Bleaching Clay Deposits, Sanders-Defiance Plateau District, Navajo County, Ariz.: Econ. Geol., vol. 50, No. 5, August 1955, 25 pp.

[40] Chemical and Engineering News, Bentonite Pastes Prevent Corrosion: Vol. 33, No. 33, Aug. 15, 1955, p. 3400.

[41] Brick and Clay Record, vol. 126, No. 1, January 1955, pp. 53–55.

[42] Ritchie, T., Study of Efflorescence on Experimental Brickwork Piers: Jour. Am. Ceram. Soc., vol. 38, No. 10, Oct. 1, 1955, pp. 357–361.

[43] Johnson, S. K., Clay Products From the Architect's Viewpoint: Bull. Am. Ceram. Soc., vol. 34, No. 5, May 1955, p. 151.

[44] Bulletin, American Ceramic Society, vol. 34, No. 4, April 1955, p. 42.

[45] Greenewald, H., Jr., Mold Composition and Process: U. S. Patent 2,701,207, Feb. 1, 1955.

[46] Dawson, L. R. (assigned to The Milwhite Co., Inc.), Improved Compositions for Well-Drilling Muds: U. S. Patent 2,702,788, Feb. 22, 1955.

[47] Adams, G. M. (assigned to The Viking Corp.), Offset-Preventing Compositions: U. S. Patent 2,713,307, July 19, 1955.

[48] Beckett, J. S., and Marenus, W. J. (assigned to Aseptic Thermo Indicator Co.) Telltale for Frozen Food Packages: U. S. Patent 2,716,065, Aug. 23, 1955.

[49] Ratcliffe, G. L. (assigned to National Lead Co.), Treatment of Bentonitic Clays: U. S. Patent 2,724,696, Nov. 22, 1955.

[50] Ackerman, W. A. (assigned to Sun Oil Co.), Wax Refining: U. S. Patent 2,708,652, May 17, 1955.

[51] Cooley, M. L. (assigned to General Mills, Inc.), Preparing Animal Feeds: U. S. Patent 2,712,997, July 12, 1955.

[52] Schubert, J. (assigned to the Atomic Energy Commission), Separation of Fission Products by Absorption From Organic Solvents: U. S. Patent 2,717,696, Sept. 13, 1955.

[53] Martens, C. R., and Bellamy, J. G. (assigned to the Sherwin-Williams Co.), Method of Coating Metal to Increase High-Temperature Resistance: U. S. Patent 2,699,407, Jan. 11, 1955.

[54] Logan, I. M., and Swentzel, J. P. (assigned to the Carborundum Co.), Devices for Confinement and Release of High-Velocity Hot Gases: U. S. Patent 2,706,382, Apr. 19, 1955.

[55] Pakkala, M. H., and Scarry, J. L. (assigned to United States Steel Corp.), Method of Hot Rolling Stainless Steel: U. S. Patent 2,708,379, May 17, 1955.

[56] Morrell, J. C., Method of Making Catalyst: U. S. Patent 2,713,560, July 19, 1955.

impregnated on fuller's earth.[57] Fuller's earth was suggested as an absorbent material for dewaxing phenols.[58]

Patents were issued on the manufacture of cracking catalyst from kaolin and silica gel [59] and for improving the properties of kaolin.[60]

WORLD REVIEW

Argentina.—A plant to manufacture activated clay, mainly for use in petroleum refineries, was built at Capitan Bermudez, Argentina, by Electroclor S. A. It was designed to produce 8,000 tons per year. Bentonite from the Province of San Juan was used as a raw material.[61]

Canada.[62]—The investigation of making lightweight aggregate from Canadian clays and shales continued in the Mines Branch. In 1955 there were 8 producing plants, and 1 was under construction. Output in 1955 was valued at $958,000.

The opening in 1955 of deposits in Nova Scotia on a large scale makes available a local source of good-grade stoneware clay.

Prices.—An indication of the 1955 prices per ton f. o. b. shipping point, for three kinds of clay is as follows: Fire clay, $4.50 to $6 per ton; kaolin or china clay, $9 to $30; and ball clay, $6 to $20.

A special report on bentonite was issued.[63] Production of bentonite was confined to two areas in western Canada, from near Morden, Manitoba, where a nonswelling type was produced, and from the Drumheller area of Alberta, where a swelling type was produced. No bentonite deposits have been found east of Manitoba. At Morden bentonite was mined by Pembina Mountain, Ltd. The material was dried, crushed, and shipped to Winnipeg, where it was ground and activated. Bentonite was produced from several localities in the Drumheller area. The material was sold in lump form to Alberta Mud Co., Ltd., which dried, ground, bagged, and sold it to consumers in western Canada.

The report stated that an estimated 50,000 short tons of bentonite was used in 1955—25,000 tons in oil-well drilling, 13,000 tons in filtering and decolorizing oils, 6,000 tons as foundry-sand bond, 2,500 tons in pelletizing operations, and the remainder for miscellaneous minor uses. The reported value of imports in 1955 was $1,247,355, compared with $835,433 in 1954. It was estimated that imports of swelling bentonite from the United States reached 35,000 tons in 1955. Activated bentonite costs $60 to $80 per short ton in carlots delivered to points in Ontario and Quebec. Alberta bentonite, ground to 90 percent minus-200-mesh, cost $40 a short ton, f. o. b. Calgary, in 1955.

---

[57] Scovill, W. E. (assigned to The Standard Oil Co. (Ohio)), Treatment of Light Hydrocarbons: U. S. Patent 2,699,420, Jan. 11, 1955.

[58] Walker, J., and Lambert, N. W. (assigned to The Pure Oil Co.), Removal of Volatile Fatty Acids From Phenol: U. S. Patent 2,727,925, Dec. 20, 1955.

[59] Simpson, T. P., Branton, P. D., and Plank, C. J. (assigned to Socony Mobil Oil Co., Inc.), Preparation of Catalyst From Kaolin and Silica Gel: U. S. Patent 2,727,868, Dec. 20, 1955.

[60] Asdell, B. K. (assigned to Minerals & Chemicals Corp. of America), Clay Comminution Method: U. S. Patent 2,726,813, Dec. 13, 1955.

Bertorelli, O. L. (assigned to J. M. Huber Corp.), Treatment of Kaolin: U. S. Patent 2,710,244, June 7, 1955.

[61] Chemical and Engineering News, vol. 33, No. 2, Jan. 10, 1955, p. 1952.

[62] Phillips, J. G., Clay and Clay Products in Canada, 1955 (Preliminary): Dept. of Mines and Tech. Surveys, Ottawa, Canada, 5 pp.

[63] Janes, T. H., Bentonite in Canada, 1955 (Preliminary): Dept. of Mines and Tech. Surveys, Ottawa, Canada, 3 pp.

TABLE 12.—Clay production, products, and trade in Canada, 1954–55

	1954	1955
Production from domestic clays:		
Clays including bentonite	$396,360	$515,855
Clay products, from—		
Common clay	26,933,343	28,094,276
Stoneware clay	4,191,934	4,948,299
Fire clays	546,968	817,637
Other products	291,493	300,000
Total	32,360,098	34,676,067
Production from imported clays, from—		
Stoneware clay	840,700	
Fire clay	2,263,244	
China clay	12,881,611	
Total	15,985,555	[1] 16,450,700
Grand total	48,345,653	51,126,767
Imports:		
Clays:		
Fire clay	396,336	421,205
China clay	1,527,075	1,902,470
All other, including activated, filtering, and bleaching clays	1,281,803	1,726,341
Total	3,205,214	4,050,016
Clay products, from—		
United States	21,981,595	23,040,013
United Kingdom	13,539,058	13,878,775
Other countries	1,802,077	2,893,679
Total	37,322,730	39,812,467
Exports:		
Clays, to—		
United States	34,866	93,681
Other countries		1,004
Total	34,866	94,685
Clay products, to—		
United States	1,297,328	1,654,546
Sweden	164,967	185,567
Belgium	103,115	96,990
Germany, West		95,601
Brazil	128,341	75,255
Union of South Africa	41,491	72,244
New Zealand	16,845	71,958
Other countries	436,081	400,530
Total	2,188,168	2,652,691

[1] Estimate.

SOURCE: Phillips, J. G., Clays and Clay Products in Canada, 1955 (Preliminary): Dept. of Mines and Tech. Surveys, Ottawa, Canada, 5 pp.

A new industry utilizing some 20,000 tons of clay in manufacturing vitrified sewer linings and tile was founded in Regina, Saskatchewan. The new company plans to build a $1,250,000 plant in 1956.[64]

Formosa.—The value of production of refractories in Formosa was estimated at US$370,000 annually and the import value at US$230,000. Only fire-clay refractories and silica refractories are generally manufactured in Taiwan. Superduty refractories usually have been imported from the United States in recent years. Development of the local refractory industry depends largely upon an extensive survey of new sources of refractory materials on the island.[65]

[64] Northern Miner, vol. 41, No. 40, Dec. 29, 1955, p. 11.
[65] Chin, Dalgen, Progress of the Refractory Industry in Formosa: Bull. Am. Ceram. Soc., vol. 34, No. 6, June 1955, p. 186.

Germany.—Geographic distribution, shrinkage, porosity refractoriness, particle-size distribution, and firing behavior were compiled for the principal refractory-clay deposits.[66]

India.—Table 13 shows production and value of fuller's earth in India, by Provinces, 1952–53.

The production capacity of basic and silica refractories in India was expected to increase from 329,410 tons per year to 460,000. Considerable research work was conducted by the Central Glass & Ceramic Research Institute at Calcutta and at the National Metallurgical Laboratory at Jamshedpur for the manufacture of forsterite and chromite refractories utilizing indigenous raw materials.[67]

The Teta Iron & Steel Co. contracted with the Didier Werke of West Germany for the construction of a plant in India to manufacture refractory materials. The project was expected to be completed in 1958.[68]

TABLE 13.—Fuller's earth production in India, by Provinces, 1952–53, in long tons

	1952		1953	
	Tons	Value [1]	Tons	Value [1]
Madhya Pradesh: Jabalpur	25	$353	61	$412
Rajasthan:				
Bikaner	3,385	148,940	940	31,960
Jodhpur	4,722	74,088	721	39,295
Total	8,132	223,381	1,722	71,667

[1] 1 rupee equals about US$0.21.

SOURCE: Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, pp. 55–56.

Mexico.—Harbison-Walker Refractories Co. announced the purchase of an interest in Fabrica de Ladrillos Industriales y Refractorios, S. A. (FLIR) of Mexico. It was planned to change the name to Harbison-Walker-FLIR, S. A. The firm produced fire-clay and silica refractories in a modern plant at Monterrey, Mexico.[69]

Peru.—Construction of a new refractories plant of Refractarios Peruanos, S. A., a subsidiary of Harbison-Walker Refractories Co., begun in 1955 at Lima, was expected to be completed and in operation by July 1956. This plant will produce fire-clay, silica, and basic refractories. Raw materials for the fire-clay and silica refractories will be obtained from deposits in Peru, and raw materials for basic refractories will be imported. The plant will cost about US$1 million and will have an annual capacity of about 40,000 tons of fired products.[70]

Rhodesia and Nyasaland, Federation of.—Production of fire clay from Southern Rhodesia totaled 72,537 short tons valued at £6,999 in 1954, compared with 11,600 tons valued at £1,850 in 1953, an increase of 525 percent (£1 equals about US$2.81).[71]

[66] Neumann, Walter, [Physical and Chemical Properties of Several Refractory Clays and Firebrick]: Siligattech., vol. 6, No. 5, May 1955, pp. 220–224.
[67] Chemical Age, vol. 73, No. 1890, Oct. 1, 1955, p. 729.
[68] U. S. Embassy, New Delhi, India, State Department Dispatch 697: Dec. 29, 1955, p. 4.
[69] Iron and Steel Engineer, vol. 32, No. 11, November 1955, p. 196.
[70] Harbison-Walker Refractories Co., Burns and Mixes: Vol. 10, No. 1, January 1956, pp. 2–4.
[71] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, p. 35.

Tanganyika.—Exports of kaolin totaled 287 short tons valued at £2,483 in 1954, compared with 1,264 short tons valued at £12,170 in 1953 (£1 equals US$2.78).[72]

Union of South Africa.—Production of kaolin in 1954 totaled 14,437 short tons, compared with 8,719 short tons in 1953; local sales totaled 13,463 in 1954, compared with 8,950 tons in 1953.[73]

[72] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 49.
[73] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, p. 35.

Cobalt

By Hubert W. Davis[1] and Charlotte R. Buck[2]

SUPPLY of cobalt in 1955 exceeded requirements despite an increase in world and United States consumption and larger deliveries to the National Stockpile. Chief sources of cobalt were certain copper and nickel ores from which it was recovered as byproducts and coproducts.

For the sixth successive year world production (exclusive of U. S. S. R.) established a new high. Output was 14,600 short tons, a gain of nearly 1 percent over 1954. Of this, Belgian Congo furnished 65 percent, producing at a rate slightly less than in 1954. Domestic production of cobalt in concentrate increased 31 percent to 2.6 million pounds. Production of cobalt products from domestic concentrate was 1.9 million pounds and was equivalent to 20 percent of the contained cobalt in products consumed in 1955.

Consumption of cobalt in the United States in 1955, the fourth largest of record, rose to 9.7 million pounds of contained cobalt (in all forms), of which 74 percent was consumed as metal; total consumption represented an increase of 33 percent over 1954. Deliveries to the National Stockpile were 7 percent more than in 1954. Increase in consumption resulted principally from larger usage of cobalt metal in high-temperature alloys and permanent-magnet alloys.

Imports, mainly in the form of metal, white alloy, and oxide, rose to a new high of 18.7 million pounds of contained cobalt, an increase of 11 percent over 1954. Belgian Congo and Belgium supplied 86 percent of the metal; Belgian Congo furnished all the imports of white alloy and Belgium nearly all the oxide.

Products from processing plants in the United States in 1955 amounted to 5,165,500 pounds of contained cobalt, an increase of 29 percent over 1954. Cobalt metal composed about 69 percent of the production and represented a 27-percent increase over 1954. Raw materials for metal production were domestic concentrate and white alloy from Belgian Congo. The new cobalt-recovery unit at Sherritt Gordon Mines, Ltd., Fort Saskatchewan, Alberta, Canada, began operating, and the refinery of Calera Mining Co. at Garfield, Utah, attained near-capacity production.

Estimated world (exclusive of U. S. S. R.) annual capacity of completed refineries, as of December 31, 1955, was about 21,000 short tons; annual capacity of present refining facilities undergoing expansion, plus refineries under construction and planned, totals about 6,000 tons. Thus, by the end of 1960, when the present Government stockpile objective may be fulfilled, the annual production capacity will be about 27,000 tons. Hence, barring full mobilization and a setback in the prosperity of the copper and nickel industries, from which cobalt issues as a byproduct, it was believed the supply of

[1] Commodity specialist.
[2] Statistical clerk.

cobalt would exceed requirements by 1960, unless there is a large increase in its use. Foreseeing a large surplus of production, some producers undertook research to find new uses for cobalt and to expand its consumption in present uses.

DOMESTIC PRODUCTION

Mine Production.—The United States continued to be the largest consumer of cobalt in the world and to depend on foreign sources for the greater part of its requirements. However, a record 2.6 million pounds of cobalt was produced from domestic mines in 1955. Moreover, full-capacity operation anticipated at the refineries of the Calera Mining Co. and the National Lead Co., will increase domestic mine production to more than 5 million pounds of cobalt annually.

Production and shipments of cobalt ore or concentrate (cobalt content) in the United States in 1955 were 31 and 10 percent, respectively, greater than in 1954.

TABLE 1.—Cobalt ore or concentrate produced and shipped in the United States, 1946–50 (average) and 1951–55 [1]

Year	Produced		Shipped from mines	
	Gross weight (short tons)	Cobalt content (pounds)	Gross weight (short tons)	Cobalt content (pounds)
1946–50 (average)	22,390	636,424	21,999	619,599
1951	28,485	902,629	26,564	755,631
1952	21,159	1,363,251	24,551	836,372
1953	22,524	1,258,924	24,026	1,775,489
1954	19,036	1,996,488	19,738	2,219,396
1955	28,398	2,608,660	25,101	2,438,546

[1] Figures, by years, for 1933–50 are given in Cobalt chapter of Minerals Yearbook, 1952, vol. I.

The Calera Mining Co., a wholly owned subsidiary of the Howe Sound Co., was again the chief producer of cobalt concentrate in the United States; its production was 18 percent more than in 1954. Its Blackbird mine and concentrator at Cobalt, Lemhi County, Idaho, were operated at varying capacities, the output depending on the rate of concentrate consumption at the refinery. Late in 1955, however, production was increased to near the rated capacity of 1,000 tons of ore per operating day. The ore carries about 0.7 percent cobalt, about twice as much copper, and minor values of nickel and gold. Concentrate, averaging about 18 percent cobalt, was refined to metal at the company refinery, Garfield, Utah. During the year 1,616,300 pounds of cobalt metal was produced, compared with 631,400 pounds in 1954. The company continued to explore for cobalt at its Blackbird property with financial assistance provided by the Defense Minerals Exploration Administration (DMEA) under the Defense Production Act. Diamond drilling intersected cobalt-copper mineralization; three drill holes cut ore containing 1 to 2 percent cobalt and 3 to 4½ percent copper.

The Idaho Metallurgical Industries, Inc., also explored for cobalt in Lemhi County near Calera's operations with financial assistance provided by DMEA.

The Bethlehem Cornwall Corp. (formerly Bethlehem Steel Co.) produced 9 percent more cobalt in 1955 than in 1954. The cobalt-bearing material (averaging 1.40 percent in 1955) was obtained as a flotation sulfide concentrate from the company magnetite mined at Cornwall, Pa. The concentrate was shipped to the Pyrites Co., Wilmington, Del., where it was processed into metal and other cobalt products.

The Sullivan Mining Co., Kellogg, Idaho, continued to recover cobalt at its electrolytic zinc plant but, as in previous years, made no shipments. In 1955 it recovered 92 short tons of residues containing 6,900 pounds of cobalt.

The St. Louis Smelting & Refining Division of National Lead Co. began treating pyrite concentrate containing 4 percent cobalt, 5.4 percent nickel, and 4.5 percent copper, which was produced at its property near Fredericktown, Mo. At its new refinery, also at Fredericktown, tests were performed, development runs were made, and some cobalt metal was produced.

TABLE 2.—Cobalt products produced and shipped in the United States, 1949–53 (average) and 1954–55, in pounds

Product	Production		Shipments	
	Gross weight	Cobalt content	Gross weight	Cobalt content
1949–53 (average)				
Metal	2,118,729	2,078,607	2,065,517	2,027,913
Oxide	584,933	418,959	576,165	412,796
Hydrate	285,563	115,653	282,482	114,627
Salts:				
Acetate	141,697	33,170	143,518	33,574
Carbonate	158,670	72,615	162,106	74,295
Sulfate	651,747	138,636	648,517	137,461
Other	127,764	28,910	123,413	28,243
Driers	9,315,488	569,397	9,188,566	558,388
1954				
Metal	2,870,381	2,805,258	2,311,780	2,254,364
Oxide	460,045	328,012	465,459	332,392
Hydrate	347,036	182,725	342,005	178,186
Salts:				
Acetate	127,522	29,729	104,057	24,260
Carbonate	177,579	83,422	171,796	80,973
Sulfate	637,972	134,724	648,108	136,658
Other	179,393	40,389	164,832	37,451
Driers	6,790,751	411,453	7,067,872	433,728
1955				
Metal	3,655,389	3,549,319	4,487,971	4,363,843
Oxide	610,120	438,711	634,154	455,301
Hydrate	322,995	169,712	344,726	180,097
Salts:				
Acetate	73,604	17,153	76,529	17,834
Carbonate	380,589	190,462	320,037	157,049
Sulfate	676,411	143,667	659,305	140,010
Other	313,590	68,493	304,961	66,460
Driers	9,791,821	588,027	9,710,882	582,737

Refinery Production.—Despite the fact that the United States is a small producer of cobalt ore, it is an important producer of cobalt products. Production of metal was 27 percent greater than in 1954 and the largest since 1945. The metal was produced from white alloy from Belgian Congo and concentrates from Idaho, Missouri, and Pennsylvania. Production of oxide was 34 percent greater than in 1954. The oxide was produced from white alloy from Belgian Congo, concentrate from Pennsylvania, metal from various sources, and domestic scrap. Production of hydrate was 7 percent less than in 1954. The hydrate was produced chiefly from scrap, but some metal and concentrate were also used. Production of salts and driers was 46 and 43 percent, respectively, greater than in 1954. The salts and driers were made chiefly from cobalt fines, metal, purchased hydrate, purchased sulfate, and scrap. Consumption of cobalt contained in white alloy and concentrate by refiners was 24 percent more than in 1954.

A list of cobalt refiners or processors in the United States is given in the Cobalt chapter of this series for 1954.

TABLE 3.—Cobalt consumed by refiners or processors in the United States, 1946–50 (average) and 1951–55, in pounds of contained cobalt

Cobalt material [1]	1946–50 (average)	1951	1952	1953	1954	1955
Alloy and ore	2,506,330	2,857,328	3,002,087	4,059,287	3,950,826	4,879,608
Metal	663,755	717,636	643,108	801,192	592,257	884,196
Hydrate	128,322	81,710	79,733	74,504	56,717	79,339
Carbonate	9,473	6,841	292	108	100	305
Purchased scrap } Other	13,165	48,549	53,081	109,204	172,757	114,181
Other				8,540	57,284	63,123

[1] Total consumption is not shown, since the metal, hydrate, and carbonate originated from alloy and ore; combining alloy and ore with these materials would result in duplication.

CONSUMPTION

Consumption of cobalt by industrial consumers in 1955 was the fourth highest of record and 33 percent more than in 1954. For the fifth consecutive year the largest single use for cobalt was for cobalt-chromium-tungsten-molybdenum alloys, which represented 35 percent of the total quantity consumed in 1955 and utilized 24 percent more than in 1954.

As in the past 4 years, magnet-alloys production was the second largest user of cobalt and consumed 29 percent of the total in 1955; moreover, consumption for this purpose was 33 percent more than in 1954. Consumption for this purpose was the second largest of record and only 2 percent less than in 1950, the record year.

More cobalt was also used for high-speed and low-cobalt alloy steels, alloy hard-facing rods, cemented carbides, ground-coat frit for porcelain enamel, and pigments.

Consumption of cobalt metal and oxide in 1955 was 41 and 54 percent, respectively, greater than in 1954, but 35 percent less cobalt scrap was used. Cobalt salts and driers were utilized at a rate about 28 percent greater than in 1954.

TABLE 4.—Cobalt consumed in the United States, 1946–50 (average) and 1951–55, by uses, in pounds of contained cobalt

Use	1946–50 (average)	1951	1952	1953	1954	1955
Metallic:						
High-speed steel	251, 062	316, 064	223, 203	217, 652	168, 893	208, 720
Other steel	167, 599	79, 885	115, 761	162, 185	112, 323	151, 030
Permanent-magnet alloys	1. 588, 307 (Permanent-magnet and soft-magnetic alloys)	2, 052, 042	1, 664, 842	2, 336, 889	2, 123, 576	2, 818, 239
Soft-magnetic alloys		58, 652	18, 727	11, 559	721	204
Cobalt-chromium-tungsten-molybdenum alloys:						
Cutting and wear-resisting materials	1, 225, 696 (Cutting and high-temperature)	4, 899, 591 (Cutting and high-temperature)	6, 408, 537 (Cutting and high-temperature)	204, 939	182, 641	194, 253
High-temperature high-strength materials				5, 116, 750	2, 571, 089	3, 220, 939
Alloy hard-facing rods and materials	117, 014	575, 268	505, 367	591, 909	432, 342	535, 488
Cemented carbides	87, 558	297, 751	610, 750	359, 125	166, 708	307, 366
Other metallic	124, 327	276, 222	132, 917	233, 428	113, 522	291, 191
Total metallic	3, 561, 563	8, 555, 475	9, 680, 104	9, 234, 436	5, 871, 815	7, 727, 430
Nonmetallic (exclusive of salts and driers):						
Ground-coat frit	548, 247	448, 983	309, 167	374, 158	403, 953	567, 645
Pigments	212, 472	50, 073	85, 262	102, 612	145, 769	235, 866
Other nonmetallic	57, 179	60, 462	42, 960	84, 293	75, 686	115, 581
Total nonmetallic	817, 898	559, 518	437, 389	561, 063	625, 408	919, 092
Salts and driers: Lacquers, varnishes, paints, inks, pigments, enamels, glazes, feed, electroplating, etc. (estimate)	873, 400	818, 000	701, 000	953, 000	853, 000	1, 094, 000
Grand total	5, 252, 861	9, 932, 993	10, 818, 493	10, 748, 499	7, 350, 223	9, 740, 522

TABLE 5.—Cobalt consumed in the United States, 1946–50 (average) and 1951–55, by forms in which used, in pounds of contained cobalt

Form	1946–50 (average)	1951	1952	1953	1954	1955
Metal	3, 572, 152	7, 534, 864	8, 328, 552	7, 727, 210	5, 119, 853	7, 226, 383
Oxide	745, 166	680, 452	418, 211	524, 401	587, 799	906, 265
Cobalt-nickel compound	25, 035	1, 786	----	----	----	----
Ore and alloy	2, 247	3, 438	2, 736	2, 451	301	68
Purchased scrap	34, 861	894, 453	1, 367, 994	1, 541, 437	789, 270	513, 806
Salts and driers	873, 400	818, 000	701, 000	953, 000	853, 000	1, 094, 000
Total	5, 252, 861	9, 932, 993	10, 818, 493	10, 748, 499	7, 350, 223	9, 740, 522

PRICES

Since November 1, 1953, prices of cobalt metal and cobalt oxide have remained unchanged. Metal rondelles (97–99 percent, in containers of 500 pounds) and metal granules (in containers of 2,152 pounds) were quoted at $2.60 a pound f. o. b. Niagara Falls or New York, N. Y., and ceramic-grade oxide (72½–73½ percent, in 350-pound containers) was $1.96 a pound east of the Mississippi River.

FOREIGN TRADE [3]

Imports.—Imports of cobalt into the United States established a new high of 18.7 million pounds (cobalt content) in 1955 and were 11 percent greater than in 1954 and 9 percent larger than in 1953, the

[3] Figures on U. S. imports and exports (unless otherwise indicated) compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

previous record year. Belgian Congo continued to be the chief source; in 1955 it supplied 67 percent of the total imports. Belgium supplied 21 percent; 87 percent of the metal and oxide was produced from Belgian Congo alloy. Imports from Belgian Congo, Belgium, and Canada were greater by 9, 40, and 11 percent, respectively. However, imports from Norway and West Germany were smaller by 22 and 32 percent, respectively. Imports of oxide were 2.5 times greater than in 1954.

TABLE 6.—Cobalt imported for consumption in the United States, 1946–50 (average) and 1951–55, by classes

[U. S. Department of Commerce]

Year	White alloy [1] (pounds)		Ore and concentrate [2]		
			Pounds		Value
	Gross weight	Cobalt content	Gross weight	Cobalt content	
1946–50 (average)	3, 589, 920	1, 597, 580	[3] 559, 193	[3] 62, 187	[3] $47, 926
1951	4, 083, 541	1, 904, 429	[4] 537, 309	40, 303	[4] 54, 015
1952	6, 113, 102	2, 841, 210	215, 572	17, 384	2, 281
1953	5, 249, 781	2, 412, 804	445, 063	51, 323	88, 470
1954	5, 464, 511	2, 360, 360	27, 130	3, 349	5, 914
1955	5, 645, 894	2, 464, 336	2, 233	223	289

Year	Metal		Oxide		Sulfate and other compounds	
	Pounds	Value	Pounds (gross weight)	Value	Pounds (gross weight)	Value
1946–50 (average)	[5] 5, 106, 492	[5] $7, 744, 764	[5] 776, 410	[5] $885, 426	1, 452	$2, 848
1951	[5] 8, 119, 326	16, 302, 356	436, 517	603, 855	3, 157	4, 048
1952	[5] 12, 014, 920	[5] 27, 291, 006	386, 935	620, 955	13, 009	11, 380
1953	[5] 14, 431, 894	[5] 33, 203, 094	610, 054	979, 541	273, 286	172, 986
1954	14, 227, 868	35, 391, 209	430, 400	723, 368	353, 094	211, 240
1955	15, 535, 040	38, 585, 251	1, 072, 950	1, 791, 939	361, 600	249, 409

[1] Reported by importer to Bureau of Mines. Figures for 1946–48 as reported by U. S. Department of Commerce cover only partial imports of "White alloy," which were classed as "Ore and concentrates." Figures for "Ore and concentrates" for 1949–55 as reported by U. S. Department of Commerce have been adjusted by Bureau of Mines to exclude "White alloy" from Belgian Congo.
[2] Figures represent imports from Canada, French Morocco, and Mexico and therefore exclude receipts of "White alloy" from Belgian Congo.
[3] Excludes 7,054,000 pounds of ore containing 742,000 pounds of cobalt, valued at $551,500, imported from Canada in 1948; see footnote 2, table 8.
[4] Includes 146 pounds of zaffer, valued at $215.
[5] Adjusted by Bureau of Mines.

During the 33 years 1923–55, imports of cobalt into the United States totaled 156,353,000 pounds (cobalt content), of which 74 percent was imported in the 10 years 1946–55. During the 33 years, receipts of metal comprised 65 percent of the cobalt imports, mostly supplied by Belgium and Belgian Congo. Smaller quantities of metal have been received from Austria, Canada, Finland, France, Germany, Japan, Federation of Rhodesia and Nyasaland, Norway, Sweden, and United Kingdom. Imports of alloy represented the second largest quantity (27 percent); virtually all was from Belgian Congo. About 7 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 Canada and Germany and smaller quantities from other countries, principally Australia, Finland, and France. Cobalt ore has been about 1 percent of the total imports; Canada has been the largest source, and most of the remainder came from Australia. Substantial quantities of ore were imported from French Morocco in 1943–44 and Canada in 1948; however, these ores were not treated in the United States, and subsequently the French Morocco ore was exported to Belgium in 1952–53 and the Canadian ore returned to Canada in 1952 for refining to metal. As the quantities are included in the imports of metal, the figures for ore have been excluded from the tabulation of imports to avoid duplication. Cobalt sulfate and other compounds have been only 0.3 percent of the total imports.

TABLE 7.—Cobalt white alloy, ore, metal, and oxide imported for consumption in the United States, 1954–55, by countries, in pounds

[U. S. Department of Commerce]

Country	White alloy, ore and concentrates				Metal		Oxide (gross weight)	
	1954		1955					
	Gross weight	Cobalt content	Gross weight	Cobalt content	1954	1955	1954	1955
North America: Canada	27,130	3,349			1,219,628	1,347,442		
Total	27,130	3,349			1,219,628	1,347,442		
Europe:								
Belgium					2,515,225	3,164,098	422,300	1,071,350
France					473	2,535		
Germany, West					918,311	606,863	8,100	1,600
Norway					322,113	250,271		
Total					3,756,122	4,023,767	430,400	1,072,950
Africa:								
Belgian Congo	[1] 5,464,511	[1] 2,360,360	[1] 5,645,894	[1] 2,464,336	9,215,438	10,163,831		
Morocco, French			2,233	223				
Rhodesia and Nyasaland, Federation of					36,680			
Total	5,464,511	2,360,360	5,648,127	2,464,559	9,252,118	10,163,831		
Grand total	5,491,641	2,363,709	5,648,127	2,464,559	14,227,868	15,535,040	430,400	1,072,950

[1] Reported by importer to Bureau of Mines.

TABLE 8.—Cobalt imported for consumption in the United States, 1946–50 (average) and 1951–55, in pounds [1]

Year	Gross weight					Total	
	White alloy	Ore and concentrate	Metal	Oxide	Sulfate and other compounds	Gross weight	Cobalt content estimated
1946–50 (average)	3,589,920	[2] 559,193	5,106,492	776,410	1,452	[2] 10,033,467	[2] 7,257,800
1951	4,083,541	[3] 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	13,009	18,743,538	15,031,000
1953	5,249,781	445,063	14,431,894	610,054	273,286	21,010,078	17,237,000
1954	5,464,511	27,130	14,227,868	430,400	353,094	20,503,003	16,865,000
1955	5,645,894	2,233	15,535,040	1,072,950	361,600	22,617,717	18,732,000

[1] Figures, by years, for 1923-50 in chapter on Cobalt, Minerals Yearbook, 1953, vol. I, p. 359.
[2] Excludes 7,054,000 pounds of ore containing 742,000 pounds of cobalt imported from Canada in 1948. This ore was reexported to Canada in 1952 for refining. The metal produced from the ore is included in the import figures for 1952–54.
[3] Includes 146 pounds of zaffer.

Exports.—Exports of cobalt from the United States are usually small, but since 1953 large quantities of cobalt-bearing scrap have been shipped abroad. In 1955, 3,823,000 pounds of metal, alloys, and cobalt-bearing scrap valued at $1,231,000 were exported. The bulk of the exports was cobalt-bearing scrap. Some oxide, salts, and driers were also exported, but the figures were 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. On September 10, 1955, the duty on salts and compounds was lowered to 15 percent ad valorem. Cobalt metal and ore enter the United States duty-free.

TECHNOLOGY

At the operations of the Rhokana Corp. at Nkana, Federation of Rhodesia and Nyasaland, intensive research was directed toward better separation of copper and cobalt and improving the grade of cobalt concentrate. The grade of cobalt concentrate has been affected by the flotation of increasing quantities of micaceous gangue in the ore from the South Orebody. Two additional roasters were being built to provide the extra capacity required to deal with the lower grade concentrate.

Concerning the cobalt refinery of the Calera Mining Co. at Garfield, Utah, the Howe Sound Co. reports as follows:[4]

The plant which had been operated and managed by Chemical Construction Corp. (Chemico) since February 15, 1954, was returned to Company operation on December 8, 1955.

During November Chemico successfully completed the demonstration and test required under the contract. Reimbursements to them for capital expenditures made under their management was required only if they could demonstrate that the plant could produce a minimum of 8,000 pounds of cobalt per day, representing a recovery of at least 90 percent of the cobalt in the concentrates tested and a bare-bone operating cost of not over 65¢ per pound of cobalt produced. For most of the year before completion of the test, production at the refinery was substantially below capacity due to delays in obtaining and installing essential equipment.

An inspection of the plant by Company engineers late in November disclosed that the brick lining of the large oxidation autoclave was badly worn and that this vessel could not be operated safely until a new lining was installed. The Company accepted the plant in this condition after a mutually satisfactory financial settlement was made with Chemico.

Using a smaller autoclave, which had been installed for standby insurance, the plant was operated at more than 50 percent capacity from December 8, 1955, to February 15, 1956, when the larger unit was returned to service.

While all the problems due to corrosion have not been solved, great progress has been made and management now believes that the refinery will be operated at a reasonably satisfactory level of output and cost in the future. Extensive engineering research will continue.

During the year a laboratory study was made of the possibility of producing high purity electrolytic cobalt. This work was encouraging and a pilot plant is being installed at the refinery which will allow a continued study of the process on a scale large enough to determine its commercial and technical possibilities in comparison with the reduction method presently in use.

[4] Howe Sound Co., Annual Report, 1955: Pp. 4–5.

The Calera refinery is described [5] briefly as follows:

Feed to the plant is a cobaltite concentrate which assays 17 to 19 percent cobalt, 25 percent arsenic, 30 to 32 percent sulfur, 19 to 20 percent iron, and some silica and nickel. The concentrate is slurried with water and pumped into the head end of a horizontal, brick-lined autoclave, which is divided into six compartments, each equipped with a mechanical agitator to keep the concentrate in suspension.

The autoclave is sized to allow a residence time of 3 hours and maintained at a pressure of about 600 p. s. i. and a temperature within the range of 300° to 400° F. Compressed air fed to the autoclave oxidizes the sulfur in the concentrate to form H_2SO_4, the leaching agent for the cobalt and nickel values. When the concentrate reaches the sixth compartment, it is discharged through a special valve to a flash tank. Steam and other gases, mainly nitrogen, are also discharged through a letdown valve to maintain the desired pressure. From the flash tank the pulp goes to filters, the cake being discarded; and the filtrate, containing cobalt and nickel sulfates, is purified and neutralized with ammonia before reduction.

Reduction is a batch operation in a number of agitated autoclaves and is accomplished at elevated pressure and temperature by hydrogen, produced from propane at the property in a small gas reform unit.

Metal is reduced from the solution as a fine powder, which contains both cobalt and nickel. No attempt is made to separate the two metals, as the alloy produced is acceptable, after the powder is melted to produce rondelles.

The process for recovering cobalt from the nickel-copper concentrate from the Lynn Lake (Manitoba) concentrator of Sherritt Gordon Mines, Ltd., is described [6] as follows:

A novel process is used to separate the valuable metals. The concentrate [12–14 percent Ni, 0.3–0.4 percent Co, 1–2 percent Cu, and 28–34 percent S] is leached [with ammonia and water] in two stages at a temperature between 150° F. and 220° F. and under a pressure of less than 125 pounds per square inch. The leached solids are filtered and sent to waste.

The pregnant liquor from the leaching operation is boiled in a still to remove some of the excess ammonia and with the resultant effect of precipitating the copper as a sulphide.

The remaining liquor is then heated under pressure in the presence of air. Precipitation of the nickel then takes place by agitating the liquor with hydrogen in high pressure autoclaves. The nickel salts react with hydrogen more readily than do cobalt salts. The nickel is removed from the circuit as small particles of from 50 to 80 microns in diameter.

The remaining solution which contains about 95 percent of the cobalt is treated with H_2S to precipitate the cobalt and the rest of the nickel. The cobalt-nickel precipitate is leached with NH_3 and air, the cobalt is removed and reduced with hydrogen under pressure to metallic cobalt powder. The residual nickel is returned to the nickel circuit for further treatment and recovery.

The final solution is evaporated to produce ammonium sulphate.

Between 50 and 75 percent of the cobalt is recovered by the process. The cobalt powder runs 99.6 percent cobalt with 0.15 percent nickel and 0.20 percent iron.

---

[5] Talbot, H. L., Chemical Metallurgy Solves Low-Grade Complex Ore Problems: Eng. and Min. Jour., vol. 156, No. 3a, Mid-March 1955, pp. 52–53.

[6] Jones, R. J., Cobalt in Canada: Canada Dept. of Mines and Tech. Surveys, Mines Branch Rept. 847, Ottawa, 1954, p. 45.

Patents were issued for the separation of nickel and cobalt [7] and for cobalt-base alloys.[8]

A new super alloy (Jetalloy 1570) of the nickel-chromium-cobalt type, which retains high strength for extended periods of time at temperatures above 1,500° F. and can be readily forged, was described.[9]

A method of producing cobalt granules from cobalt powder was described.[10]

WORLD REVIEW

Virtually all cobalt is found associated with other metals, such as copper, nickel, iron, arsenic, lead, zinc, manganese, silver, and gold; it seldom occurs in large enough quantity to be mined for itself alone. Belgian Congo and Federation of Rhodesia and Nyasaland, where cobalt is associated with copper; French Morocco, where it occurs with nickel, gold, and silver; Canada, where it is associated chiefly with nickel, copper, and silver; and the United States, where it occurs chiefly with iron, copper, and nickel, have been the chief producing countries for many years. Some cobalt production is derived from pyrites residues, but a complete record of such output is lacking.

TABLE 9.—World mine production of cobalt, by countries,[1] 1946–50 (average) and 1951–55, in short tons of contained cobalt

(Compiled by Berenice B. Mitchell)

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada [2]	340	476	711	801	1,091	1,500
Mexico (content of ore)		[3] 2	[3] 9		([4])	
United States (shipments) (content of concentrate)	310	378	418	888	1,110	1,219
Total	650	856	1,138	1,689	2,201	2,719
Asia: Japan (content of concentrate)	3					
Africa:						
Belgian Congo (recoverable cobalt)	4,318	6,300	7,530	9,125	[5] 9,490	9,443
Morocco, French (content of concentrate)	275	750	1,100	661	811	834
Rhodesia and Nyasaland, Federation of [6] (content of white alloy, cathode metal, and ferrocobalt): Northern Rhodesia	532	747	645	746	1,264	871
Total	5,125	7,797	9,275	10,532	11,565	11,148
Oceania: Australia (recoverable cobalt)	10	9	12	12	12	12
Grand total (estimate)[1]	6,100	9,300	10,900	12,700	14,300	14,600

[1] The world total includes an estimate of cobalt recovered from pyrites produced in Finland and other European countries.
[2] Figures comprise cobalt content of Canadian ore processed in Canada and exported (irrespective of year when mined), plus the cobalt recovered from nickel-copper ores at Port Colborne, Ontario; and Kristiansand, Norway; consequently, the figures exclude the cobalt recovered at Clydach, Wales, from Canadian nickel-copper ores, for which estimate by senior author of chapter has been included in the world total.
[3] Imports into United States.
[4] Less than 0.5 ton.
[5] Revised figure.
[6] Year ended June 30 of year stated.

[7] Van Hare, G. F., Jr., and McCormick, W. R., Jr. (assigned to Chemical Construction Corp.), Separation of Nickel and Cobalt: U. S. Patent 2,728,636, Dec. 27, 1955.
[8] Harris, G. T., and Child, H. C. (assigned to William Jessop & Sons, Ltd.), Cobalt-Base Alloys: U. S. Patent 2,713,537, July 19, 1955.
Payson, Peter (assigned to Crucible Steel Co. of America), High-Temperature High-Strength Alloys: U. S. Patent 2,704,250, Mar. 15, 1955.
[9] Guard R. W., and Prater, T. A.. New Super Alloy Speeds Jet Progress: Iron Age, vol. 176, No. 16, Oct. 20, 1955, pp. 116–118.
[10] Marchant, J. D., Banning, L. H., and Hergert, W. F., Melting, Refining, and Granulation of Cobalt Powder: Bureau of Mines Rept. of Investigations 5133, 1955, 14 pp.

NORTH AMERICA

Canada.—In Canada cobalt production was derived from the cobalt-silver ores in the Cobalt-Gowganda area of northern Ontario; as a byproduct of the nickel-copper ores of the Sudbury district, Ontario, and Lynn Lake area, Manitoba; and as a residue from the Port Hope uranium refinery at Port Radium, Northwest Territories.

According to the Dominion Bureau of Statistics, production of cobalt (content) was 3 million pounds in 1955, compared with 2,182,-000 pounds in 1954. These figures, however, do not include the cobalt recovered by the Mond Nickel Co. at its Clydach (Wales) nickel refinery from nickel matte produced from the nickel-copper ores of the Sudbury district.

Since 1947 the International Nickel Co. of Canada, Ltd., has recovered an impure cobalt oxide from the electrolytic unit at its nickel refinery at Port Colborne, Ontario; and in October 1954 it began commercial production of electrolytic cobalt metal, also at Port Colborne. The cobalt is contained in nickel-copper ores of the Inco Sudbury district mines. In 1955 some of the cobalt oxide was shipped to Clydach (Wales) for the production of high-grade cobalt oxides, hydrate, and salts, which were sold to consumers in the United Kingdom and many other foreign countries; much of it, however, was reduced to metal, which was sold chiefly in the United States. Deliveries of cobalt were the highest for any year in company history; they were 1,637,400 pounds in 1955 compared with 1,317,100 in 1954 and 906,500 in 1953.

A new pilot plant and cobalt-recovery unit of the Sherritt Gordon Mines, Ltd., at Fort Saskatchewan, Alberta, were put into operation at the end of June 1955. It recovers the cobalt contained in the nickel-copper concentrate produced by the company at Lynn Lake, Manitoba.

Falconbridge Nickel Mines, Ltd., produced 21 percent more electrolytic cobalt at its refinery at Kristiansand, Norway, than in 1954. An additional cobalt-precipitation section was being installed at year end. The cobalt was recovered from the matte produced from Sudbury nickel-copper ores.

The smelter of Deloro Smelting & Refining Co., Ltd., Deloro, Ontario, was operated on arsenical cobalt-silver concentrates from the Cobalt-Gowganda area and residue from the Northwest Territories for its own account and on Canadian concentrates for the account of the United States Government.

Operation of the smelter of Cobalt Chemicals, Ltd., at Cobalt, Ontario, was suspended during the fourth quarter 1954, because the present process was found to be uneconomic.[11]

EUROPE

Finland.—The cupriferous pyrite of the Outokumpu mine in eastern Finland contains about 0.2 percent cobalt, 3 percent copper, 25 percent iron, 27 percent sulfur, and 1.2 percent zinc. Sinter produced by roasting pyrite concentrate to remove the sulfur was shipped to Duisburg, Germany, for recovery of cobalt, copper, iron, and zinc. The cobalt content of the sinter averaged 0.4 to 0.5 percent.

[11] Metal Bulletin (London), No. 3967, Feb. 8, 1955, p. 20.

Germany, West.—No cobalt ore was mined in West Germany in 1955, and its two refineries depended on foreign sources for their raw materials. The refinery of Duisburger Kupferhütte at Duisburg, which was the larger producer of cobalt, recovered it from pyrite sinter obtained from Finland, Spain, Norway, Sweden, and other countries. The refinery of Gebrüder Borchers A. G. at Goslar treated chiefly cobalt-bearing scrap from the United States.

TABLE 10.—Production of cobalt in West Germany, 1948–55

Year	Short tons	Year	Short tons
1948	18	1952	500
1949	121	1953	642
1950	331	1954	951
1951	491	1955	986

AFRICA

Belgian Congo.—The 8-year uptrend in production of cobalt in Belgian Congo was halted in 1955, when output was 9,400 short tons, an 0.5-percent decrease from 1954, the record year. The Union Minière du Haut-Katanga continued to be the sole producer, and the Belgian Congo continued to be the world's premier source of cobalt.

At the Jadotville–Panda plant two single-phase, 700-kv.-a. furnaces were reconstructed to form one 3-phase, 2,000 kv.-a. furnace. The Jadotville–Shituru plant produced granules containing about 99.5 percent cobalt, and the Jadotville–Panda plant produced a white alloy containing about 43 percent cobalt, which was shipped to Belgium and the United States for refining.

French Morocco.—Production of cobalt concentrate in French Morocco was 8,344 short tons containing 834 tons of cobalt in 1955 compared with 8,113 short tons containing 811 tons in 1954. La Société Minière de Bou-Azzer et du Graara, Casablanca, was the sole producer. Exports of cobalt concentrate were 8,089 tons in 1955, of which 5,838 tons went to France, 2,228 tons to Belgium, 22 tons to West Germany, and 1 ton to the United States. The concentrate shipped to Belgium was refined to metal by the Société Générale Métallurgique de Hoboken at Oolen, Belgium, for the United States Government.

Rhodesia and Nyasaland, Federation of.—The Federation of Rhodesia and Nyasaland, which regained second place as a producer of cobalt in 1954, dropped to fourth place in 1955. Output, which declined 31 percent, was adversely affected, chiefly by a strike (January 3–March 2) of African employees and by the lower grade of concentrates roasted, which contained 2.71 percent cobalt compared with 3.22 percent in 1954. The Rhokana Corp., which has been producing cobalt since 1933, continued to be the only producer of finished cobalt. In the year ended June 30, 1955, production comprised 533 short tons of cathode metal, 355 tons of carbonate containing 140 tons of cobalt, 25 tons of ferrocobalt containing 11 tons of cobalt, 2 tons of cobalt in electrolytic sludge, and 503 tons of alloy containing 185 tons of cobalt. Thus, the total production of cobalt in various forms was 871 tons in 1955 compared with 1,264 tons in 1954. The overall recovery of cobalt from concentrate to salable products was 45.43 percent in 1955 compared with 46.16 percent in 1954.

The grade of ore treated was 0.152 percent cobalt in 1955 compared with 0.154 percent in 1954. Concentrate produced contained 1.38 percent cobalt in 1955 compared with 1.48 percent in 1954.

The Chibuluma Mines, Ltd., began production of copper–cobalt ore at its mine near Nkana, Northern Rhodesia, in October. Ore was to be stockpiled until the new flotation concentrator is placed in operation early in 1956. The cobalt concentrate will be treated in a plant near Ndola. Production of 500,000 pounds of cobalt annually was expected when full operation is attained.

Uganda.—The construction program of Kilembe Mines, Ltd., in western Uganda, was reported[12] to be proceeding on schedule with operation to begin in 1956, as planned. The hydroelectric plant was to be ready in April, the concentrator in May, the roasting plant in June, and the smelter in August. The 250-mile railroad, which will connect the smelter at Jinja with the mine, was expected to be completed in 1956. Initial rate of production will be 16,369,000 pounds of copper and 1,104,000 pounds of cobalt.

[12] Mining World, vol. 17, No. 11, October 1955, p. 80.

Columbium and Tantalum

By Kenneth B. Higbie[1]

COLUMBIUM (niobium) and tantalum minerals were in adequate supply in 1955. Since 1951, high prices paid by the United States Government through the columbium-tantalum mineral-purchase program provided the incentive for discovery of extensive new mineral resources, all in foreign lands, and their subsequent development and exploitation for producing valuable minerals. The overwhelming success of this program was evidenced in 1955 in world production of over 11 million pounds of concentrate, almost 5 times the 2.4 million pounds produced in 1950.

The success of the United States purchase program was indicated also by the fact that the Government stopped buying columbium and tantalum concentrates in May 1955, when the quantity of concentrate received, plus forward commitments to buy, equaled the 15 million pounds of contained combined columbium and tantalum pentoxides authorized for purchasing. This came about 18 months before the official closing date, December 1956. In July, General Services Administration (GSA) announced an 18-percent cutback on its outstanding foreign orders for columbium-tantalum ores to make sure it would not unduly exceed its purchase quota of 15 million pounds of contained combined columbium and tantalum pentoxides. The cutbacks were across-the-board percentages and applied to undelivered outstanding purchase orders. The effect of the termination of the program upon the world market was varied. Most countries maintained a high rate of production to meet forward commitments on delivery dates throughout the remainder of the year. Prices for concentrate for open-market consumption were not quoted during a 3-month period, pending the decision of how firm a price the world market would accept. Year-end prices were less than one-half of the standard program price.

The Government program was less successful in developing domestic mineral production. No major commerical source of columbium or tantalum was found in the United States. A placer deposit containing euxenite with minor quantities of columbite was developed in Idaho. Known to exist before the Korean War, its actual commercial utilization was an indirect result of the purchase program. The final concentrate obtained did not satisfy the program specification requirements. During this period, however, extremely large columbium deposits containing pyrochlore, a mineral of the type $NaCaCb_2O_6F$, were discovered in neighboring Canada; although low grade (0.2 to 0.7 percent Cb_2O_5), the deposits contained many thousand tons of columbium.

Kennecott Copper Corp. and Molybdenum Corp. of America revealed plans to jointly develop a columbium- and tantalum-ore deposit at

[1] Commodity specialist.

Oka near Montreal, Quebec. The latter company either owned or had options on 7,100 acres in the area. The arrangement included an option on behalf of Kennecott to acquire a 51-percent interest in the Oka property. Other companies interested in the Canadian pyrochlores include Multi-Minerals, Ltd., with its Nemegosenda property 15 miles east of the village of Champleau, Ontario; Quebec Metallurgical Industries, Ottawa, investigating the Bugaboo group of placer deposits in southeastern British Columbia; Beaucage Mines, Ltd., whose deposits are at Lake Nipissing, Ontario; and Northwest Explorations, Ltd., with rights to mineral deposits east of Manson Creek, central British Columbia.

Private industry's program of columbium and tantalum research during 1955 was designed to develop methods for exploiting pyrochlore-type mineral deposits. Successful solution of research problems for concentrating and recovering columbium from these Canadian deposits would end United States dependence on seaborne imports of columbium. No private organization had announced any successful and economic plan for treating pyrochlores by the end of the year. Success was believed possible insofar as the same or similar minerals are at present recovered from Norwegian mineral deposits and chemically converted into useful columbium oxide products.

Other developments in the columbium-tantalum industry included Kennecott Copper Corp.'s purchase of the controlling 52-percent interest in one of the world's major producing columbium properties at Odegi on the Northern Nigerian Plateau, 300 miles inland. Formerly owned by a Nigerian company, Tin & Associated Minerals, Ltd., and second-ranking in the world, the mine produced approximately 600,000 pounds of columbite annually.

An initial million-dollar expansion of the tantalum-columbium industry, which appeared destined to grow to new record proportions, was announced by Fansteel Metallurgical Corp. late in the year. Mallinckrodt Chemical Works planned to build a plant for processing the euxenite concentrate from Porter Bros. Corp., Bear Valley, Idaho, placer deposits. It will recover columbium and tantalum oxides and uranium oxide for purchase by the Government. A new firm, Niobium Corp., Rego Park, N. Y., was formed to reclaim valuable and critical nonferrous metals, such as columbium, nickel, and cobalt.

DOMESTIC PRODUCTION

Mine Production.—The early termination of the Government purchase program resulted in a 60-percent decrease in domestic production of columbium- and tantalum-bearing minerals. Nevertheless, the quantity produced ranked third in the history of the industry. South Dakota remained the leading State, producing over 5,500 pounds, 22 percent of its 1954 total. Colorado production exceeded 4,000 pounds. Other States contributing, in order of decreasing total production, were New Hampshire, Arizona, Maine, New Mexico, and Connecticut.

No differentiation was made as to whether the concentrate recovered was columbite or tantalite. All domestically mined concentrate was sold to the purchase program under Amendment 1, authorizing unanalyzed small-lot purchases of less than 2,000 pounds, which Government agents had determined, by visual inspection, to contain at least

50-percent combined-oxides. On this basis the 12,954 pounds of concentrate produced was estimated to contain 2,260 pounds of columbium and 2,650 pounds of tantalum.

The principal domestic source of columbium found before 1955 was Porter Bros. Corp. placer deposit in Bear Valley, Valley County, Idaho, containing large quantities of euxenite and some columbite. Production of columbium and tantalum oxides from the mineral euxenite is unusual. Euxenite is a radioactive mineral containing mixed oxides of columbium, tantalum, uranium, thorium, rare-earth metals, titanium, and various less valuable elements. Concentrates produced from this area assay as follows: Columbium oxide 20–25 percent, tantalum oxide 2–5 percent, uranium oxide 6–10 percent, thorium oxide 1–2 percent, rare-earth oxides 18–22 percent, and titanium oxide 15–20 percent. Porter Bros. Corp. began recovering euxenite concentrates from the placer deposits very late in 1955. One dredge was in operation, but the corporation did not obtain enough rough concentrates for a final product from its mineral dressing mill at Loman, Idaho. Porter Bros. Corp. expected to be operating 2 dredges in 1956 and to produce over 1 million pounds of concentrates annually. Its contract with the Government requires production of 1,050,000 pounds of combined columbium-tantalum pentoxides by June 20, 1961.

TABLE 1.—Salient statistics of columbium-tantalum concentrate in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Columbium-tantalum concentrate shipped from mines......pounds..	1,871	925	5,385	14,867	32,829	12,954
Value	$4,410	$1,528	$16,723	$29,779	$57,262	$22,125
Imports for consumption:						
Columbium-mineral concentrate..........pounds..	2,101,161	1,536,773	1,878,135	4,186,080	6,804,076	9,612,576
Tantalum-mineral concentrate pounds..	275,077	238,445	328,866	759,409	981,872	1,907,686
World production of columbium-tantalum concentrate....pounds..	2,990,000	2,800,000	3,430,000	5,770,000	9,590,000	11,730,000

Refinery Production.—United States consumers of columbium-tantalum minerals and producers of primary columbium-tantalum metals, alloys, and compounds from the mineral concentrates were as follows:

Ferrocolumbium and ferrotantalum-columbium:
- Electro Metallurgical Corp., Division of Union Carbide Corp., Niagara Falls, N. Y.
- Kennametal, Inc., Latrobe, Pa.

Columbium and tantalum carbides: Kennametal, Inc., Latrobe, Pa.

Columbium and tantalum metal and metal shapes: Fansteel Metallurgical Corp., North Chicago, Ill.

Columbium and tantalum oxides:
- Kennametal, Inc., Latrobe, Pa.
- Fansteel Metallurgical Corp., North Chicago, Ill.

CONSUMPTION AND USES

Consumption of columbium- and tantalum-bearing minerals increased during 1955. Approximately 230 short tons of columbium and tantalum metal was recovered from columbite and tantalite ores, and an additional 350 short tons of metal was obtained from processing metal-bearing tin slags.

Order M-80 of the National Production Authority, originally issued in December 1951 to regulate the distribution and use of columbium-tantalum steels, was revoked November 1, 1953, but the use of columbium did not increase until 1955. Industry was convinced that the supply or availability of columbium- or tantalum-bearing minerals was no major problem. This conviction and the revocation of the order gave the industry a feeling of security resulting in increased application and consumption of these metals.

Pure columbium and tantalum metals are ductile and corrosion resistant. Their uses, however, have differed greatly. Columbium was employed primarily as an alloying metal for high-temperature applications; tantalum, for the most part, was utilized in its pure metallic state.

The primary use of columbium was in the formation of ferrocolumbium (about 60 percent Cb) and ferrotantalum-columbium (40 percent Cb+20 percent Ta) for manufacturing stabilized austenitic (chromium-nickel) stainless steels, type 347. Columbium and tantalum have greater affinity than chromium for carbon and will form carbides, leaving the uncombined chromium to resist corrosion. As a result, age hardening is reduced, and toughness, weldability, ductility, and corrosion resistance are increased.

Titanium probably was the most important substitute for columbium in steel, but still could not do all that columbium does for the steel and alloy. A comparison of the properties of columbium with titanium in the stabilization of stainless steel indicated that columbium imparts better intercrystalline corrosion-resistance properties than titanium. The acid-resistant characteristics of hardened stainless steel are high and virtually the same with and without columbium and titanium. However, annealed columbium steel is more acid resistant than titanium steel or ordinary stainless steel. Columbium imparts better weldability to the steel than titanium; the seam is denser, is more resistant to intercrystal corrosion, has four times greater resistance to nitric acid, and is more plastic.[3]

The second major use of columbium was for forming alloys resistant to high temperatures, such as those for the modern gas turbine of the aircraft industry. The alloy must furnish adequate service under severe conditions of stress, temperature, and thermal shock; for economic reasons it should contain a minimum of scarce and expensive metals. Columbium, combined with such other metals as chromium, vanadium, tungsten, molybdenum, nickel, cobalt, and iron in varying percentages, imparts superior creep resistance and fatigue strength to the final alloy metal.

Other uses were in titanium-columbium carbide for high-temperature electrodes for welding stainless steel, low-voltage rectifiers, and electronic tubes. Tantalum-columbium carbides were employed in cutting tools.

A small quantity of columbium metal was consumed in experimental work for atomic-energy applications, a large potential market. Columbium has a moderately low neutron-absorption characteristic.

[3] Samarin, A. M., and Yaskevich, A. A., [The Influence of Niobium and Titanium on the Properties of Stainless Steels]: Izevest. Akad. Nauk. (USSR), Otel. Tekh. Knaulk, No. 10, 1955, pp. 107-116; Chem. Abs. vol. 50, No. 5, Mar. 10, 1956, p. 3178i.

This fact, coupled with its chemical inertness and high strength, makes the metal a logical choice for use within a nuclear reactor. Because of the relatively high neutron-absorption characteristic of tantalum, any columbium metal used must first be free of tantalum impurities. The AEC was conducting a comprehensive investigation of the mechanical and corrosion behavior, especially at high temperatures, of pure columbium and many of its alloys.

Probably the most important use of tantalum was in the electrolytic capacitor field. A tantalum oxide film that forms on the surface of the metal provides a higher dielectric constant than any other known material. As a companion to the transistor, the capacitor, with its small size (many occupied less than one-tenth cubic inch of space), was destined to aid commercial development of miniature, light-weight electronic equipment. Another application of tantalum was in the electronics field as an anode and grid material to meet high-performance requirements for transmitting tubes that operate at extremely high temperatures and high voltage. Heated tantalum absorbs and retains stray gases in electronic tubes; thus, it helps to maintain the high vacuum necessary for good tube performance. The metal also acts as a rectifier. Tantalum rectifier units have been designed for service in railway-signal controls, telephone switchboards, and fire and burglar alarms.

Significant quantities of tantalum metal were consumed by the chemical and petroleum industries in such shapes and forms as heat exchangers, leach tanks, bayonet heaters, condensers, and other equipment, where resistance to chemical corrosion and good mechanical strength are required. Because of its resistance to body acids, tantalum was also employed in wire form for sutures, sheet and plate for cranial repairs, woven gauze for abdominal-wall reinforcement after certain types of surgery, and in dental plates.

PRICES

World prices of columbium-tantalum mineral concentrate as quoted in E&MJ Metal and Mineral Markets were controlled by the United States mineral purchase program through the week of May 19. Ore containing 50-percent combined oxide averaged $3.40 per pound. When the program closed the world price was immediately affected. A price was not quoted for columbite from the week of May 26 through the week of August 18; then the quotation was nominally set at $2.25 @ $2.50 per pound of contained pentoxides. During the week of September 22 the price declined further to $2.00 @ $2.25 and 1 week later to $1.75 @ $2.00. The final price of $1.35 @ $1.65 was adjusted during the week of December 8 and remained constant during the remainder of the year.

The price of ferrocolumbium per pound of contained columbium, 50–55 percent, was quoted in E&MJ Metal and Mineral Markets at $12.00 January through July 1, when it was reduced to $6.90. One week later it dropped to $6.80 and remained constant through September 22, when the quoted price returned to $6.90 and remained there for the rest of the year.

The price of ferrotantalum-columbium was $6.25 at the beginning of the year and dropped to $4.65 on July 1, when the prices of columbium-metal products became stable.

457676—58——25

Tantalum metal was quoted per kilogram, base price, $137 for rod and $93 for sheet throughout 1955 in E&MJ Metal and Mineral Markets. Columbium-metal power was quoted in American Metal Market at a nominal $75 per pound through March 23, when the price increased to $119.25; it remained at that rate for the rest of the year.

FOREIGN TRADE [3]

Imports.—Columbium-tantalum mineral imports in 1955 were the largest on record—more than four times the quantity imported annually before the Korean War. Tantalum minerals increased 94 percent and columbium minerals increased 43 percent over the 1954 figures. This rise was a direct result of the Government mineral-purchase program.

TABLE 2.—Columbium-mineral concentrate imported for consumption in the United States, 1946–50 (average) and 1951–55, by countries, in pounds

[U. S. Department of Commerce]

Country	1946–50 (average)	1951	1952	1953	1954	1955
South America:						
Argentina					11,023	10,800
Bolivia	[1] 1,367		14,678	10,375	5,714	
Brazil	6,838	6,377	5,017	34,391	124,460	233,012
British Guiana			800	2,324		7,033
Total	8,205	6,377	20,495	47,090	141,197	250,845
Europe:						
Belgium-Luxembourg [2]	5,425					
Germany, West					267,957	849,310
Norway				40,367	342,886	562,759
Portugal	421			68,121	148,732	168,362
Spain				4,410		2,525
Sweden				16,713		
United Kingdom [2]	240					
Total	6,086			129,611	759,575	1,582,956
Asia:						
Japan [2]	6,367					
Korea, Republic of				2,000		
Malaya			20,264	101,967	180,225	515,688
Total	6,367		20,264	103,967	180,225	515,688
Africa:						
Belgian Congo	143,200	177,273	354,732	580,232	976,832	1,247,901
British West Africa						14,521
Rhodesia and Nyasaland, Federation of				[3] 20,460	11,788	13,529
French Equatorial Africa						4,700
Madagascar					11,060	36,412
Mozambique	240	17,082	21,205	57,894	31,183	64,974
Nigeria	1,936,699	1,336,041	1,450,787	3,167,344	4,575,648	5,739,526
Uganda [4]			4,622	19,891	4,446	24,399
Union of South Africa	364		6,030	34,472	76,714	55,539
Total	2,080,503	1,530,396	1,837,376	3,880,293	5,687,671	7,201,501
Oceania: Australia				25,119	35,408	61,586
Grand total: Pounds	2,101,161	1,536,773	1,878,135	4,186,080	6,804,076	9,612,576
Value	$714,835	$1,362,393	$2,368,769	$6,890,914	$14,191,142	$19,852,356

[1] Classified by U. S. Department of Commerce as from Chile; some is believed to be the country of transshipment only.
[2] Presumably country of transshipment rather than original source.
[3] Southern Rhodesia.
[4] Classified by the U. S. Department of Commerce as British East Africa.

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

The weight of tantalum-mineral concentrate imported by the United States during 1955 was 1.9 million pounds, almost twice the weight imported during 1954. West Germany replaced Belgian Congo as the leading world exporter of tantalum minerals to the United States. West Germany produced the largest quantity of tantalum concentrate in its history. It supplied 31 percent of United States imports; Belgian Congo, 28 percent; Nigeria, 16 percent; and Brazil, 11 percent. Tantalum imports from Portugal fell sharply. Shipments were received from Norway for the first time.

The quantity of columbium concentrate imported also increased to a record high during 1955. A total of 9.6 million pounds was purchased compared with 6.8 million pounds during 1954. Nigeria, continuing as the principal source, supplied 60 percent of the total imports. Belgian Congo, the next ranking producer, supplied 13 percent of the total imports. Columbium minerals were obtained for the first time from British West Africa and French Equatorial Africa. British Guiana and Spain resumed exporting columbium ore to the United States after a productionless year in 1954.

TABLE 3.—Tantalum-mineral concentrate imported for consumption in the United States, 1946–50 (average) and 1951–55, by countries, in pounds

[U. S. Department of Commerce]

Country	1946–50 (average)	1951	1952	1953	1954	1955
South America:						
Argentina	215					6,614
Brazil	51,153		49,813	46,146	255,533	221,834
French Guiana				10,987	24,809	23,085
Total	51,368		49,813	57,133	280,342	251,533
Europe:						
Belgium-Luxembourg [1]	17,776	20,876				
Germany, West					62,865	594,030
Netherlands [1]	5,900					
Norway						11,729
Portugal			35,428	154,323	86,279	6,614
Spain			741			11,276
Sweden				4,242	19,251	
United Kingdom						28,533
Total	23,676	20,876	36,169	158,565	168,395	652,182
Asia:						
Japan [1]	2,138					
Malaya			2,087	3,639	1,479	5,853
Total	2,138		2,087	3,639	1,479	5,853
Africa:						
Belgian Congo	183,616	210,402	236,701	507,282	420,562	539,214
Rhodesia and Nyasaland, Federation of	[2] 4,768		[2] 233	[2] 8,163	4,944	18,326
Madagascar					6,173	10,693
Mozambique					10,893	57,184
Nigeria	6,916	5,700	2,273		50,018	[3] 303,692
Uganda [4]				2,050	2,158	8,507
Union of South Africa	601			2,036	4,480	14,428
Total	195,901	216,102	239,207	519,531	499,228	952,044
Oceania: Australia	1,994	1,467	1,590	20,541	32,428	46,074
Grand total: Pounds	275,077	238,445	328,866	759,409	981,872	1,907,686
Value	$250,725	$190,383	$398,849	$1,229,534	$1,972,320	$4,634,231

[1] Presumably country of transshipment rather than original source.
[2] Southern Rhodesia.
[3] Probably includes material classified as columbium-mineral concentrate in world-production totals.
[4] Classified by U. S. Department of Commerce as British East Africa.

Exports.—Only a small quantity of columbium minerals was exported during 1955: 6,370 pounds, worth $9,700, was purchased by West Germany. No tantalum minerals were exported this year. United Kingdom and West Germany bought 325 pounds of columbium metal valued at $22,039. Canada purchased 2,000 pounds of tantalum metal and scrap valued at $5,380. Approximately 1,390 pounds of tantalum in semifabricated shapes and forms, at a value of $101,868, was exported to 13 different countries.

Tables 2 and 3 present statistics of columbium and tantalum mineral concentrates imported for consumption in the United States. Details of the columbium and tantalum oxide content of the ores as published in the Columbium and Tantalum chapter in Minerals Yearbook, 1954, were not obtained by the U. S. Department of Commerce for 1955.

TECHNOLOGY

Development of ample reserves and the existence of a large surplus revived interest in research for developing better high-temperature alloys using columbium and tantalum. The AEC began a comprehensive investigation of the high-temperature mechanical characteristics and corrosion behavior of pure columbium and many of its alloys.[4] The U. S. Department of Defense, although continuing restrictions on the use of columbium in military aircraft, actively encouraged research on the use of both columbium and tantalum in high-temperature alloys.[5]

A turbine-blade alloy containing columbium that can be cast was developed, thus saving large quantities of metal normally lost in machining processes. The cast turbine blades show strength properties as good as those of the forged alloys.[6]

Factors influencing the arc melting of columbium and columbium-base alloys were investigated at Battelle Memorial Institute. Small quantities of carbon, oxygen, and nitrogen were particularly deleterious to the formability of arc-melted columbium.[7]

Concurrent with physical metallurgy investigations, analytical methods for determining columbium and tantalum in the presence of various impurities were studied.

The solvent-extraction technique, developed for separatinng columbium and tantalum from source materials, was used to determine the quantity of columbium or tantalum in uranium and zirconium-base alloys.[8]

Ion-exchange techniques were applied to analyzing jet-engine alloys containing columbium, tantalum, cobalt, nickel, and other metals.[9]

A method employing an acetone-intensified thiocyanate procedure for determining columbium in the presence of titanium was developed.[10]

[4] Material Advisory Board, Report on Columbium-Tantalum: Report 101M, Oct. 21, 1955.
[5] Work cited in footnote 4.
[6] Siegfried, W., and Eisermann, E., A Turbine-Blade Alloy Castable and Low in Cobalt and Columbium: Metal Prog., vol. 67, No. 1, January 1955, pp. 141–146.
[7] Saller, H. A., Stacy, J. T., and Porembka, S. W., Initial Investigation of Niobium and Niobium Base Alloys: USAEC, BMI-1003, May 23, 1955, 42 pp.
[8] Milner, G. W. C., Barnett, G. A., and Smales, A. A., Determination of Niobium or Tantalum in Uranium and Zirconium Base Alloys: Analyst, vol. 80, No. 950, May 1955, pp. 380–390.
[9] National Bureau of Standards Technical News Bulletin, vol. 39, No. 10, October 1955.
[10] Mundy, R. J., Colorimetric Determination of Niobium in the Presence of Titanium: Anal. Chem., vol. 27, No. 9, September, 1955, pp. 1408–1412.

A review of the Analytic Chemistry of Columbium and Tantalum was prepared.[11]

Analyses, specific gravity, optical data, and other physical characteristics for various types of columbium-tantalum minerals were collected and reported.[12]

Pure columbium metal has been considered as canning material for use in atomic reactors. Possessing a relatively low neutron- absorption characteristic of 1.2 Barn, its use has been proposed in conjunction with the metal vanadium, which has a neutron characteristic of 4.8 Barn. The proposal called for encasing the fuel material in a biwall cylinder, with the inner wall of columbium and outer wall of vanadium.[13]

Tantalum metal was investigated by the Signal Corps for use at low ambient temperatures. The metal can be used with safety at temperatures down to minus 100° F. without impairment of its mechanical qualities. Both sheet and wire show excellent fatigue qualities, high endurance ratio, and tensile properties that improve with decreasing temperatures.[14]

The Bureau of Mines investigated the recovery of columbium- and tantalum-bearing minerals in several alluvial black-sand deposits from Dismal Swamp, Bear Valley, and Cascade, Idaho. These deposits contain varying quantities of samarskite, euxenite, ilmenorutile, and columbite. Final concentrates containing combined columbium-tantalum pentoxides in the following percentages were obtained: Dismal Swamp, 66.0 percent; Bear Valley, 26.4 percent; and Cascade, 36.0 percent. The lower oxide contents were considered normal for concentrate containing large percentages of euxenite or ilmenorutile.[15]

Separation of columbite from tin-mining wastes was aided by the development of a new sieve-type machine.[16]

The separation of columbium from tantalum based upon the tendency of columbium pentoxide to be more completely reduced to Cb_2O_4 in an atmosphere of dry hydrogen gas at 900–1,000° C. than tantalum oxide was patented. The resulting lower oxide is extracted with hot, concentrated H_2SO_4.[17]

RESERVES

Resources of columbium throughout the world were believed to be more than adequate for foreseeable requirements. Columbite deposits in Nigeria contained over 70,000 short tons of Cb_2O_5. Deposits of pyrochlore throughout the world were considered the greatest potential source of the metal. Pyrochlore deposits in Africa have been estimated to have 1.2 million tons of Cb_2O_5. Canadian deposits contained about 400,000 tons of Cb_2O_5, and Brazilian pyrochlore deposits also were known to be extremely large. Norwegian koppite deposits were

[11] Bagshave, B., Analytical Chemistry of Niobium and Tantalum: Chem. Age, (London), vol. 72, No. 1876, June 25, 1955, pp. 1457–1462; vol. 73, No. 1877, July 2, 1955, pp. 29–33.
[12] Hutchinson, R. W., Preliminary Report on Investigations of Minerals of Niobium and Tantalum and of Certain Associated Minerals: Am. Mineral., vol. 40, 1955, pp. 432–452.
[13] Nucleonics, vol. 13, No. 11, November 1955, p. 21.
[14] Bornemann, A., and Gela, T., Studies in the Behavior of Certain Nonferrous Metals at Low Temperatures: OTS Rept. PB 111,657, December 1953 (declassified August 1955).
[15] Shelton, J. E., and Stickney, W. A., Beneficiation Studies of Columbium-Tantalum-Bearing Minerals in Alluvial Black-Sand Deposits: Bureau of Mines Rept. of Investigations 5105, 1955, 16 pp.
[16] Hurst, J., Separation of Columbite by Sieving Unit: Min. Jour. (London), July 15, 1955, vol. 245, No. 6256, pp. 72–73.
[17] Heraeus, W. C., British Patent 740,868, Nov. 23, 1955.

estimated to contain at least 50,000 tons Cb_2O_5. United States deposits of the mineral euxenite in Bear Valley, Idaho, were believed to include over 8,000 tons of Cb_2O_5.

The development of an economic metallurgical process for concentrating the pyrochlore mineral and extracting the valuable oxide would make available tremendous quantities of high-grade source materials.

World tantalum reserves are not available for publication; most of the large columbium-bearing deposits are relatively low in tantalum. More tantalum, however, is probably derived from columbite concentrates than from tantalite ores, because of the greater quantity of columbium concentrates processed.

WORLD REVIEW

World production of columbium and tantalum mineral concentrates in 1955, approximately 11.7 million pounds, was by far the greatest in history, exceeding 1954, the previous record high year, by 22 percent. Record high productions, (by Argentina, Australia, Brazil, West Germany, Madagascar, Malaya, Nigeria, Norway, and Uganda) were not expected to be exceeded in the immediate future because of termination of the United States columbium-tantalum mineral-purchase program.

Argentina.—Tantalite and columbite development is largely in Salta Province in the El Onemado zone, where pegmatite deposits have produced up to 1 ton each annually. All this material was exported. There are no ore-reserve figures, but the situation was considered promising.[18]

Australia.—North-West Tantalum N. L. suspended mining operations at Wodgina because of the disappointing low-grade ore material. For the period January to April 1955, and at an estimated cost of $25,000, 1,743 tons of ore was milled, yielding 2,281 pounds of 65-percent of tantalite valued at $12,600. The company had not decided whether it would operate its Tabba Tabba and Strelley deposits.[19]

Brazil.—A deposit of pyrochlore estimated to exceed 3 million tons was found at Araxa in Minas Gerais. Samples from test drillings analyzed 3 to 14 percent Cb_2O_5 to a depth of 3 meters. The grade decreased with depth but was more than 1 percent at 45 meters.[20] The pyrochlore in minute crystals is associated with magnetite, zircon, and koppite.

British East Africa.—The Kenya Government announced that it would receive applications from commercial companies for the investigation and exploitation of pyrochlore deposits at Mrima Hill, southwest of Mombasa. A license was subsequently issued to Anglo-American Prospecting Co. (Africa), Ltd. Initial drillings by the Kenya Government indicated a deposit 1 square mile in size containing 30 million tons of ore averaging 0.7 percent Cb_2O_5.[21]

British Guiana.—British Guiana Consolidated Goldfields, 1 of 3 companies exploring for columbite in the Rumong-Rumong region

[18] Mining World, vol. 17, No. 3, March 1955, p. 77.
[19] Industrial and Mining Standard (Melbourne), Low-Grade Ore Stops North-West Tantalum: Vol. 110, No. 2787, May 5, 1955, p. 20.
[20] Engineering and Mining Journal, Brazil: Vol. 156, No. 11, November 1955, p. 176.
[21] United States Consulate, Nairobi, Kenya, State Department Dispatch 457, Apr. 7, 1955; Dispatch 81 Sept. 15, 1955.

TABLE 4.—World production of columbium and tantalum mineral concentrates by countries,[1] 1946–50 (average) and 1951–55, in pounds

[Compiled by Augusta W. Jann]

Country [1]	1946–50 (average)		1951		1952		1953		1954		1955	
	Columbium	Tantalum	Columbium	Tantalum	Columbium	Tantalum	Columbium	Tantalum	Columbium	Tantalum	Columbium	Tantalum
Argentina	485								[2] 11,023		[2] 10,800	[2] 6,614
Australia		6,856	5,125		16,108		18,124		117,767		[3] 125,000	
Belgian Congo (incl. Ruanda-Urundi)[4]	317,903		209,437		231,042		623,902		967,819		947,978	
Bolivia (exports)	1,367		1,043				3,366				2,350	
Brazil	[5] 17,316	[5] 57,765	[5] 11,200	[5] 8,960	[5] 4,480	[5] 53,760	[5] 67,200	[5] 40,320	[2] 124,460	[2] 255,533	[2] 233,012	[2] 221,834
British Guiana					2,000		11,200		4,480		6,720	
Canada									90	77	42	390
French Equatorial Africa	4,460				3,527		3,514		6,261		2,672	
French Guiana							13,228		28,250			[2] 23,085
Germany, West									[2] 267,957	[2] 62,865	[2] 849,310	[2] 594,030
Madagascar			8,598		5,732		8,377		36,596		38,801	
Malaya	3,584		56,000		105,280		116,480		248,640		529,104	
Mozambique	1,738		[6] 11,257		32,652		[6] 58,133		94,031		82,884	
Nigeria	2,546,432	5,233	2,419,200	6,720	2,896,320	2,240	4,388,160		6,527,360	22,400	[7] 7,047,040	35,840
Norway							[2] 40,367		392,419		675,930	
Portugal		[5] [8] 3,009		[5] 4,526		[2] 35,428	[2] 68,121	[2] 154,323	[2] 148,732	[2] 86,279	[2] 168,362	[2] 6,614
Rhodesia and Nyasaland, Fed. of:												
Northern Rhodesia										1,252		
Southern Rhodesia		14,572			1,120	10,360	5,100	27,060	18,060	14,300	12,240	4,660
Sierra Leone									8,960		8,960	
South-West Africa	3,689		3,974		4,400		17,634		22,439	3,868	8,299	2,924
Spain [2]						741	4,410				2,525	11,276
Sweden [2]							16,713	4,242		19,251		
Uganda [9]	[5] 5,390		[5] 42,560		[5] 9,094		23,542		23,117		34,003	
Union of South Africa		1,600		6,000		8,000		38,000		46,000		22,000
United States (mine shipments)	1,871		925		5,385		14,867		32,829		12,954	
World total (estimate)	2,990,000		2,800,000		3,430,000		5,770,000		9,590,000		11,730,000	

[1] Frequently the composition (Cb_2O_5–Ta_2O_5) of these mineral concentrates lies in an intermediate position, neither Cb_2O_5 nor Ta_2O_5 being strongly predominant. In such instances the production figure has been centered.

[2] United States imports.

[3] Estimate.

[4] In addition, tin-columbium-tantalum concentrates were produced as follows: 1945–50 (average), 1,224,876 pounds; 1951, 2,597,019 pounds; 1952, 2,813,070 pounds; 1953, 3,575,861 pounds; 1954, 5,970,057 pounds; 1955, 3,941,825 pounds; columbium-tantalum content averaging about 10 percent.

[5] Exports.

[6] In addition to figure shown, 176 pounds of samarskite was produced in 1951 and 132 in 1953.

[7] Probably includes material classified as tantalum mineral concentrates in United States import totals (table 3).

[8] Average for 1 year only, as 1950 was first year of commercial production.

[9] In addition, tin-columbium-tantalum concentrates were produced as follows: 1950, 1,210 pounds; 1951, 336 pounds; 1952, 3,248 pounds; 1953, 4,480 pounds; 1954, 6,720 pounds.

NOTE: This table incorporates a number of revisions of data published in previous chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.

in British Guiana, abandoned its search for the mineral because no economic deposits were found in the area.

Canada.—Boreal Rare Metals, Ltd., was reconstructing its columbium-tantalum mill near Great Slave Lake, which was destroyed by fire in January 1955. The new plant will be equipped to crush 500 tons daily, and the concentrating equipment will be able to handle 150 tons.[22]

Commercial production of tantalum oxide was begun by the The Boreal Rare Metals, Ltd., refinery of Cap de la Madeline, Quebec, in February 1955.[23]

Initial drillings in several pyrochlore deposits indicated over 5 million tons of material averaging 0.53 percent Cb_2O_5 on Newman Island in Lake Nipissing. Inspiration Mining & Development Co. subsidiary, Beaucage Mines, was developing the property. Battelle Memorial Institute of the United States developed a process for recovering columbium and uranium from this material.[24]

Another pyrochlore deposit in the Oka area, Quebec, was held jointly by Coulee Lead & Zinc Mines, Ltd., and Headway Red Lake Gold Mines. The property had indicated reserves of 15 million tons, running 7.8 pounds of Cb_2O_5 per ton.[25]

French Guiana.—Mine production from Guiana in 1955 was about 22,000 pounds of columbite-tantalite. Some new deposits were found, but no information concerning their value was released.

Germany, West.—Closing the columbite purchase program affected development at Kaiserstuhl, West Germany, where a vast marble deposit containing calcium niobate was being investigated. The reserves amounted to hundreds of thousands of tons of material containing 0.2 percent of recoverable columbium pentoxide. Future development of this property depends upon the world requirements for this mineral.[26] The large United States imports of columbium concentrate from West Germany consisted of chemical products obtained from processing columbium-bearing tin slags produced in Europe and Africa.

Mozambique.—The largest producer of columbite was the Empresa Mineira do Alto Ligonha (EMDAL). The firm had several mines in the Alto Molecue area north of Zambezia.

Malaya.—Before the United States purchase program was terminated organizations in Malaya produced an estimated 20 short tons of columbite per month. This rate was maintained throughout the year, even though the price dropped. The Government reported the average grade of Malayan columbite to be about 75 percent combined oxides, with a ratio of columbite to tantalite about 4:1. The minerals were recovered as byproducts of tin mining in the State of Kedah and as coproducts in the State of Bakri.[27]

Nigeria.—Approximately 90 percent of the Nigerian columbite produced was shipped to the United States. Kennecott Copper Corp. purchased controlling interest in Tin & Associated Minerals,

[22] Mining World, vol. 17, No. 8, July 1955, p. 78.
[23] South African Mining and Engineering Journal, vol. 65, No. 3235, Feb. 12, 1955, p. 1037.
[24] Canadian Mining Journal, Beaucage Mines: Vol. 76, No. 1, January 1955, pp. 112–113.
[25] Metal Bulletin, (London), No. 4026 Columbite: Sept. 13, 1955, p. 28.
[26] Metal Bulletin (London), No. 4017, Aug. 12, 1955, p. 22.
[27] American Consulate, Kuala Lumpur, Malaya, State Department Dispatch 30, Aug. 2, 1955.

Ltd., of Nigeria shareholdings of columbite [28] at Odegi, Benue Province. The mine has been the world's second ranking producer.

The economic potentialities of a uranium-columbium deposit discovered at Kabba, Northern Nigeria, had not been investigated.[29]

Norway.—Continued investigations into the pyrochlore deposits of Norway were made in the Fen district near Söve on the shore of Lake Norsjo. Mining was limited to the Cappelen dike, containing 1.5 million tons of ore assaying 0.2–0.5 percent Cb_2O_5. The valuable oxides are contained in koppite with magnetite, apatite, and some pyrite. A rough concentrate of the ore was first prepared by table concentration, the pyrite removed by flotation, magnetite removed by magnetic separators, and the apatite dissolved in nitric acid. The final concentrate contained about 50 percent of Cb_2O_5. Production was 15 tons per month, with facilities being expanded for a production rate of 30 tons per month.[30] Other deposits in the area were not being exploited.

Tests on ore from the Hydro deposit showed a lower columbium content, and ore from the Tufte deposit has a high magnesia content.[31]

South-West Africa.—Columbium-tantalum minerals have been obtained primarily from the Karibib-Omaruru area of north central South-West Africa and the Orange River pegmatite area in Northern Cape Province of Union of South Africa. Descriptions of the more productive of 60 pegmatites in the area were released, indicating the general geological formations and minerals present.[32]

Tanganyika.—A carbonatite deposit containing pyrochlore was discovered at Panda Hill in an area lying between Rukwa and Nyasa Lakes. Mbeya Exploration Co., formed in April 1955 and owned by Billiton Co. in partnership with Colonial Development Corp., was investigating the area. Anglo-American Corp. was investigating a second niobium-bearing carbonatite at Ngualla, east of Lake Rukwa.[33]

The area has been divided into several zones and ore reserves and the average percentage of Cb_2O_5 content calculated for each. The Museum zone contained 8,000 tons of Cb_2O_5; Kati-Chuma zone, 22,000 tons of Cb_2O_5; and the Barabara and Mbale zones, a large tonnage of rich ore averaging 1 percent Cb_2O_5.[34]

[28] Metal Bulletin (London), Columbium: No. 4034, Oct. 11, 1955, p. 31.
[29] Metal Bulletin (London), Columbium: No. 4024, Sept. 6, 1955, p. 19.
[30] Björlykke, H., The Niobium Deposits at Söve, Southern Norway: Min. Jour. (London), vol. 244, No. 6243, Apr. 15, 1955, pp. 412–413.
[31] Mining World and Engineering Record (London), Columbite in Norway: Vol. 169, No. 4401, Aug. 6, 1955, p. 88.
[32] Cameron, E. N., Occurrence of Mineral Deposits in the Pegmatites of the Karibib-Omaruru and Orange River Areas of South-West Africa: Min. Eng., vol. 7, No. 9, September 1955, pp. 867–874.
[33] Mining Journal (London), Recent Mineral Discoveries in Tanganyika: Vol. 246, No. 6281, Jan. 6, 1956 p. 13.
[34] Mining Magazine (London), A Carbonatite in Tanganyika: Vol. 93, No. 5, November 1955, pp. 312–314

Copper

By J. W. Pennington [1] and Gertrude N. Greenspoon [2]

DESPITE an accelerated rate of copper production in 1955, supplies of metal were inadequate to meet increased demand, and copper prices soared to the highest point in 90 years.

Domestic mine output in 1955 exceeded 1954 by 20 percent but failed to reach anticipated amounts because of work stoppages at several major mines. The consumption of refined copper in the United States also jumped 20 percent; however, the quantity of metal involved in the consumption gain was 1½ times that of the production increase.

Copper shortages caused the price of domestic copper to move upward sharply during the year; but, as foreign prices rose even more sharply, increased quantities of metal were not attracted from abroad to the United States markets. Consequently, the total imports of unmanufactured copper in 1955 were virtually unchanged from 1954.

The Government, in an effort to alleviate the situation, permitted postponement of Stockpile deliveries; authorized sale of metal from Defense Production Act (DPA) inventories; and placed restrictions on exports of refined domestic copper, copper scrap, and copper-alloy scrap. Suspension of the 2-cent excise tax on copper was extended to June 30, 1958, and suspension of nonferrous-scrap duties was extended to June 30, 1956.

Production gains in many countries—notably Belgian Congo, Canada, Chile, and the United States—raised 1955 world mine production to an alltime peak. Yet, the world, as well as the United States, had an inadequate supply. As a result, the United Kingdom Board of Trade took action similar to that of the United States Government and released stockpiled electrolytic and blister copper.

During the year a formal contract was executed between the Southern Peru Copper Corp. and the Export-Import Bank of Washington, providing for credit amounting to $100 million plus capitalized interest during the construction period for development of the Toquepala copper deposit in Peru.

[1] Assistant chief, Branch of Base Metals.
[2] Statistical assistant.

TABLE 1.—Salient statistics of the copper industry in the United States, 1946–50 (average) and 1951–55, in short tons

	1946–50 (average)	1951	1952	1953	1954	1955
New (primary) copper produced—						
From domestic ores, as reported by—						
Mines	790,641	928,330	925,359	926,448	835,472	998,570
Copper ore produced [1]	81,088,921	95,494,214	99,947,492	101,064,945	93,654,258	112,549,665
Average yield of copper, percent	.91	.90	.85	.85	.83	.83
Smelters	794,858	930,774	927,365	943,391	834,381	1,007,311
Percent of world total	.32	.30	.30	.29	.25	.28
Refineries	792,686	951,559	923,192	932,232	841,717	997,499
From foreign ores, matte, etc., refinery reports	270,082	255,429	254,504	360,885	370,202	344,960
Total new refined, domestic, and foreign	1,062,768	1,206,988	1,177,696	1,293,117	1,211,919	1,342,459
Secondary copper recovered from old scrap only	456,810	458,124	414,635	429,388	407,066	514,585
Imports (unmanufactured) [2]	512,162	489,135	618,880	676,104	[3] 594,829	593,579
Refined	229,229	238,972	346,960	274,111	[3] 215,086	201,640
Exports of metallic copper [4]	177,965	166,274	[5] 212,390	[5] 171,393	[3] [5] 312,433	[5] 259,942
Refined (ingots and bars)	125,051	133,305	174,135	109,580	215,951	199,819
Stocks at end of year (producers)	290,600	217,000	211,000	272,000	214,000	235,000
Refined copper	62,000	35,000	26,000	49,000	25,000	34,000
Blister and materials in solution	228,600	182,000	185,000	223,000	189,000	201,000
Withdrawals (apparent) from total supply on domestic account:						
Total new copper	1,282,000	1,304,000	1,360,000	1,435,000	1,235,000	1,335,000
Total new and old copper (old scrap only)	1,739,000	1,762,000	1,775,000	1,864,000	1,642,000	1,850,000
Price average [6] ... cents per pound	19.5	[7] 24.2	[7] 24.2	[7] 28.7	[7] 29.5	[7] 37.3
World smelter production, new copper	2,505,000	3,085,000	3,105,000	3,275,000	3,275,000	3,640,000

[1] Includes old tailings smelted or re-treated. Not comparable with mine production figure shown in that latter includes recoverable copper content of ores not classified as "copper."
[2] 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.
[3] Revised figure.
[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 before 1953. (See table 35.)
[5] Due to changes in classifications 1952–55 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.

United States Government efforts to relieve the copper shortage included releasing Government holdings of metal and metal under contract for delivery to the Government. Between October 16, 1954, and September 30, 1955, 31,100 tons was diverted from delivery to the stockpile, 6,200 tons was diverted from delivery to DPA inventory, and 34,700 tons was sold from DPA inventory—a total of 72,000 tons in about a year.

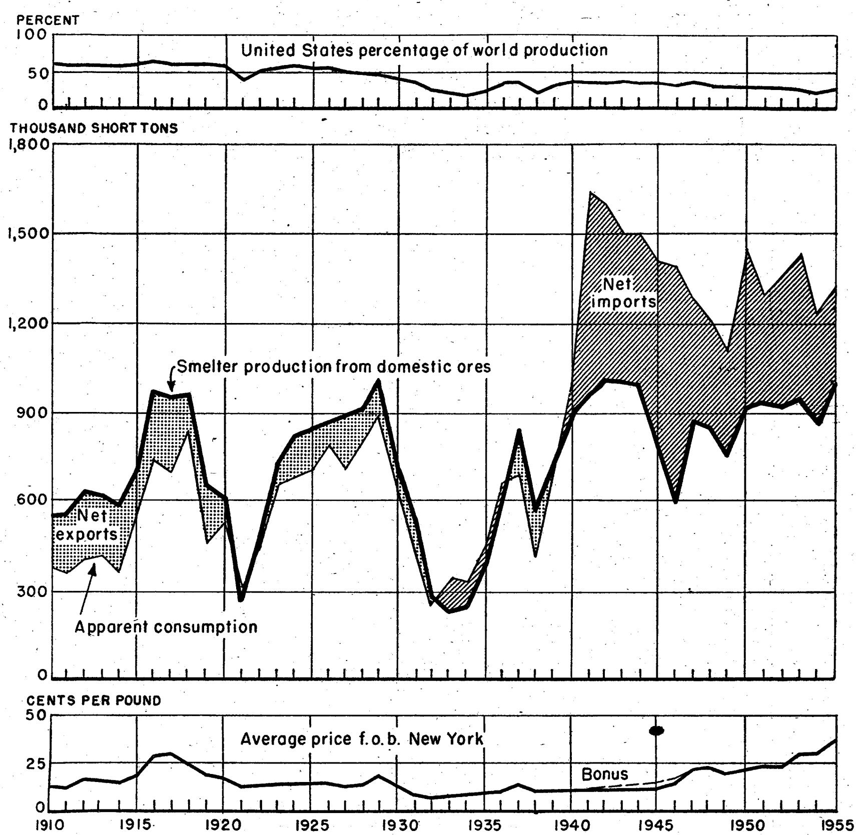

FIGURE 1.—Production, consumption, and price of copper in the United States, 1910–55.

TABLE 2.—Salient statistics of the copper industry, 1924–55

(All figures in short tons, except price and tenor of ore)

Year	Mine production	Average yield of copper ores (percent)	Refinery production from— Domestic ores	Refinery production from— Foreign ores	Refinery production from— Total	Imports (refined)[1]	Exports (refined)[1]	Apparent consumption of new copper[2]	Quoted price at New York[3] (cents per pound)	World production (smelter)	Production from scrap as metal and in alloys: Old scrap	New scrap	Total
1924	803, 083	1. 59	837, 107	292, 931	1, 130, 038	72, 955	504, 812	677, 371	13. 16	1, 493, 600	266, 200	122, 100	388, 300
1925	839, 059	1. 54	841, 448	260, 839	1, 102, 287	49, 887	484, 033	700, 506	14. 16	1, 546, 500	291, 010	129, 200	420, 210
1926	862, 638	1. 46	865, 649	295, 594	1, 161, 243	85, 283	428, 062	785, 068	13. 93	1, 608, 300	337, 300	142, 500	479, 800
1927	824, 980	1. 41	859, 476	303, 406	1, 162, 882	51, 640	461, 233	711, 480	13. 05	1, 673, 300	339, 400	150, 800	490, 200
1928	904, 898	1. 41	895, 899	347, 905	1, 243, 804	42, 365	474, 737	804, 269	14. 68	1, 880, 500	365, 500	170, 900	536, 400
1929	997, 555	1. 41	991, 366	378, 690	1, 370, 056	67, 007	411, 227	889, 293	18. 23	2, 098, 800	404, 350	222, 200	626, 550
1930	705, 074	1. 43	695, 612	382, 918	1, 078, 530	43, 105	297, 057	632, 509	13. 11	1, 760, 000	342, 200	125, 000	467, 200
1931	528, 875	1. 50	537, 303	213, 418	750, 721	87, 225	202, 698	451, 032	8. 24	1, 536, 000	261, 300	85, 700	347, 000
1932	238, 111	1. 83	222, 539	117, 895	340, 434	83, 897	110, 977	259, 602	5. 67	1, 027, 000	180, 980	67, 200	248, 180
1933	190, 643	2. 11	240, 669	130, 120	370, 789	5, 432	124, 582	339, 350	7. 15	1, 143, 000	260, 300	77, 800	338, 100
1934	237, 401	1. 92	233, 029	212, 331	445, 360	27, 417	262, 366	322, 638	8. 53	1, 448, 000	310, 900	66, 500	377, 400
1935	386, 491	1. 89	338, 321	250, 484	588, 805	18, 071	260, 735	441, 371	8. 76	1, 681, 000	361, 700	87, 200	448, 900
1936	614, 516	1. 54	645, 462	177, 027	822, 489	4, 782	220, 390	656, 179	9. 58	1, 895, 000	382, 700	101, 900	484, 600
1937	841, 998	1. 29	822, 253	244, 561	1, 066, 814	7, 487	295, 064	694, 906	13. 27	2, 585, 000	408, 900	123, 200	532, 100
1938	557, 763	1. 34	552, 574	239, 842	792, 416	1, 802	370, 545	406, 994	10. 10	2, 254, 000	267, 300	92, 500	359, 800
1939	728, 320	1. 25	704, 873	304, 642	1, 009, 515	16, 264	372, 777	714, 873	11. 07	2, 396, 000	286, 900	212, 800	499, 700
1940	878, 086	1. 20	927, 239	386, 317	1, 313, 556	68, 337	356, 431	1, 008, 785	11. 40	2, 734, 000	333, 890	198, 156	532, 046
1941	958, 149	1. 15	975, 408	419, 901	1, 395, 309	346, 994	103, 602	1, 641, 550	11. 87	2, 905, 000	412, 699	313, 697	726, 396
1942	1, 080, 061	1. 09	1, 064, 792	349, 769	1, 414, 561	401, 436	131, 406	1, 608, 000	11. 87	3, 076, 000	427, 122	500, 633	927, 755
1943	1, 090, 818	1. 04	1, 082, 079	297, 184	1, 379, 263	402, 762	175, 859	1, 502, 000	11. 87	3, 038, 000	427, 521	658, 526	1, 086, 047
1944	972, 549	. 99	973, 852	247, 335	1, 221, 187	492, 395	68, 373	1, 504, 000	11. 87	2, 850, 000	456, 710	494, 232	950, 942
1945	772, 894	. 93	775, 738	332, 861	1, 108, 599	531, 367	48, 563	1, 415, 000	11. 87	2, 436, 000	497, 095	509, 421	1, 006, 516
1946	608, 737	. 91	578, 429	300, 233	878, 662	154, 371	52, 629	1, 391, 000	13. 92	2, 067, 000	406, 453	397, 093	803, 546
1947	847, 563	. 90	909, 213	250, 757	1, 159, 970	149, 478	147, 642	1, 286, 000	21. 15	2, 490, 000	503, 376	458, 365	961, 741
1948	834, 813	. 92	860, 022	247, 424	1, 107, 446	249, 124	142, 598	1, 214, 000	22. 20	2, 580, 000	505, 464	467, 324	972, 788
1949	752, 750	. 91	695, 015	232, 912	927, 927	275, 811	137, 827	1, 072, 000	19. 36	2, 600, 000	383, 548	329, 595	713, 143
1950	909, 343	. 89	920, 748	319, 086	1, 239, 834	317, 363	144, 561	1, 447, 000	21. 46	2, 915, 000	485, 211	492, 028	977, 239
1951	928, 330	. 90	951, 559	255, 429	1, 206, 988	238, 972	133, 305	1, 304, 000	24. 37	3, 085, 000	458, 124	474, 158	932, 282
1952	925, 359	. 85	923, 192	254, 504	1, 177, 696	346, 960	174, 135	1, 360, 000	24. 37	3, 105, 000	414, 635	488, 562	903, 197
1953	926, 448	. 85	932, 232	360, 885	1, 293, 117	274, 111	109, 580	1, 435, 000	28. 92	3, 275, 000	429, 388	529, 076	958, 464
1954	835, 472	. 83	841, 717	370, 202	1, 211, 919	215, 086	215, 951	1, 235, 000	29. 82	3, 275, 000	407, 066	432, 841	839, 907
1955	998, 570	. 83	997, 499	344, 960	1, 342, 459	201, 640	199, 819	1, 335, 000	37. 39	3, 640, 000	514, 585	474, 419	989, 004

[1] Imports and exports may include some refined copper produced from scrap. Categories not wholly comparable from year to year.
[2] Adjusted for changes in stocks.
[3] American Metal Market price for electrolytic copper in New York; f. o. b. refinery through August 1927, New York refinery equivalent thereafter.

DEFENSE PRODUCTION ACT STIMULATION

No contracts for expansion of copper production under the Defense Production Act of 1950, as amended, were entered into by the Government during the year; however, as shown in table 3, three companies were granted tax-amortization assistance.

TABLE 3.—Contracts for expansion and maintenance of supply of copper under the Defense Production Act, as amended, in 1955

Type of contract or assistance, name of contractor, and location of project	Amount	Effective date of contract
Tax amortization: [1]		
Pima Mining Co., Pima County, Ariz.	$12,401,000	Sept. 29, 1955
Inspiration Consolidated Copper Co., Gila County, Ariz.	[2] 5,316,000	Sept. 15, 1955
The Anaconda Company, Greater Butte, Mont.	3,391,000	Oct. 28, 1955

[1] Amortization—5 years at 75 percent of total amount involved.
[2] Original contract provided for $3,600,000.

Defense Minerals Exploration Administration (DMEA) contracts involving copper, in effect during 1955, totaled 6 in 4 States. The location and amount of each project are shown in table 4.

TABLE 4.—DMEA contracts involving copper during 1955, by States

State and contractor	Property	County	Contract	
			Date	Total amount [1]
IDAHO				
Centrida Mines, Inc.	Pope-Shenon	Lemhi	Dec. 28, 1953	$63,140
MICHIGAN				
Calumet & Hecla, Inc.	Caledonia	Ontonagon	Feb. 10, 1955	113,110
MONTANA				
Elmer & Jessie M. Allen	Allen Prop	Sanders	Oct. 27, 1952	10,800
Norman E. Boe, et al.	Bulware	Jefferson	Nov. 13, 1953	26,730
W. J. Noon	Sunrise	Granite	Aug. 20, 1953	21,460
WASHINGTON				
Chewelah Copper Co., Inc.	United Copper	Stevens	Sept. 16, 1954	63,100

[1] Government participation was 50 percent in exploration projects for copper.

DOMESTIC PRODUCTION

Statistics on copper production are compiled on mine, smelter, and refinery bases. Mine data are most accurate for showing the geographic distribution of production, smelter figures are best for showing the actual recovery of metal and source of production, and refinery statistics show recovery of metal but indicate only generally the source of crude materials treated. Minerals Yearbook, volume I, 1954, discusses differences among the three sets of figures.

TABLE 5.—Copper produced from domestic [1] ores, as reported by mines, smelters, and refineries, 1951–55, in short tons

Year	Mine	Smelter	Refinery
1951	928,330	930,774	951,559
1952	925,359	927,365	923,192
1953	926,448	943,391	932,232
1954	835,472	834,381	841,717
1955	998,570	1,007,311	997,499

[1] Includes Alaska.

PRIMARY COPPER

Mine Production.—Production in the United States rose 20 percent in 1955, despite serious work stoppages at several important mines during the year. The increase was due mainly to new output from properties put into production in 1954 and stepped-up output at many mines encouraged by high prices.

A new large mine—the San Manuel, Pima County, Ariz.—began to produce in 1955 and was expected to attain a peak capacity of 70,000 tons of copper annually by the end of 1956. Total ore reserves of 479.5 million tons, averaging 0.769 percent copper and containing gold, silver, and molybdenum, will be mined by gravity-block-caving methods. Other facilities include a 30,000-ton-per-day mill and a smelter. Blister copper is shipped to an electrolytic plant for refining.

The properties of Calumet & Hecla, Inc., in Michigan were closed by a strike from early May until late August. Many of the principal mines, smelters, and refineries of the country, including several divisions of the Kennecott Copper Corp., all mines and most plants of the Phelps Dodge Corp., and a number of the American Smelting & Refining Co. plants were closed by strikes beginning July 1. These stoppages continued for 1 to 1½ months.

Again in 1955 Arizona led all other States by a wide margin in production, supplying 45 percent of the total and exceeding its previous peak output of 1951 by 9 percent. Utah was in second place, with 23 percent. Arizona's output was from a number of important copper-producing districts and mines, whereas the output from Utah was predominantly from one mine (Utah Copper), the largest copper producer in the United States. Production from Montana, Nevada, New Mexico, and Michigan, ranking next in importance as copper producers in 1955, made up 28 percent of the total. These 6 States produced 97 percent of the United States total in 1955. Montana's production was not affected by strikes in 1955, and output was the highest since 1945. Production in Michigan was the largest since 1931, following the first full year's operation of the White Pine mine.

Classification of production by mining methods shows that approximately 77 percent of the recoverable copper and 83 percent of the copper ore came from open pits in 1955. Most domestic copper ore was treated by flotation at or very near the mine of origin, and the resulting concentrate was shipped for smelting. Some copper ores were direct-smelted either because of their high grade or their fluxing qualities.

The first 5 mines in table 10 produced 57 percent of the United States total, the first 10 produced 78 percent, and the entire 25 furnished 97 percent.

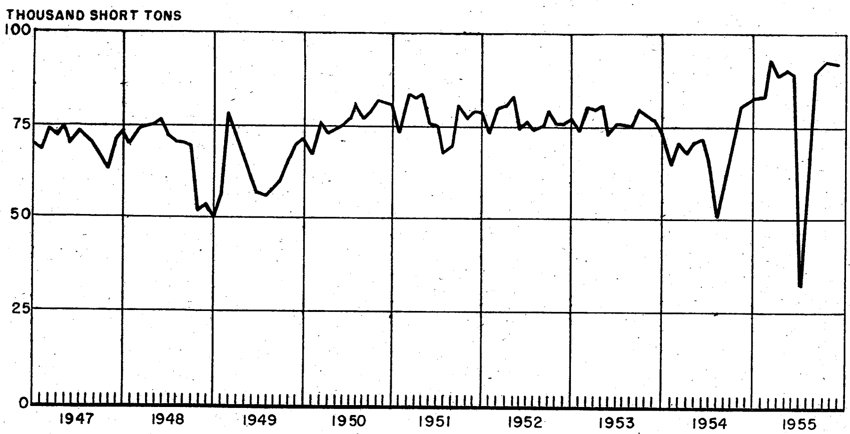

FIGURE 2.—Mine production of recoverable copper in the United States, 1947–55, by months, in short tons.

TABLE 6.—Copper ore and recoverable copper produced by open-pit and underground methods 1939–55, percent of total

Year	Open pit		Underground		Year	Open pit		Underground	
	Ore	Copper	Ore	Copper		Ore	Copper	Ore	Copper
1939	59	41	41	59	1948	76	68	24	32
1940	61	44	39	56	1949	78	70	22	30
1941	63	47	37	53	1950	81	74	19	26
1942	66	51	34	49	1951	84	74	16	26
1943	69	54	31	46	1952	85	77	15	23
1944	68	57	32	43	1953	83	75	17	25
1945	68	61	32	39	1954	83	79	17	21
1946	66	58	34	42	1955	83	77	17	23
1947	73	68	27	32					

TABLE 7.—Mine production of recoverable copper in the United States in 1955, by months [1]

Month	Short tons	Month	Short tons
January	83,320	August	67,645
February	83,549	September	90,424
March	93,746	October	92,616
April	89,176	November	92,087
May	90,813	December	92,444
June	89,460		
July	33,290	Total	998,570

[1] Includes Alaska. Monthly figures adjusted to final annual mine-production total.

TABLE 8.—Mine production of recoverable copper in the United States, 1945–55, with production of maximum year, and cumulative production from earliest record to end of 1955, by States, in short tons

State	Maximum production[1]		Production by years											Total production from earliest record to end of 1955
	Year	Quantity	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	
Western States and Alaska:														
Alaska	1916	59,927	5	2	12	16	4	6	1			4	1	685,910
Arizona	1955	454,105	287,203	289,223	366,218	375,121	359,010	403,301	415,870	395,719	393,525	377,927	454,105	14,718,888
California	1909	28,644	6,473	4,240	2,407	481	649	646	921	800	382	362	613	633,085
Colorado	1938	14,171	1,485	1,754	2,150	2,298	2,403	3,141	3,212	3,606	2,941	4,523	4,323	279,308
Idaho	1955	5,618	1,548	1,038	1,640	1,624	1,438	2,107	2,160	3,213	3,136	4,828	5,618	133,551
Montana	1916	176,464	88,506	58,481	57,900	58,252	56,611	54,478	57,406	61,948	77,617	59,349	81,542	7,143,456
Nevada	1942	83,663	52,595	48,616	49,603	45,242	38,058	52,569	56,474	57,537	61,850	70,217	78,925	2,293,143
New Mexico	1942	8C,100	56,571	50,191	60,205	74,687	55,388	66,300	73,558	76,112	72,477	60,558	66,417	1,955,901
Oregon	1916	1,791	1	7	14	2	20	19	11	1	9	5	4	12,428
South Dakota	1918	32												106
Texas	1928	224	55	3	6	23	24	2	1	18			1	1,384
Utah	1943	323,989	226,376	114,284	266,533	227,007	197,245	278,630	271,086	282,894	269,496	211,835	232,949	7,138,116
Washington	1940	9,612	5,821	4,527	2,240	5,665	5,275	5,057	4,089	4,357	3,740	3,636	3,958	116,943
Wyoming	1900	2,102		1							1	1		16,328
Total			726,639	572,367	808,928	790,418	716,125	866,256	884,789	886,205	885,174	793,245	928,456	35,128,547
West Central States: Missouri	1949	3,670	3,399	1,857	1,760	2,370	3,670	2,982	2,422	2,576	2,374	1,925	1,722	[2] 41,479
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	30,401	21,663	24,184	27,777	19,506	25,608	24,979	21,699	24,097	23,593	50,066	5,060,999
New Hampshire	1908	[4] 94												(3)
North Carolina	1930	6,695										(5)	(5)	(3)
Pennsylvania	1942	6,410	3,565	2,839	3,613	5,347	3,974	4,142	5,297	3,485	3,027	3,270	4,110	(3)
South Carolina	(3)	(3)												(3)
Tennessee	1930	10,584	6,959	6,985	6,825	6,693	6,489	6,851	7,069	7,620	7,829	9,087	9,911	(3)
Vermont	1954	4,352	1,861	3,026	2,248	2,208	2,986	3,504	3,774	3,774	3,947	4,352	4,305	(3)
Virginia	1944	291	70		5									(3)
Wisconsin	1914	5												(2)
Total			42,856	34,513	36,875	42,025	32,955	40,105	41,119	36,578	38,900	40,302	68,392	[6] 5,765,885
Grand total	1943	1,090,818	772,894	608,737	847,563	834,813	752,750	909,343	928,330	925,359	926,448	835,472	998,570	[7] 40,935,911

[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] Less than 0.5 ton.
[6] For States other than Michigan, figures represent largely smelter output. Excludes small quantity, not separable, for Wisconsin shown with Missouri.
[7] Largely smelter production for States east of the Mississippi except Michigan.

TABLE 9.—Mine production of recoverable copper in the principal districts [1] of the United States, 1946–50 (average) and 1951–55, in short tons

District or region	State	1946–50 (average)	1951	1952	1953	1954	1955
West Mountain (Bingham)	Utah	215,076	270,183	282,098	268,511	210,643	232,016
Copper Mountain (Morenci)	Arizona	137,641	143,921	124,882	123,789	114,362	124,630
Globe-Miami	do	86,589	90,225	93,079	86,478	63,222	86,575
Summit Valley (Butte)	Montana	56,529	56,826	61,557	77,520	59,240	81,428
Ajo	Arizona	54,657	63,093	63,808	64,730	60,794	70,222
Central (including Santa Rita)	New Mexico	[2] 59,354	71,526	74,008	69,869	58,178	64,084
Warren (Bisbee)	Arizona	12,811	27,271	27,440	29,344	41,884	58,145
Lake Superior	Michigan	23,748	24,979	21,699	24,097	23,593	50,066
Mineral Creek (Ray)	Arizona	21,816	50,580	49,274	47,574	40,462	49,174
Robinson (Ely)	Nevada	45,482	56,198	57,148	60,557	43,972	44,417
Yerington	do	27	(3)	---	(3)	26,040	33,918
Pioneer (Superior)	Arizona	18,228	17,662	17,716	25,093	26,521	23,948
Silver Bell	do	28	1	71	85	(3)	(3)
Eureka (Bagdad)	do	7,650	9,087	9,228	10,072	8,838	11,040
Ducktown	Tennessee	6,769	7,069	7,620	7,829	9,087	9,911
Pima (Sierritas, Papago, Twin Buttes)	Arizona	292	334	1,090	1,353	4,132	(3)
Orange County	Vermont	2,794	3,774	3,774	3,947	4,352	4,305
Lebanon (Cornwall mine)	Pennsylvania	3,983	5,297	3,485	3,027	3,270	4,110
Chelan Lake	Washington	[4] 4,503	3,932	[5] 4,273	[5] 3,614	[6] 3,534	[6] 3,733
Blackbird	Idaho	2	148	[7] 1,214	(3)	(3)	2,673
Coeur d'Alene	do	1,315	1,874	1,862	2,100	2,566	2,637
Lordsburg	New Mexico	1,734	1,521	1,475	1,988	2,210	(3)
Redcliff (Battle Mountain)	Colorado	200	278	195	440	2,355	2,246
Cochise	Arizona	836	1,350	1,838	1,849	1,947	1,948
San Juan Mountains	Colorado	1,837	2,712	3,157	2,376	2,076	1,843
Southeastern Missouri	Missouri	2,528	2,422	2,576	2,374	1,925	1,722
Verde (Jerome)	Arizona	15,166	9,742	4,524	626	(3)	(3)

[1] Districts producing 1,000 short tons or more in any year of the period 1951–55.
[2] Includes average for Burro Mountain for 1946 and 1948–49 to avoid disclosing individual company operations.
[3] Figures withheld to avoid disclosing individual company operations.
[4] Includes average for Peshastin Creek and Wenatchee for 1949 to avoid disclosing individual company operations.
[5] Includes Ferry to avoid disclosing individual company operations.
[6] Includes Ferry and King to avoid disclosing individual company operations.
[7] Includes Spring Mountain and Texas to avoid disclosing individual company operations.

TABLE 10.—Twenty-five leading copper-producing mines in the United States, in 1955, 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	Copper, gold-silver ores.
3	Butte Mines (includes Kelley, Berkeley and Skyrme).	Summit Valley (Butte)	Montana	The Anaconda Co	Copper, lead-zinc ores.
4	New Cornelia	Ajo	Arizona	Phelps Dodge Corp	Copper, gold ores, copper tailings.
5	Chino	Central	New Mexico	Kennecott Copper Corp	Copper ore.
6	Copper Queen-Lavender Pit	Warren (Bisbee)	Arizona	Phelps Dodge Corp	Do.
7	Ray	Mineral Creek (Ray)	do	Kennecott Copper Corp	Do.
8	Inspiration	Globe-Miami	do	Inspiration Consolidated Copper Co	Do.
9	Yerington	Yerington	Nevada	The Anaconda Co	Do.
10	White Pine	Lake Superior	Michigan	White Pine Copper Co	Do.
11	Porphyry Reserve	Globe-Miami	Arizona	Copper Cities Mining Co	Do.
12	Magma	Pioneer (Superior)	do	Magma Copper Co	Do.
13	Silver Bell	Silver Bell	do	American Smelting & Refining Co	Do.
14	Miami	Globe-Miami	do	Miami Copper Co	Do.
15	Ruth Pit	Robinson (Ely)	Nevada	Kennecott Copper Corp	Do.
16	Morris Brooks Pit	do	do	Consolidated Coppermines Corp	Do.
17	Calumet & Hecla, Inc	Lake Superior	Michigan	Calumet & Hecla, Inc	Copper ore and tailings.
18	Kimbley Pit	Robinson (Ely)	Nevada	Kennecott Copper Corp	Copper ore.
19	Bagdad	Eureka (Bagdad)	Arizona	Bagdad Copper Corp	Do.
20	Burra Burra, Calloway, Mary, Eureka, Boyd.	Polk County	Tennessee	Tennessee Copper Co	Copper-zinc ore.
21	Elizabeth	Orange County	Vermont	Appalachian Sulphides, Inc	Copper ore.
22	Mineral Hill, Daisy, Copper Queen	Pima	Arizona	Banner Mining Co	Do.
23	Cornwall	Lebanon County	Pennsylvania	Bethlehem Steel Co	Magnetite-pyrite-chalcopyrite ore.
24	Holden	Chelan Lake	Washington	Howe Sound Co	Copper-zinc ore.
25	Ruth Pit Extension	Robinson (Ely)	Nevada	Consolidated Coppermines Corp	Copper ore.

Quantity and Estimated Recoverable Content of Copper-Bearing Ores.—Tables 11 to 14 list the quantity and estimated recoverable copper content of the ore produced by copper mines in the United States in 1955. Copper production during 1955 from ore concentrated before smelting, direct-smelting ore and ore, treated by straight leaching was virtually unchanged from 1954.

Close agreement between the output as reported by smelters and the recoverable quantity as reported by mines indicates that estimated recoverable copper 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 pyrite ore.

TABLE 11.—Copper ore sold or treated in the United States in 1955, with copper, gold, and silver content in terms of recoverable metals [1]

State	Ore sold or treated (short tons)	Recoverable metal content: Copper, Pounds	Copper, Percent	Gold (fine ounces)	Silver (fine ounces)	Value of gold and silver per ton of ore
Arizona	52, 189, 728	856, 270, 850	0. 82	105, 330	3, 629, 191	$0. 13
California	9, 315	378, 000	2. 03	166	9, 415	1. 54
Colorado	67, 513	4, 008, 800	2. 97	7, 350	1, 322, 305	21. 54
Idaho	180, 033	5, 538, 000	1. 54	2, 030	6, 812	. 43
Michigan [2]	6, 808, 553	100, 132, 000	. 74	------	478, 000	. 06
Montana	5, 760, 564	154, 894, 491	1. 34	10, 083	2, 732, 585	. 49
Nevada	10, 520, 428	157, 714, 300	. 75	40, 011	126, 014	. 14
New Mexico	7, 281, 739	107, 201, 861	. 74	1, 096	89, 413	. 02
Oregon	44	6, 400	7. 27	11	28	9. 32
Tennessee [3]	1, 285, 442	19, 821, 900	. 77	221	66, 619	. 05
Texas	35	1, 224	1. 75	------	------	------
Utah	27, 742, 337	449, 236, 080	. 81	396, 567	2, 924, 184	. 60
Vermont	294, 396	8, 610, 000	1. 46	181	50, 447	. 18
Washington [4]	409, 538	7, 826, 400	. 96	18, 375	92, 211	1. 77
Total	112, 549, 665	1, 871, 640, 306	. 83	581, 421	11, 527, 224	. 28

[1] Excludes copper recovered from precipitates as follows: Arizona, 45,124,900 pounds; California, 17,500 pounds; Montana, 3,518,795 pounds; New Mexico, 24,594,169 pounds; Utah, 12,834,500 pounds.
[2] Includes tailings.
[3] Copper-zinc ore.
[4] Includes ore classed as copper-zinc ore and copper, gold, and silver recovered therefrom.

Smelter Production.—Smelter recovery of copper in the United States from domestic ore was 1,007,000 tons in 1955—the largest since 1943 and 21 percent greater than in 1954. Output constituted 28 percent of the world production, compared with 51 percent in 1925–29 and a range of 25–34 percent in 1945–54.

The smelter of the San Manuel Copper Co., San Manuel, Ariz., was completed in late 1955, and production of blister copper was expected in early Janutry 1956, about 1 year ahead of schedule.

The figures for smelter production shown in table 15 are based upon voluntary reports from all domestic primary smelters handling copper-bearing materials. Blister copper is accounted for in terms of fine-copper content. Some casting and electrolytic copper produced from ore or matte is included in the smelter production, as well as in the refinery output. In the case of Michigan, furnace-refined copper is included. Metallic and cement copper recovered by leaching is included in smelter production.

TABLE 12.—Copper ore concentrated in the United States in 1955, with content in terms of recoverable copper

State	Ore concentrated (short tons)	Recoverable copper content	
		Pounds	Percent
Arizona	[1] 48,149,190	[2] 742,250,900	0.77
California	8,931	351,700	1.97
Colorado	85	11,700	6.88
Idaho	177,527	5,341,400	1.50
Michigan [3]	6,808,553	100,132,000	.74
Montana	5,694,371	152,084,240	1.34
Nevada	[4] 10,415,833	[4] 153,608,500	.74
New Mexico	[5] 7,076,084	[6] 106,134,411	.75
Oregon	25	700	1.40
Tennessee [7]	1,285,442	19,821,900	.77
Utah	27,740,600	448,871,900	.81
Vermont	294,396	8,610,000	1.46
Washington [8]	409,488	7,819,900	.95
Total	108,060,525	1,745,039,251	.81

[1] In addition 3,491,853 tons was treated by straight leaching.
[2] In addition 59,517,500 pounds of copper was recovered by straight leaching.
[3] Includes tailings.
[4] Includes ore treated by straight leaching, and copper precipitates recovered therefrom; Bureau of Mines not at liberty to publish.
[5] In addition 120,000 tons was treated by heap leaching.
[6] In addition 160,700 pounds of copper was recovered by heap leaching.
[7] Copper-zinc ore.
[8] Mostly copper-zinc ore.

TABLE 13.—Copper ore shipped to smelters in the United States in 1955, with content in terms of recoverable copper, and copper produced from all sources, in terms of recoverable copper

State	Ore shipped to smelters			Copper from all sources, including old tailings, old slag, smelter cleanings, and precipitates (pounds)
	Short tons	Recoverable copper content		
		Pounds	Percent	
Alaska				2,000
Arizona	548,685	54,502,450	4.97	[1] 908,210,000
California	384	26,300	3.42	1,226,000
Colorado	67,428	3,997,100	2.96	8,646,000
Idaho	2,506	196,600	3.92	11,236,000
Michigan				100,132,000
Missouri				3,444,000
Montana	66,193	2,810,251	2.12	[1] 163,084,000
Nevada	104,595	4,105,800	1.96	[1] 157,850,000
New Mexico	85,655	906,750	.53	[1] 132,834,000
Oregon	19	5,700	15.00	8,000
Pennsylvania				[2] 8,220,000
Tennessee				19,821,900
Texas	35	1,224	1.75	1,224
Utah	1,737	364,180	10.48	[1] 465,898,000
Vermont				8,610,000
Washington	50	6,500	6.50	7,916,000
Total	877,287	66,922,855	3.81	1,997,139,124

[1] Considerable copper was recovered from precipitates.
[2] From magnetite-pyrite-chalcopyrite ore.

TABLE 14.—Copper ores [1] produced in the United States, 1946–50 (average) and 1951–55, 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
1946–50 (average)	760, 043	3. 50	76, 825, 398	0. 88	81, 088, 921	0. 91	0. 0057	0. 092	$0. 28
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
1953	893, 248	3. 47	96, 594, 903	. 82	101, 064, 945	. 85	. 0061	. 091	. 30
1954	896, 363	4. 02	89, 620, 197	. 79	93, 654, 258	. 83	. 0056	. 087	. 27
1955	877, 287	3. 81	108, 060, 525	. 81	112, 549, 665	. 83	. 0052	. 102	. 28

[1] Includes old tailings, smelted or retreated, etc., for 1946–52.
[2] Includes some ore classed as copper-zinc ore.
[3] Includes copper ore leached.

TABLE 15.—Copper produced (smelter output from domestic ores) in the United States, 1845–1955

Year	Short tons	Value (thousand dollars)	Year	Short tons	Value (thousand dollars)	Year	Short tons	Value (thousand dollars)
1845	112	45	1882	45, 323	17, 313	1919	643, 210	239, 274
1946	169	57	1883	57, 763	19, 062	1920	604, 531	222, 467
1847	336	124	1884	72, 473	18, 843	1921	252, 793	65, 221
1848	560	218	1885	82, 938	17, 915	1922	475, 143	128, 289
1849	784	349	1886	78, 881	17, 512	1923	717, 500	210, 945
1850	728	320	1887	90, 739	25, 044	1924	817, 125	214, 087
1851	1, 008	334	1888	113, 181	38, 029	1925	837, 435	237, 832
1852	1, 232	542	1889	113, 388	30, 615	1926	869, 811	243, 547
1853	2, 240	985	1890	129, 882	40, 523	1927	842, 020	220, 609
1854	2, 520	1, 108	1891	142, 061	36, 368	1928	912, 950	262, 930
1855	3, 360	1, 814	1892	172, 499	40, 020	1929	1, 001, 432	352, 504
1856	4, 480	2, 419	1893	164, 677	35, 570	1930	697, 195	181, 271
1857	5, 376	2, 688	1894	177, 094	33, 648	1931	521, 356	94, 887
1858	6, 160	2, 833	1895	190, 307	40, 726	1932	272, 005	34, 273
1859	7, 056	3, 104	1896	230, 031	49, 687	1933	225, 000	28, 800
1860	8, 064	3, 709	1897	247, 039	59, 289	1934	244, 227	39, 076
1861	8, 400	3, 696	1898	263, 256	65, 288	1935	381, 294	63, 295
1862	10, 580	4, 655	1899	284, 333	97, 242	1936	611, 410	112, 499
1863	9, 520	6, 473	1900	303, 059	100, 615	1937	834, 661	201, 988
1864	8, 960	8, 422	1901	301, 036	100, 546	1938	562, 328	110, 216
1865	9, 520	7, 473	1902	329, 754	80, 460	1939	712, 675	148, 236
1866	9, 968	6, 828	1903	349, 022	95, 632	1940	909, 084	205, 453
1867	11, 200	5, 682	1904	406, 269	104, 005	1941	966, 072	227, 993
1868	12, 992	5, 976	1905	444, 392	138, 650	1942	1, 087, 991	[1] 256, 766
1869	14, 000	6, 790	1906	458, 903	177, 136	1943	1, 092, 939	[1] 257, 934
1870	14, 112	5, 977	1907	434, 498	173, 799	1944	1, 003, 379	[1] 236, 797
1871	14, 560	7, 023	1908	471, 285	124, 419	1945	782, 726	[1] 184, 723
1872	14, 000	9, 956	1909	546, 476	142, 084	1946	599, 656	[1] 172, 701
1873	17, 360	9, 721	1910	540, 080	137, 180	1947	862, 872	[1] 360, 680
1874	19, 600	8, 624	1911	548, 616	137, 154	1948	842, 477	365, 635
1875	20, 160	9, 152	1912	621, 634	205, 139	1949	757, 931	298, 625
1876	21, 280	8, 937	1913	612, 242	189, 795	1950	911, 352	379, 122
1877	23, 520	8, 937	1914	575, 069	152, 968	1951	930, 774	450, 495
1878	24, 080	7, 994	1915	694, 005	242, 902	1952	927, 365	448, 845
1879	25, 760	9, 582	1916	963, 925	474, 288	1953	943, 391	541, 506
1880	30, 240	12, 943	1917	943, 060	514, 911	1954	834, 381	492, 285
1881	35, 840	13, 046	1918	954, 267	471, 408	1955	1, 007, 311	751, 454

[1] 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.

Refinery Production.—The refinery output of primary copper in the United States during 1955 came from 14 plants; 8 of these employed the electrolytic method only, 3 the furnace process on Lake Superior copper, and 2 used both the electrolytic and furnace methods. One western smelter fire-refined most of its blister. The leaching plant of the Inspiration Consolidated Copper Co. at Inspiration, Ariz., produced electrolytic copper direct from leaching solutions, and in 1954 and 1955 almost all output was shipped as cathodes to other refineries, where it was melted and cast into merchant shapes.

These 14 plants constitute what commonly are termed "primary refineries." The electrolytic plants, exclusive of that at Inspiration, have a rated capacity of 1,687,000 tons of refined copper a year and produced at 83 percent of capacity in 1955, compared with 81 percent in 1954 and 85 percent in 1953.

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 each at Great Falls, Mont.; Tacoma, Wash.; El Paso, Tex.; and Garfield, Utah. The first fire-refined copper was produced at the White Pine plant of the White Pine Copper Co. in 1955. The El Paso plant of the Phelps Dodge Refining Corp. and the Carteret plant of the American Metal Co., produced fire-refined copper in addition to the electrolytic grade.

TABLE 16.—Copper smelters and refineries in the United States in 1955

(Plants that treat primary crude materials exclusively or chiefly)

Location	Company	Final product
Arizona:		
Ajo	Phelps Dodge Corp	Blister.
Morenci	do	Do.
Douglas	do	Do.
Hayden	American Smelting & Refining Co	Do.
Inspiration	Inspiration Consolidated Copper Co	Electrolytic.
Miami	International Smelting & Refining Co	Blister.
Superior	Magma Copper Co	Do.
Maryland: Baltimore	American Smelting & Refining Co	Electrolytic.
Michigan:		
Hancock	Quincy Mining Co	Lake.
Hubbell	Calumet Div., Calumet & Hecla, Inc	Do.
White Pine	White Pine Copper Co	Blister and lake.
Montana:		
Anaconda	The Anaconda Company	Blister.
Great Falls	do	Electrolytic.
Nevada: McGill	Kennecott Copper Corp	Blister.
New Jersey:		
Carteret	American Metal Co	Blister, electrolytic, and fire-refined.
Perth Amboy	American Smelting & Refining Co	Electrolytic.
Do	International Smelting & Refining Co	Do.
New Mexico: Hurley	Kennecott Copper Corp	Blister and fire-refined.
New York: Laurel Hill	Phelps Dodge Refining Corp	Blister and electrolytic.
Tennessee: Copperhill	Tennessee Copper Co	Blister.
Texas:		
El Paso	American Smelting & Refining Co	Do.
Do	Phelps Dodge Refining Corp	Electrolytic and fire-refined.
Utah:		
Garfield	American Smelting & Refining Co	Blister.
Do	Kennecott Copper Corp	Electrolytic.
Washington: Tacoma	American Smelting & Refining Co	Blister and electrolytic.

TABLE 17.—Annual capacity (in short tons) of primary refineries in the United States, Canada, and Mexico, in 1955 [1]

	Electrolytic	Lake	Fire refined
United States:			
American Metal Co., Ltd., Carteret, N. J.	150,000		121,000
American Smelting & Refining Co.:			
Baltimore, Md.	198,000		
Perth Amboy, N. J.	168,000		
Tacoma, Wash.	114,000		
The Anaconda Company, Great Falls, Mont.	150,000		
Calumet & Hecla, Inc., Hubbell, Mich.		60,000	
Inspiration Consolidated Copper Co., Inspiration, Ariz.	39,000		
International Smelting & Refining Co., Perth Amboy, N. J.	240,000		
Kennecott Copper Corp.:			
Hurley, N. Mex.			84,000
Garfield, Utah	204,000		
Phelps Dodge Refining Corp.:			
Laurel Hill, N. Y.	175,000		
El Paso, Tex.	288,000		25,000
Quincy Mining Co., Hancock, Mich.		12,000	
White Pine Copper Co., White Pine, Mich.		36,000	
	1,726,000	108,000	230,000
Canada:			
Canadian Copper Refiners, Ltd., Montreal, East, Quebec	180,000		
International Nickel Co. of Canada, Ltd., Copper Cliff, Ontario	168,000		
	348,000		
Mexico: Cobre de Mexico, S. A., Atzcapotzalco, D. F.	43,000		
Casting capacity	**United States**	**Canada**	**Mexico**
1. Electrolytic (including scrap)	1,853,000	348,000	43,000
2. Lake	108,000		
3. Fire refined (in addition to capacity reported under item 1)	230,000		
Total	2,191,000	348,000	43,000

[1] From 1955 Yearbook of American Bureau of Metal Statistics.

TABLE 18.—Primary and secondary copper produced by primary refineries in the United States, 1946–50 (average) and 1951–55, in short tons

	1946-50 (average)	1951	1952	1953	1954	1955
Primary:						
From domestic ores, etc.: [1]						
Electrolytic	691,004	835,419	819,539	826,086	777,507	883,674
Lake	23,848	25,309	21,681	23,671	22,510	35,387
Casting	77,834	90,831	81,972	82,475	41,700	78,438
Total	792,686	951,559	923,192	932,232	841,717	997,499
From foreign ores, etc.: [1]						
Electrolytic	270,082	255,429	254,504	353,727	353,667	320,822
Casting and best select				7,158	16,535	24,138
Total refinery production of new copper	1,062,768	1,206,988	1,177,696	1,293,117	1,211,919	1,342,459
Secondary:						
Electrolytic [2]	187,938	127,347	113,827	166,802	156,764	196,386
Casting	16,496	7,676	8,549	22,783	23,179	10,169
Total secondary	204,434	135,023	122,376	189,585	179,943	206,555
Grand total	1,267,202	1,342,011	1,300,072	1,482,702	1,391,862	1,549,014

[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 19.—Copper cast in forms at primary refineries in the United States, 1953–55

Form	1953		1954		1955	
	Thousand short tons	Percent	Thousand short tons	Percent	Thousand short tons	Percent
Wirebars	829	56	789	57	963	62
Billets	172	11	168	12	162	11
Cakes	130	9	135	10	158	10
Ingots and ingot bars	150	10	104	7	141	9
Cathodes	190	13	185	13	109	7
Other forms	12	1	11	1	16	1
Total	1,483	100	1,392	100	1,549	100

Copper Sulfate.—Production of copper sulfate totaled 78,100 tons in 1955, an increase of 20 percent over 1954 and a reversal of the downward trend that began in 1952. Shipments of 79,100 tons were 19 percent greater than in 1954. Of the total shipments of 79,100 tons (66,500 in 1954), producers' reports indicated that 18,200 tons (17,600) were for agricultural, 21,500 (19,300) for industrial, and 39,400 (29,600) for other purposes, chiefly for export. Stocks decreased for the second successive year and were 12 percent below inventories at the beginning of the year.

TABLE 20.—Production, shipments, and stocks of copper sulfate in 1946–50 (average) and 1951–55, in short tons

Year	Production		Shipments (gross weight)	Stocks at end of year [1] (gross weight)
	Gross weight	Copper content		
1946–50 (average)	95,980	23,996	96,020	8,720
1951	106,944	26,736	104,260	4,888
1952	94,536	23,634	92,472	6,884
1953	72,944	18,236	72,188	7,072
1954	65,308	16,327	66,488	5,540
1955	78,088	19,522	79,112	4,852

[1] Some small quantities are purchased and used by producing companies, so that the figures given do not balance exactly.

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.

Secondary copper is produced from both new and old scrap. "New scrap" is defined as refuse produced while manufacturing 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 are discarded 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 21 summarizes the production of secondary copper during 1946–55. 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.

In addition to the primary refineries, many plants throughout the country consume scrap exclusively, producing metallic copper and a variety of alloys. The output of the secondary plants is not included in refined-copper production in tables 18 and 19 but is included in table 21 on secondary-copper production.

TABLE 21.—Secondary copper produced in the United States, 1946–50 (average) and 1951–55, in short tons

	1946–50 (average)	1951	1952	1953	1954	1955
Copper recovered as unalloyed copper	246, 964	186, 462	173, 904	242, 855	212, 241	246, 928
Copper recovered in alloys [1]	638, 727	745, 820	729, 293	715, 609	627, 666	742, 076
Total secondary copper	885, 691	932, 282	903, 197	958, 464	839, 907	989, 004
From new scrap	428, 881	474, 158	488, 562	529, 076	432, 841	474, 419
From old scrap	456, 810	458, 124	414, 635	429, 388	407, 066	514, 585
Percentage equivalent of domestic mine output	112	100	98	103	101	99

[1] Includes copper in chemicals, as follows: 1946–50 (average), 17,579; 1951, 22,905; 1952, 15,388; 1953, 21,550; 1954, 18,055; 1955, 15,898.

CONSUMPTION

Apparent consumption of primary copper, which includes deliveries to the National Stockpile when there are any, increased 8 percent in 1955. The demand for copper was strong throughout the year, and available larger supplies would have resulted in higher consumption.

TABLE 22.—New refined copper withdrawn from total year's supply on domestic account, 1951–55, in short tons

	1951	1952	1953	1954	1955
Production from domestic and foreign ores, etc	1, 206, 988	1, 177, 696	1, 293, 117	1, 211, 919	1, 342, 459
Imports [1]	238, 972	346, 960	274, 111	[2] 215, 086	201, 640
Stock at beginning of year [1]	26, 000	35, 000	26, 000	49, 000	25, 000
Total available supply	1, 471, 960	1, 559, 656	1, 593, 228	[2] 1, 476, 005	1, 569, 099
Copper exported [1]	133, 305	174, 135	109, 580	215, 951	199, 819
Stock at end of year [1]	35, 000	26, 000	49, 000	25, 000	34, 000
Total	168, 305	200, 135	158, 580	240, 951	233, 819
Apparent withdrawals on domestic account [3]	1, 304, 000	1, 360, 000	1, 435, 000	1, 235, 000	1, 335, 000

[1] May include some copper refined from scrap.
[2] Revised figure.
[3] Includes copper delivered by industry to the National Stockpile.

Actual consumption of refined copper in 1955 was 20 percent more than in 1954. In the first quarter consumption averaged 124,400 tons monthly, in the second 132,900, in the third 99,000, and in the fourth 147,000. The peak was 151,000 tons in December. The low rate in the third quarter was caused by brass-mill vacations in July and by devastating floods in the Connecticut Valley during August.

Distribution of consumption by principal consuming groups followed the pattern of recent years, with wire mills using 54 percent (53 in 1954) of the total consumed and brass mills 43 percent in both 1954 and 1955. Refined copper consumed by brass foundries, previously combined with miscellaneous plants, is shown separately for the first time for 1955. Unlike table 22, in which all but new copper is eliminated so far as possible, table 23 does not distinguish between new and old copper but lists all copper in refined form.

Some copper precipitates are used directly in manufacturing paints and other items. The figures may not be shown separately and are not listed in table 23, which relates to refined copper only.

TABLE 23.—Refined copper consumed in 1953–55, by classes of consumers, in short tons

Class of consumer	Cathodes	Wire bars	Ingots and ingot bars	Cakes and slabs	Billets	Other	Total
1953:							
Wire mills	4,066	732,228	16,615	120	----	----	753,029
Brass mills	157,735	57,195	140,332	188,315	145,625	275	689,477
Chemical plants	----	----	300	----	----	3,549	3,849
Secondary smelters	6,588	----	8,269	114	----	334	15,305
Foundries and miscellaneous	3,902	258	19,493	227	851	7,824	32,555
Total	172,291	789,681	185,009	188,776	146,476	11,982	1,494,215
1954:							
Wire mills	8,803	649,567	10,231	----	----	----	668,601
Brass mills	83,136	54,237	82,750	170,144	155,359	19	545,645
Chemical plants	----	----	11	----	----	2,318	2,329
Secondary smelters	5,037	----	2,064	131	----	202	7,434
Foundries and miscellaneous	1,972	308	16,683	257	536	10,964	30,720
Total	98,948	704,112	111,739	170,532	155,895	13,503	1,254,729
1955:							
Wire mills	9,050	791,816	11,797	----	----	----	812,663
Brass mills	100,819	63,394	133,710	200,012	149,064	45	647,044
Chemical plants	----	----	564	----	----	1,180	1,744
Secondary smelters	4,768	----	1,213	469	----	377	6,827
Foundries	4,063	58	13,004	3	211	139	17,478
Miscellaneous [1]	1,403	131	4,079	318	377	9,940	16,248
Total	120,103	855,399	164,367	200,802	149,652	11,681	1,502,004

[1] Includes iron and steel plants, primary smelters producing alloys other than copper, consumers of copper powder and copper shot, and miscellaneous manufacturers.

Figures on apparent consumption of primary copper are available for a long period, whereas compilations on the 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 table 22 aims to show primary consumption only, it should be noted that exports and stocks, as well as the import component of "total supply," doubtless 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.

STOCKS

Industry stocks of refined and unrefined copper rose 10 percent in 1955.

Year-end producers' inventories of refined copper increased 36 percent over 1954 but continued low in relation to earlier years. Producers' stocks of unrefined metal rose 6 percent. Of the total stocks at the end of 1955, only 14 percent was in the form of refined copper; the remainder was in smelter shapes and in transit to refineries and in smelter shapes and materials in process of refining at refineries. Table 24 lists 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.

Figures compiled by the Copper Institute show that domestic stocks of refined copper increased from 47,100 tons to 61,554 in 1955. Inventory data of the Bureau of Mines and 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. 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 24.—Stocks of copper at primary smelting and refining plants in the United States at end of year, 1950–55, 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]
1950	26,000	232,000	1953	49,000	223,000
1951	35,000	182,000	1954	25,000	189,000
1952	26,000	185,000	1955	34,000	201,000

[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 389,974 tons at the end of 1955 (an 8-percent increase over those on hand at the beginning of the year). Working stocks (see table 25) were 314,145 tons (3 percent more than at the end of 1954). After accounting for unfilled sales of metal, the deficiencies in stocks in relation to unfilled orders rose 55,792 tons to 78,341 tons at the end of 1955. The latter figure represented the first increase since 1951 in the deficit in stocks.

TABLE 25.—Stocks of copper in fabricators' hands at end of year, 1951–55, in short tons

[United States Copper Association]

	Stocks of refined copper [1]	Unfilled purchases of refined copper from producers	Working stocks	Unfilled sales to customers	Excess stocks over orders booked [2]
	(1)	(2)	(3)	(4)	(5)
1951	280,402	32,147	295,385	303,050	−285,886
1952	331,499	32,652	292,157	275,608	−203,614
1953	380,881	25,022	309,664	170,917	−74,678
1954	360,526	58,125	304,619	136,581	−22,549
1955	389,974	139,094	314,145	293,264	−78,341

[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

Prices again were an outstanding feature of the copper industry in 1955; they rose to the highest levels in 90 years. Reports from copper-selling agencies indicate that 1,041,300 tons of domestic refined copper were delivered to purchasers in 1955 at an average price of 37.3 cents a pound. The average price of foreign copper delivered in the United States was 37.5 cents a pound. On January 1, the price of electrolytic copper delivered in the United States, unchanged since April 1954, was 30 cents a pound; in late January the price was raised to 33 cents, and by the end of March 1955 all sellers were quoting 36 cents a pound, a price that held until August. The inadequate supply, caused by large-scale consumption and production losses due to major strikes, led to an advance in prices of principal producers from 36 to 40 cents, then to 43 cents in August. The leading United States producers' price remained at 43 cents beyond the end of the year. On the other hand, custom smelters' prices rose to 50 cents a pound in September, then fluctuated between that price and the principal producers' price until late in December, when it increased to 50.25 cents.

TABLE 26.—Average weighted prices of copper deliveries,[1] f. o. b. refinery,[2] 1951–55, in cents per pound

Year	Domestic copper	Foreign copper	Year	Domestic copper	Foreign copper
1951	24.2	26.2	1954	29.5	29.4
1952	24.2	33.6	1955	37.3	37.5
1953	28.7	34.1			

[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] In 1951–53 a substantial quantity of copper was sold on a delivered consumers' plant basis; beginning 1954 all deliveries were made on that basis and the delivered price is reflected in averages shown.

TABLE 27.—Average monthly quoted prices of electrolytic copper for domestic and export shipments, f. o. b. refineries, in the United States, 1954–55, in cents per pound

Month	1954			1955		
	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	29.62	29.671	28.767	30.02	29.783	32.574
February	29.62	29.669	29.000	32.87	32.700	36.236
March	29.74	29.686	29.168	33.14	32.935	37.314
April	29.83	29.700	29.520	35.87	35.700	37.938
May	29.87	29.700	29.658	35.87	35.700	36.187
June	29.87	29.700	29.603	35.87	35.700	36.339
July	29.87	29.700	29.570	35.87	35.700	36.504
August	29.87	29.700	29.492	37.61	38.150	40.009
September	29.87	29.700	30.066	42.87	44.052	44.339
October	29.87	29.700	31.529	42.87	43.030	43.411
November	29.87	29.700	31.259	42.87	42.964	43.860
December	29.87	29.700	31.036	42.87	43.480	44.665
Average for year	29.82	29.694	29.889	37.39	37.491	39.115

[1] American Metal Market.
[2] E&MJ Metal and Mineral Markets.

TABLE 28.—Average yearly quoted prices of electrolytic copper for domestic and export shipments, f. o. b. refineries, in the United States, 1946–55, in cents per pound

	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
Domestic f. o. b. refinery [1]	13.92	21.15	22.20	19.36	21.46	24.37	24.37	28.92	29.82	37.39
Domestic f. o. b. refinery [2]	13.820	20.958	22.038	19.202	21.235	24.200	24.200	28.798	26.694	37.491
Export f. o. b. refinery [2]	14.791	21.624	22.348	19.421	21.549	26.258	31.746	30.845	29.889	39.115

[1] American Metal Market.
[2] E&MJ Metal and Mineral Markets.

London Price.—Prices on the London Metal Exchange substantially exceeded those in the United States throughout the year. LME prices advanced to the equivalent of 40 cents a pound at the end of January and in February reached a new peak of £360 per long ton (equivalent to 45 cents a pound). In late March the price rose to £367 (45.875 cents); in July to £370 (46.25 cents) and in August to £400 (50 cents). In mid-December the LME price reached an all-time peak of £405 per long ton (50.625 cents per pound) but dropped to 50 cents at the end of the month.

On May 6 the Roan Antelope Copper Mines, Ltd., and the Mufulira Copper Mines, Ltd., large copper producers in Northern Rhodesia, announced that, effective May 9 they would offer copper at a fixed basic price of £280 a long ton (35 cents per pound), c. i. f. United Kingdom, to those of their consumers who were willing and able to instill a degree of stability into resale prices of copper and brass products. Prices were fixed for 30 days, at which time they were to be fixed for another definite period, and in June the Rhodesian Selection Trust Co., representing the 2 producers, announced that the price of £280 would continue, subject to change on 24 hours' notice. In early September the RST price was raised to £360 (45 cents) and thereafter remained unchanged through December.

TABLE 29.—United Kingdom monthly average prices in 1955 [1]

Month	Cash		Three months		Settlement	
	Per long ton £ s. d.	Cents per pound [2]	Per long ton £ s. d.	Cents per pound [2]	Per long ton £ s. d.	Cents per pound [2]
January	302 8 1	37.60	284 1 2	35.32	303 2 5	37.69
February	341 15 3	42.47	325 8 0	40.44	342 13 0	42.58
March	351 2 5	43.76	340 8 11	42.42	351 10 10	43.81
April	328 0 0	40.95	319 3 11	39.85	328 10 0	41.01
May	318 10 8	39.76	303 5 8	37.85	319 1 11	39.83
June	343 1 4	42.73	330 10 11	41.17	343 12 3	42.80
July	348 6 11	43.31	342 9 0	42.58	348 16 2	43.37
August	370 17 9	46.14	363 2 9	45.17	371 8 2	46.20
September	383 19 1	47.75	379 11 4	47.21	384 7 9	47.80
October	355 17 10	44.36	346 3 1	43.15	356 7 2	44.42
November	377 11 7	47.22	365 19 9	45.77	378 1 4	47.28
December	395 9 6	49.48	387 15 6	48.52	395 18 6	49.54
Average	351 14 10	43.83	341 0 3	42.49	352 5 6	43.90

[1] Metal Bulletin (London).
[2] Averages per long ton converted to cents per pound by using average monthly rates of exchange by Federal Reserve Board.

FOREIGN TRADE [3]

Imports.—Imports of unmanufactured copper in 1955 were virtually unchanged from 1954. Chile continued to be the chief source of foreign supplies; however, the downward trend in imports of Chilean copper continued for the third successive year. Increased quantities of copper from Canada, Peru, and Rhodesia nearly equaled the decreased imports from Chile.

Canada displaced Chile as the principal foreign supplier of refined copper, as receipts of refined copper from Chile declined nearly 50 percent from 1954. Strong demands and higher prices in foreign markets were principal factors in diverting Chilean refined copper from the United States.

Supplies of unrefined copper from Chile, Peru, and Rhodesia were greater than in the preceding year. Much of the foreign copper that entered the country was later exported in refined or manufactured forms. United States smelters and refineries continued in 1955 to treat foreign crude materials, both purchased and toll.

Exports.—Most of the copper exported from the United States was in the form of refined copper and in advanced forms of manufacture in which the copper content is not calculable. Inadequate supplies of copper led the United States to restrict exports. On February 7 exports of refined copper of domestic origin were virtually banned and those of copper and copper-base scrap curtailed. Effective March 10, copper and copper-base-alloy wire and cable were made subject to licensing to all destinations except Canada; and on July 26, third-quarter exports of foreign copper (formerly without quota) were limited to 54,000 tons. Exports of scrap were restricted further.

Exports of refined copper were 7 percent less than in 1954, and most of the shipments went to European countries. Exports of old

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

and scrap decreased 59 percent from the all-time high of 1954 and went mainly to West Germany.

Tariff.—Suspension of the 2-cent excise tax on copper was extended from June 30, 1955, to June 30, 1958, by a bill signed by the President June 22. The law provides that the Tariff Commission must notify the President within 15 days after the end of any calendar month in which the average price drops below 24 cents a pound, delivered Connecticut Valley; within 20 days thereafter the President has to revoke the suspension. Effective June 8, suspension of nonferrous-scrap duties was extended to June 30, 1956.

TABLE 30.—Copper (unmanufactured) imported into the United States, 1946–50 (average) and 1951–55, in short tons, in terms of copper content [1]

[U. S. Department of Commerce]

	Ore	Concentrate	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
1946-50 (average)	7,435	81,464	2,995	178,640	229,229	12,399	512,162
1951	2,035	97,591	3,051	141,922	238,972	5,564	489,135
1952	3,198	98,143	3,900	162,193	346,960	4,486	618,880
1953	6,997	106,574	7,019	273,610	274,111	7,793	676,104
1954							
North America:							
Canada	587	29,665	1,962	4,537	51,241	1,919	89,911
Cuba	242	17,356				684	18,282
Mexico	54	11,590	2,630	30,620	6,276	59	51,229
Other North America	1	14	3			388	406
Total	884	58,625	4,595	35,157	57,517	3,050	159,828
South America:							
Bolivia	465	3,436	12				3,913
Chile	1,064	11,483		128,850	[2] 125,536		[2] 266,933
Peru	507	8,056	884		13,003		22,450
Other South America	3	4					7
Total	2,039	22,979	896	128,850	[2] 138,539		[2] 293,303
Europe:							
Belgium-Luxembourg					718		718
France						1,587	1,587
Germany, West			77		4	(3)	81
Norway					5,664		5,664
Turkey				2,664			2,664
Yugoslavia					3,886		3,886
Other Europe		17				25	42
Total		17	77	2,664	10,272	1,612	14,642
Asia:							
Philippines	(4)	[4] 19,405				20	19,425
Other Asia					32	1	33
Total	(4)	[4] 19,405			32	21	19,458
Africa:							
Belgian Congo				8,045	7,494		15,539
Federation of Rhodesia and Nyasaland		256		60,417	1,232		61,905
Union of South Africa	2,016	5,377		6,089			13,482
Total	2,016	5,633		74,551	8,726		90,926
Oceania: Australia	404	779	227	[2] 15,262			[2] 16,672
Grand total	5,343	107,438	5,795	[2] 256,484	[2] 215,086	4,683	[2] 594,829

See footnotes at end of table.

TABLE 30.—Copper (unmanufactured) imported into the United States, 1946–50 (average) and 1951–55, in short tons, in terms of copper content [1]—Con.

[U. S. Department of Commerce]

	Ore	Concentrate	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
1955							
North America:							
Canada	1,435	24,909	1,047	301	72,371	6,990	107,053
Cuba	706	19,650	----	----	----	766	21,122
Mexico	190	7,889	4,226	28,105	7,919	1,313	49,642
Other North America	----	8	2	----	----	683	693
Total	2,331	52,456	5,275	28,406	80,290	9,752	178,510
South America:							
Bolivia	476	2,948	9	----	----	----	3,433
Chile	4,560	16,876	164	137,886	66,614	----	226,100
Peru	760	7,947	1,141	3,483	17,771	17	31,119
Other South America	5	10	----	----	----	5	20
Total	5,801	27,781	1,314	141,369	84,385	22	260,672
Europe:							
Belgium-Luxembourg	----	----	----	----	338	45	383
France	----	----	----	----	----	2,128	2,128
Germany, West	----	----	----	----	3,577	5	3,582
Malta, Gozo and Cyprus	----	4,388	----	----	----	----	4,388
Netherlands	----	----	----	----	2,291	----	2,291
Norway	----	----	----	----	149	----	149
Sweden	----	----	----	----	1,024	----	1,024
Turkey	----	----	----	547	----	----	547
United Kingdom	----	----	----	542	11,105	3	11,650
Yugoslavia	----	----	----	----	2,149	----	2,149
Total	----	4,388	----	1,089	20,633	2,181	28,291
Asia:							
Philippines	(4)	[4] 13,321	----	----	----	----	13,321
Other Asia	----	----	----	----	145	100	245
Total	(4)	[4] 13,321	----	----	145	100	13,566
Africa:							
Belgian Congo	----	----	----	9,231	4,929	----	14,160
Federation of Rhodesia and Nyasaland	----	262	----	62,545	10,656	1	73,464
Union of South Africa	----	10,269	----	2,218	602	----	13,089
Total	----	10,531	----	73,994	16,187	1	100,713
Oceania: Australia	(3)	1,152	1,309	8,835	----	531	11,827
Grand total	8,132	109,629	7,898	253,693	201,640	12,587	593,579

[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] Less than 1 ton.
[4] Some copper in "Ore" and "Other" from Republic of the Philippines is not separately classified and is included with "Concentrate."

TABLE 31.—Copper (unmanufactured) imported into the United States, 1946–50 (average) and 1951–55 [1]

[U. S. Department of Commerce]

Year	Contained copper (short tons)	Year	Contained copper (short tons)
1946–50 (average)	512,162	1953	676,104
1951	489,135	1954	[2] 594,829
1952	618,880	1955	593,579

[1] Data are "general" imports; that is, they include copper imported for immediate consumption plus material entering the country under bond.
[2] Revised figure.

TABLE 32.—Copper (unmanufactured) imported into the United States, 1946–50 (average) and 1951–55, by countries, in short tons, in terms of copper content [1]

[U. S. Department of Commerce]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada (including Newfoundland and Labrador)	54,688	54,554	81,932	107,427	89,911	107,053
Cuba	16,468	22,302	19,934	18,206	18,282	21,122
Mexico	65,127	47,878	50,997	65,818	51,229	49,642
Other North America	454	744	408	629	406	693
Total	136,737	125,478	153,271	192,080	159,828	178,510
South America:						
Bolivia	5,589	4,449	3,097	3,972	3,913	3,433
Chile	265,791	268,359	362,303	281,074	[2] 266,933	226,100
Peru	26,621	10,054	11,317	26,523	22,450	31,119
Other South America	1,432	300	213	328	7	20
Total	299,433	[2] 283,162	376,930	311,897	[2] 293,303	260,672
Europe:						
Belgium-Luxembourg	167		646	5,615	718	383
France	812	1,587	1,806	2,160	1,587	2,128
Germany	9		[3] 8,932	[3] 3,570	[3] 81	[3] 3,582
Malta, Gozo and Cyprus	3,221	5,556	5,441	3,680		4,388
Netherlands	275	47	41	175		2,291
Norway	851		1	4,427	5,664	149
Sweden	11			2,217		1,024
Turkey	5,437		3,779	11,894	2,664	547
United Kingdom	1,449	6	37	2,194	25	11,650
Yugoslavia	7,668	6,223	14,833	7,775	3,886	2,149
Other Europe	345	91	79		17	
Total	20,245	[2] 13,510	35,595	43,707	14,642	28,291
Asia:						
Japan	11,759	1,908	223		1	75
Philippines	4,507	12,608	14,787	13,538	19,425	13,321
Other Asia	481	140	4	110	32	170
Total	16,747	14,656	15,014	13,648	19,458	13,566
Africa:						
Belgian Congo	914		(4)	5,799	15,539	14,160
Northern Rhodesia	27,968	43,717	28,225	88,042	[6] 61,905 (Northern and Southern Rhodesia)	73,464 (Northern and Southern Rhodesia)
Southern Rhodesia	[5] 1,162	98	167	212		
Union of South Africa	7,972	7,353	8,588	7,678	13,482	13,089
Other Africa	99	17				
Total	38,115	51,185	36,980	101,731	90,926	100,713
Oceania:						
Australia	883	1,143	684	13,041	[2] 16,672	11,827
Other Oceania	2	1	406			
Total	885	1,144	1,090	13,041	[2] 16,672	11,827
Grand total	512,162	489,135	618,880	676,104	[2] 594,829	593,579

[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] Less than 1 ton.
[5] Chiefly from Northern Rhodesia.
[6] Beginning July 1, 1954, classified as Federation of Rhodesia and Nyasaland.

TABLE 33.—Old brass and clippings from brass or Dutch metal [1] imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Short tons		Value	Year	Short tons		Value
	Gross weight	Copper content			Gross weight	Copper content	
1946–50 (average)	51,489	36,332	$15,985,804	1953	9,679	7,503	$3,737,085
1951	6,523	4,945	2,095,962	1954	5,272	3,657	[2] 1,567,574
1952	10,321	7,627	3,765,416	1955	11,748	8,284	[2] 5,144,577

[1] For remanufacture.
[2] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to years prior to 1954.

TABLE 34.—Copper imported for consumption in the United States, 1946–50 (average) and 1951–55, by classes [1]

(Quantity in terms of copper content)

[U. S. Department of Commerce]

Year	Ore		Concentrates [2]		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 value
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	
1946–50 (average)	3,190	$1,217,906	62,952	$23,151,465	1,226	$528,384	146,303	$51,743,641	230,325	$89,281,668	11,466	$3,839,625	$169,762,689
1951	3,373	1,418,640	74,862	36,303,596	2,012	1,072,705	129,666	63,979,207	242,553	126,126,464	6,792	3,318,880	232,219,492
1952	3,666	1,975,987	96,562	52,620,100	4,025	2,553,797	173,425	106,325,258	347,338	227,213,872	5,125	2,559,127	393,248,141
1953	5,560	3,057,966	96,448	53,006,531	6,547	4,040,632	279,242	179,225,693	274,111	182,190,014	7,827	4,017,577	425,538,413
1954	6,182	3,398,562	[3] 114,353	[3] 62,675,609	5,408	3,088,549	[3] 257,393	[3] 150,790,719	[3] 215,118	[3] 127,130,493	4,752	[4] 2,080,720	[3, 4] 349,164,652
1955	7,476	4,948,251	105,045	68,405,687	6,386	4,515,264	253,693	182,073,314	201,640	153,603,524	12,597	[4] 9,058,028	[4] 422,604,068

[1] Exclude imports for manufacture in bond and export, which are classified as "imports for consumption" by the U. S. Department of Commerce.

[2] Some copper in "Ore" and "Other" from Republic of the Philippines is not separately classified and is included with "Concentrate."

[3] Revised figure.

[4] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to years prior to 1954.

TABLE 35.—Copper exported from the United States, 1946–50 (average) and 1951–55 [1] in short tons

[U. S. Department of Commerce]

	Ore, concentrate, 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 [2]	Wire and cable insulated	Other copper manufactures [2]
1946–50 (average)	685	125,051	7,144	4,375	3,723	2,517	8,256	26,899	(3)
1951	234	133,305	521	7,701	2,160	572	7,983	14,032	(3)
1952	648	174,135	1,937	8,941	2,591	553	7,163	17,070	(3)
1953	495	109,580	321	34,568	1,622	367	9,313	15,622	294
1954	2,369	215,951	344	[1]75,749	1,199	300	4,548	[1]14,342	250
1955									
North America:									
Canada		1,164	50	2,340	356	313	403	2,277	221
Cuba		5	2		87	23	230	1,057	
Mexico	5,824	292	5		68	31	287	780	11
Other North America		23	5		65	32	206	1,246	
Total	5,824	1,484	62	2,340	576	399	1,126	5,360	23
South America:									
Argentina		2,975			8			206	
Brazil		8,906			20	11	24	153	
Chile		16	5		(4)	21	26	162	
Colombia		6			47	3	222	1,047	1
Peru		1			20	1	26	518	
Venezuela		5			103	7	569	1,671	
Other South America		1	3		5	3	26	191	
Total		11,910	8		203	46	893	3,948	1
Europe:									
Austria		1,261		222				(4)	
Belgium-Luxembourg		1,155		740	33		6	57	
Denmark		270					14	11	
France		65,062		44		3	111	111	
Germany, West	1,581	35,251	1	19,243	8		4	33	
Italy		9,659	(4)	354	(4)		1,094	130	
Netherlands	19	16,224		241	53		42	49	
Norway		2,575			39		58	88	
Spain	223			53		3	995	91	
Sweden		6,447	(4)				1	19	
Switzerland		8,685	56	273	4	(4)		1	
Turkey					4	6	14	314	
United Kingdom		28,092	62	6,730	1	38	273	85	
Other Europe			1		2	1	65	262	
Total	1,823	174,681	120	27,900	144	51	2,677	1,251	
Asia:									
India		4,830		744	62	35	15	41	
Israel					15		41	98	
Japan	1	184	7	143	36	(4)	36	480	
Korea, Republic of					14	2	55	1,168	
Nansei and Nanpo Islands					66	3	4	81	
Pakistan				10	4		1,504	193	
Philippines		6	3		67	1	160	2,063	
Taiwan		187			4		6	4,036	
Other Asia		1	1		62	5	248	890	
Total	1	5,208	11	897	330	46	2,069	9,050	

See footnotes at end of table.

TABLE 35.—Copper exported from the United States, 1946–50 (average) and 1951–55,[1] in short tons—Continued

[U. S. Department of Commerce]

	Ore, concentrate, 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 [2]	Wire and cable insulated	Other copper manufactures [3]
1955—Continued									
Africa:									
Federation of Rhodesia and Nyasaland	----------	273	------	------	1	------	13	3	--------
Union of South Africa	----------	--------	------	------	15	------	116	182	--------
Other Africa	----------	--------	1	------	20	(4)	81	160	1
Total	----------	273	1	------	36	(4)	210	345	1
Oceania:									
Australia	----------	6,263	------	------	1	(4)	1	16	--------
Other Oceania	----------	--------	------	------	2	------	------	4	--------
Total	----------	6,263	------	------	3	(4)	1	20	--------
Grand total	7,648	199,819	202	31,137	1,292	542	6,976	19,974	234

[1] Changes in Minerals Yearbook, 1954, should read as follows: Old and scrap—West Germany 35,049 short tons; wire and cable, insulated—Venezuela 986 short tons.
[2] Due to changes in classification data for 1952–55 not strictly comparable to earlier years.
[3] Weight not recorded.
[4] Less than 1 ton.

TABLE 36.—Copper exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Ore, concentrate, composition metal, and unrefined copper (copper content)		Refined copper and semimanufactures [1]		Other copper manufactures [1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	685	$275,203	177,965	$85,847,093	(2)	$1,892,352	178,650	$88,014,648
1951	234	174,298	166,274	98,836,756	(2)	1,982,042	166,508	100,993,096
1952	648	494,930	212,390	155,121,116	(2)	211,201	213,038	155,827,247
1953	495	290,405	171,393	116,212,961	294	352,124	172,182	116,855,490
1954	2,369	1,309,158	[3] 312,433	[3] 197,050,734	250	307,848	[3] 315,052	[3] 198,667,740
1955	7,648	7,325,855	259,942	207,741,551	234	308,792	267,824	215,376,198

[1] Due to changes in classifications 1952–55 data not strictly comparable to earlier years.
[2] Weight not recorded.
[3] Revised figure.

TABLE 37.—Unfabricated copper-base alloy[1] ingots, bars, rods, shapes, plates, and sheets exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1946–50 (average)	6,934	$4,158,805	1953 [2]	4,453	$3,568,657
1951	3,820	2,951,881	1954 [2]	3,492	2,924,161
1952 [2]	5,514	5,424,662	1955 [2]	2,175	3,200,780

[1] Includes brass and bronze.
[2] Due to changes in classifications data not strictly comparable to earlier years.

TABLE 38.—Copper-base alloys (including brass and bronze) exported from the United States, 1954–55, by classes

[U. S. Department of Commerce]

Class	1954		1955	
	Short tons	Value	Short tons	Value
Ingots	2,601	$1,762,433	810	$1,186,281
Scrap	93,972	38,468,745	45,260	24,506,514
Bars, rods, and shapes	455	518,882	648	821,335
Plates, sheets, and strips	436	642,846	717	1,193,164
Pipes and tubes	865	1,215,410	1,157	1,715,171
Pipe fittings	983	2,222,044	1,302	3,047,430
Plumbers' brass goods	2,920	6,979,584	3,081	7,838,925
Welding rods and wire	760	1,444,106	823	1,641,970
Castings and forgings	435	708,889	468	777,191
Powder	68	71,166	196	236,473
Hardware	(1)	2,485,595	(1)	3,398,552
Semifabricated forms, not elsewhere classified	16	42,834	22	56,724
Other copper-base-alloy manufactures	(1)	523,062	(1)	555,827
Total	(1)	57,085,596	(1)	46,975,557

[1] Weight not recorded.

TABLE 39.—Copper sulfate (blue vitriol) exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1946–50 (average)	35,873	$4,632,670	1953	32,659	$6,250,121
1951	43,129	8,753,641	1954	29,762	5,780,801
1952	43,421	8,482,870	1955	37,382	8,381,815

TECHNOLOGY

The history, geology, mining, and milling of a new copper mine of the Chibougamau district, Quebec Province, Canada, are described.[4] This modern operation treated daily over 2,000 tons of copper-gold ore containing 3.0 percent copper and 0.1 ounce of gold per ton, with recoveries of 93 and 70 percent, respectively. A similar report [5] was issued on the Mineral Hill copper mine in Arizona.

At the Chino mines in New Mexico,[6] blasting problems caused by lack of uniformity in rocks were overcome through the use of 12-inch-diameter drill holes instead of 3- and 4½-inch. The change to 12-inch holes resulted in a 33-percent saving in the churn-drill footage necessary to blast a bench and also saved time in loading holes. The greater concentration of explosives improved fragmentation and resulted in less "heave" and greater "back break."

Following conversion to mobile drilling [7] at the Utah copper operations of the Kennecott Copper Corp. in November 1953, the man-count of the Drilling and Blasting Department was reduced 34 percent;

[4] Mamen, Chris, Campbell Chibougamau Mines: Canadian Min. Jour., vol. 76, No. 11, November 1955, pp. 56–64.
[5] Bowman, A. B., Banner Mining Co., Opens the Mineral Hill Copper Property in Arizona: Min. Eng., vol. 7, No. 11, November 1955, pp. 1022–1025.
[6] Ballmer, G. J., and Harris, K. U. N., Factors in Selection of Drill Hole Size at Chino: Min. Cong. Jour., vol. 41, No. 7, November 1955, pp. 74–76, 105.
[7] Snow, L. E., Mobile Drill Improvements at Utah Copper Pit: Min. Cong. Jour., vol. 41, No. 1, January 1955, pp. 18–21.

and 60 miles of compressed-air line, as well as an annual cost of $105,000 for operating a central compressed-air plant, 94 conventional drills and accessories, and maintenance costs, was eliminated. In addition to these benefits safety and general operations were improved by use of the mobile drill.

Development at the Greater Butte project in Montana,[8] by The Anaconda Company has raised reserve estimates from 130 to 160 million tons. The Skyrme open pit, which started operations in 1954, may be supplemented by a large open pit, containing an indicated ore reserve of 100 million tons, south and east of the Kelley mine. Changes in hoisting, the addition of an auxiliary shaft, the use of slushers in block caving, and substituting steel for wood forms in concreting operations have improved operations and helped to boost production. Illustrated descriptions of the block development, mining procedures, and ventilation systems at Butte were published in another report.[9]

The underground block-caving practice at the Miami mine in Arizona is described.[10] Few changes have been made in the basic scheme adopted in 1925; from then until mid-1954 about 97 million tons was mined. As the mining system proved itself, sizable additions were made to the original ore reserves of 84 million tons. Planning stope development, stope-draw maintenance, and illustrations are included in the article.

To reduce mining costs and increase mine output, the Bagdad Copper Corp., in Arizona, changed from underground block caving to open-pit operation.[11]

The Yerington mine in Nevada was confronted with some unusual problems, even though it is similar to many open pits. One problem is the large quantity of ground water in the open pit, and another is the very close control required in selective mining to obtain an average grade of ore. Methods used to successfully solve the problems are described.[12] Also included is a description of the Leviathan sulfur mine in Alpine County, Calif., which supplies sulfur to produce sulfuric acid for leaching oxide copper ore at Yerington.

Methods of keeping cost data and determining when equipment units should be replaced in Arizona open-pit copper mines are discussed.[13]

The use of a 24-inch Dorrclone,[14] equipped with vactrol underflow control, at the Quincy Mining Co. reclamation plant at Hubbell, Mich., eliminated decreases in plant capacity owing to excessive quantities of fines in the feed. Before the Dorrclone was installed, large volumes of minus-48-mesh material could not be handled, which curtailed production; after the installation, dewatered, deslimed, and scrubbed material was fed from the cyclone directly to the flotation cells. Underflow density of the unit can be regulated within narrow limits, even though plant feed varies widely in particle size.

---

[8] Engineering and Mining Journal, Anaconda Changes Mining Techniques as Butte Output and Reserves Climb: Vol. 156, No. 8, August 1955, pp. 86–89.

[9] Hannifan, M. K., The Greater Butte Project: Min. Cong. Jour., vol. 41, No. 6, June 1955, pp. 46–49.

[10] Still, J. W., Block Caving at Miami: Min. Cong. Jour., vol. 41, No. 4, April 1955, pp. 89–92.

[11] Colville, George W., The Bagdad Open-Pit Conveyor: Min. Cong. Jour., vol. 41, No. 7, July 1955, pp. 24–25, 48.

[12] Burch, H. R., Operating Problems at Yerington: Min. Cong. Jour., vol. 41, No. 3, March 1955, pp. 62–64.

[13] Coil, B. R., What Is the Economical Point of Replacement of Pit Equipment in the Southwest Copper Pits?: Min. Eng., vol. 7, No. 10, October 1955, pp. 921–924.

[14] Koepel, Louis G., and Keller, Leon D., Wet Cyclone Eliminates Bottleneck Caused by Too Many Fines: Eng. and Min. Jour., vol. 156, No. 4, April 1955, pp. 86–88.

Methods and procedures [15] used at the Kosaka hydrometallurgical plant of the Dowa Mining Co. of Japan to recover metals from the copper-zinc concentrate were published. Roasting of the concentrate, followed by leaching of the calcine and electrodeposition of the metals, recovers 93 percent of the copper and 65 percent of the zinc.

Concentrate was smelted at the rate of 1,000 tons a day by the new commercial flash-smelting process developed by the International Nickel Co.[16] The substitution of energy from local sources for imported coal and the production of liquid sulfur dioxide, replacing equivalent imported sulfur, are the major benefits of the process. In 1954 the savings in coal totaled 60,000 tons, and the production of 70,000 tons of liquid sulfur dioxide was equivalent to 35,000 tons of sulfur.

It has been determined that the copper content of ferrous alloys can be lowered by the addition of sodium sulfide slags.[17] These slags also lower the initial sulfur content present before the addition of slag or prevent an excessive pickup of sulfur. Hydrated sodium sulfide, sodium sulfate, and sodium sulfite may be used to form the slags. Short holding times were best, as increased slag-metal contact did not increase removal of copper and caused an increase in the sulfur content of the iron alloy.

The latest development [18] in continuous casting at the American Smelting & Refining Co. plant at Barber, N. J., turned out bars and tubes up to 9⅛ inches in diameter. Pure copper and various alloying metals were melted in an electric-arc furnace and poured into an electrically heated holding furnace under a blanket of nitrogen to exclude air. The metal flows from the bottom of the holding furnace in a steady stream into a water-cooled graphite die or mold about 1 foot long. When the metal has passed halfway through the die, it has already solidified and emerges from the bottom as a continuous bar or tube.

Good-quality copper strip was produced from roll-bonded copper powder.[19] Low-grade copper-bearing scrap, which cannot be remelted into good-quality ingot was leached with alkaline cupric ammonium carbonate solution. After the solution was purified, the copper was precipitated with carbon monoxide or hydrogen in an agitated autoclave. Nickel, lead, steel, tin, and zinc are byproducts. Loose powder was compacted into strips or rods between rolls, sintered, and rerolled, followed by rolling and annealing to obtain necessary mechanical properties.

A film of black copper oxide applied to copper wire by continuous electrolytic oxidation in a hot alkaline solution serves as an ideal barrier substrate between the copper conductor and the insulation.[20] Electrical apparatus, wound with black oxidized copper wire insulated

[15] Kurushima, Hideraburo, and Tsunoda, Suketoshi, Hydrometallurgy of Copper-Zinc Concentrates: Jour. Metals, vol. 7, No. 5, sec. 1, May 1955, pp. 634-638.
[16] Staff, Mining and Smelting Division, International Nickel Co. of Canada, Ltd., Oxygen Flask Smelting Swings Into Commercial Operation· Jour. Metals, vol. 7, No. 6, June 1955, pp. 742-750.
[17] Langenberg, Frederick C., Lindsay, Robert W., and Robertson, D. P., Removal of Copper From Iron-Copper-Carbon Melts by the Use of Sodium Sulfide Slags: Blast Furnace and Steel Plant, vol. 43, No. 10, October 1955, pp. 1142-1147.
[18] Business Week, Tubes Come Out Bigger: No. 1365, Oct. 29, 1955, pp. 92-93.
[19] Work, Lincoln T., Shaw, John D., and Knapp, Walter V., Rolled Metal Powder Sheet: Metal Prog. vol. 68, No. 4, October 1955, pp. 115-116.
[20] Hurd, Dallas T., Kriehle, James G., and Pfeiffer, H. G., Continuous Anodic Oxidation of Copper Wire: Ind. Eng. Chem., vol. 47, No. 12, December 1955, pp. 2483-2491.

by a thin plastic film operated satisfactorily at temperatures over 300° C. for several hours.

The purpose and effects of annealing copper and copper alloys are discussed.[21] Annealing temperature and time are factors to be considered. Although a long annealing period at the lowest possible temperature is ideal, high temperatures and short processes are used commercially. The importance of grain size, stress relief, and age hardening on properties are discussed. Tables are included showing annealing and stress-relieving temperatures for copper and copper-base alloys.

A new series of copper-tube sizes for soil, waste, and vent lines was announced.[22] Owing to the corrosion-resistant properties of copper, the tubes will be a permanent installation and, at the same time, provide savings for all types of building construction. Because of its lighter weight and easier procedure for joining, copper tubing lends itself to shop prefabrication for larger building developments with a multiplicity of units.

Another article [23] lists the advantages in using copper tubing to replace underground piping systems that have deteriorated from corrosion. The principal benefit is in lower cost of installation.

Microsize, powdered mixtures of pure copper and pure lead in either a dry form or in a lubricant suspension effectively recondition worn, scarred, or corroded bearing surfaces.[24] The material can be applied without dismantling equipment. Benefits of the mixture are due to the lubricity of lead and the ability of copper to dissipate heat rapidly.

Using beryllium copper [25] for plunger tips and water cooling increases the life of the plunger tip and the sleeve of an aluminum die-casting machine. The beryllium-copper tips are still in good condition after giving enough service to wear out 70 made tips of the material used previously. In addition, the alloy has tensile strength, endurance, and wear resistance comparable to steel.

When a special copper supplement (4 percent copper sulfate) was included in rations for fattening pigs, a positive response in terms of live-weight gain and efficiency of food utilization was observed.[26] There were no significant changes in carcass quality due to the copper supplement.

A new method was developed and tested for determining copper in soil and rock in the field.[27] Known as the biquinoline technique, it is simple and will permit 60 to 80 determinations per man-day in the field. Necessary reagents and apparatus for both the laboratory and field are listed.

During an investigation of a Zolon red, it was found that this new reagent formed deep-blue insoluble compounds with silver and cuprous ions.[28] The test using this red dye prepared from 1-phenyl-3-

[21] Heim, Arthur I., Heat-Treating Copper-Base Alloys: Steel, vol. 137, No. 12, Sept. 19, 1955, pp. 114-117.
[22] Air Conditioning, Heating, and Ventilating, Copper Drainage Tube: Vol. 52, No. 4, April 1955, pp. 160. 165-166.
[23] Saurwein, G. K., Renewing Underground Piping: Heating, Piping, and Air Conditioning, vol. 27, No. 1, January 1955, pp. 173-175.
[24] Hodge, Stanley, New Powdered Material Reduces Bearing Wear: Iron Age, vol. 176, No. 6, Aug. 11, 1955, pp. 87-89.
[25] Iron Age, Beryllium-Copper, Water Cooling Prolongs Plunger Life: Vol. 176, No. 20, Nov. 17, 1955, p. 115.
[26] Barber, R. S., Brande, R., Mitchell, K. G., and Cassidy, J., High Copper Mineral Mixture for Fattening Pigs: Chem. Ind. (London), No. 21, May 21, 1955, p. 601.
[27] Almond, Hy, Rapid Field Determination of Trace Copper: Eng. and Min. Jour., vol. 156, No. 10, October 1955, pp. 88-89.
[28] Gehauf, Bernard, and Golderson, Jerome, New Organic Reagent for Silver and Copper: Anal. Chem., vol. 27, No. 3, March 1955, pp. 420-421.

methyl–5–pyrozolone, pyridine, sodium cyanide, and chloramine–T has a sensitivity of 1 part in 600,000 for silver and 1 in 250,000 for copper.

Copper ranging from 0.001 to 1.00 percent in molybdenum can be determined rapidly and accurately by spectrophotometric methods using alpha-benzoinoxime.[29]

Flame spectrophotometric methods were used to determine the copper in aluminum-, tin-, and zinc-base alloys.[30] In precision and accuracy the flame-analysis method compared favorably with conventional colorimetric methods in the concentration range of 0.0 to 5.0 percent copper. However, as preliminary separations were not required before the flame analysis, the time determination was shortened to only a few minutes after dissolution of the sample.

As little as 0.0001 percent of either nickel or zinc in cupriferous materials may be determined by electrolysis of an ammoniacal solution of the sample with a mercury electrode at a constant definite potential.[31] Ultimate sensitivity of the method is usually 0.0005 mg. of nickel or zinc in a sample containing up to 10 grams.

A rapid spectrographic method [32] may be used for the quantitative determination of very small quantities of lead in oxygen-free, high-conductivity copper. Essentially, the method consists of direct arcing of metal samples and standards, photometry of the resulting spectral line chosen as analytical lines, and the preparation of a working curve for determination of lead concentration. The spectrographic method does not require preliminary complexing or removal of copper as do the colorimetric and polarographic methods.

A complete bibliography [33] of 1954 publications on all phases of the copper industry with summaries of the outstanding articles appeared early in 1955.

Bureau of Mines Reports.—The following Bureau of Mines publications relate to copper in whole or in part:

Bulletin.—

556. Copper, Mineral Facts and Problems: by Helena M. Meyer, 1955, 27 pp.

Reports of Investigations.—

5139. Investigation of the Copper King Copper-Gold-Silver Deposits, Silver Crown Mining District, Laramie County, Wyo., by J. H. Soulé, 1955, 37 pp.

5177. Investigation of Copper-Nickel Mineralization in Kawishiwi River Area, Lake County, Minn., by W. A. Grosh, J. W. Pennington, P. A. Wasson, and S. R. B. Cooke, 1955, 18 pp.

Geological Survey Reports.—The following publications of the Geological Survey also relate to copper:

Bulletins.—

1000–D. Geochemical Relations of Zinc-Bearing Peat to the Lockport Dolomite, Orleans County, N. Y., by H. L. Cannon, 1955, pp. 119–185.

---

[29] Madera, Joseph, Photometric Determination of Copper in Molybdenum Products with Alpha-Benzoinoxime: Anal. Chem., vol. 27, No. 12, December 1955, pp. 2003–2004.

[30] Dean, John A., Flame Spectrophotometric Determination of Copper in Nonferrous Alloys: Anal. Chem., vol. 27, No. 8, August 1955, pp. 1224–1229.

[31] Meites, Louis, Determination of Traces of Nickel and Zinc in Copper and Its Salts: Anal. Chem., vol. 27, No. 6, June 1955, pp. 977–979.

[32] Deal, Samuel B., Spectrographic Determination of Lead in Oxygen-Free, High-Conductivity Copper: Anal. Chem., vol. 27, No. 5, May 1955, pp. 753–755.

[33] Voce, E., Copper and Copper Alloys—A Survey of Technical Progress During 1954: Metallurgia, vol. 51, No. 303, January 1955, pp. 1–16.

1007. Geology of the Uinta River-Brush Creek Area, Duchesne and Uintah Counties, Utah, by D. M. Kinney, 1955, 185 pp.
1015-C. Zinc-Lead-Copper Resources and General Geology of the Upper Mississippi Valley District, by A. V. Heyl, E. J. Lyons, A. F. Agnew, and C. H. Behre, Jr., 1955, pp. 227-245.
1036-A. Rapid Field and Laboratory Method for the Determination of Copper in Soil and Rocks, by Hy Almond, 1955, pp. 1-8.

Professional Paper.—

273. Geology and Mineral Deposits of the Boleo Copper District, Baja California, Mexico, by I. F. Wilson in collaboration with V. S. Rocha, 1955 [1956], 134 pp.

WORLD REVIEW

The worldwide copper supply was inadequate because of increased consumption, combined with production losses induced by major strikes. Despite the losses, world mine production in 1955 established an alltime peak of 3.4 million short tons—10 percent more than in 1954. Of the larger producers, gains were registered in Belgian Congo, Canada, Chile, and the United States; only Northern Rhodesia showed a loss. Output in Belgian Congo established a production record for the sixth consecutive year, the United States domestic mine output was the largest since 1943, and Chile's production was the highest since 1948. Chile regained its position from Northern Rhodesia as the world's second largest producer. Among the smaller producers notable increases were made in Australia, Cuba, Peru, the Philippines, and South-West Africa.

The most serious strike outside of the United States was that of major producers in Northern Rhodesia, lasting from January 3 until March 2. The strike in Northern Rhodesia broke the trend of the previous 5 years for consecutive new-record annual-production rates in that country. In mid-December workers struck in American-owned mines in Chile and continued on strike at the end of the year.

TABLE 40.—World mine production of copper, by countries, 1946–50 (average) and 1951–55, in short tons [1]

[Compiled by Augusta W. Jann]

Country	1946-50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	238,387	269,971	258,038	253,252	302,732	326,599
Cuba	17,450	21,700	19,700	17,800	17,500	20,760
Mexico	66,704	74,242	64,444	66,302	60,413	60,269
United States	790,641	928,330	925,359	926,448	835,472	998,570
Total	1,113,182	1,294,243	1,267,541	1,263,802	1,216,117	1,406,198
South America:						
Bolivia (exports)	6,340	5,342	5,184	4,920	4,034	3,855
Chile	433,585	419,630	450,440	400,287	400,861	477,866
Ecuador	1,008	2				6
Peru	27,152	35,576	33,563	39,023	42,055	52,268
Total	468,085	460,550	489,187	444,230	446,950	533,995

See footnotes at end of table.

TABLE 40.—World mine production of copper, by countries, 1946–50 (average) and 1951–55, in short tons [1]—Continued

Country	1946–50 (average)	1951	1952	1953	1954	1955
Europe:						
Austria	947	2,026	2,913	3,279	3,381	2,841
Finland	18,008	20,280	24,250	21,000	23,150	23,700
France	511	770	660	500	[2] 550	[2] 550
Germany:						
East [2]	16,000 (East and West)	13,200	12,100	17,600	22,000	25,300
West		1,840	2,593	2,262	2,460	1,335
Hungary	[2] 360	(3)	(3)	(3)	(3)	(3)
Italy	80	213	144	235	689	317
Norway	15,998	15,436	15,027	14,362	15,432	15,432
Portugal	411	623	705	827	474	992
Spain [4] [5]	8,153	8,333	9,895	9,406	7,951	6,726
Sweden	16,692	15,925	17,500	14,924	14,565	17,271
U. S. S. R. [2] [6] [7]	200,000	280,000	325,000	334,000	352,000	385,000
Yugoslavia [7]	36,468	35,286	36,177	34,381	33,394	31,151
Total [2] [6]	314,000	395,000	448,000	454,000	477,000	511,000
Asia:						
China [2] [7]	1,800	6,600	6,600	8,800	8,800	9,900
Cyprus (exports)	16,694	25,145	29,564	23,937	30,059	26,179
India	6,866	8,144	7,183	5,500	8,300	8,500
Japan	30,013	47,135	59,031	64,907	73,056	78,374
Korea, Republic of	227	7	550	1,540	550	1,760
Philippines	5,125	14,013	14,596	14,016	15,817	19,247
Taiwan (Formosa)	702	[2] 1,100	[2] 1,100	287	550	1,100
Turkey [7]	11,925	14,436	25,717	25,901	27,042	26,234
Total [2] [6] [8]	73,350	116,600	144,300	144,900	164,200	171,300
Africa:						
Algeria	18	132	57	110	220	77
Angola	558	1,200	1,100	1,200	1,900	880
Belgian Congo [7]	169,210	211,598	226,799	236,057	243,424	259,156
French Morocco	222	31	891	1,202	838	823
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	258,354	352,048	363,190	410,808	438,708	395,308
Southern Rhodesia	142	105	120	197	298	1,179
South-West Africa	7,045	13,619	15,457	13,357	15,668	23,562
Tanganyika [9]	8	151	282	543	478	915
Union of South Africa	33,523	37,182	38,704	39,843	46,638	49,169
Total	469,080	616,066	646,600	703,317	748,172	731,069
Australia	16,042	18,600	22,498	40,875	45,760	50,956
World total (estimate)	2,455,000	2,900,000	3,020,000	3,050,000	3,100,000	3,405,000

[1] This table incorporates a number of revisions of data published in previous Copper chapters. Data do not add to totals shown due to rounding where estimated figures are included in detail.
[2] Estimate.
[3] Data not available; estimate by authors of chapter included in continental and world totals.
[4] Yearbook, American Bureau of Metal Statistics.
[5] Does not include content of iron pyrites, the copper content of which may or may not be recovered.
[6] Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.
[7] Smelter production.
[8] Includes estimates for Burma, beginning in 1951.
[9] Copper content of exports and local sales.

TABLE 41.—World smelter production of copper, 1946–50 (average) and 1951–55, by countries, in short tons [1]

[Compiled by Augusta W. Jann]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	210,180	245,466	196,320	236,966	253,365	290,478
Mexico	56,755	65,302	56,402	57,633	48,527	49,730
United States [2]	878,226	1,036,637	1,024,427	1,047,810	945,899	1,106,526
Total	1,145,161	1,347,405	1,277,149	1,342,409	1,247,791	1,446,734
South America:						
Chile	416,255	396,944	422,498	371,745	372,818	477,232
Ecuador [3]	586					
Peru	20,589	26,804	22,640	25,802	27,907	34,872
Total	437,430	423,748	445,138	397,547	400,725	512,104
Europe:						
Austria	2,603	7,110	7,097	10,278	10,357	11,363
Finland	20,835	19,677	20,191	21,814	23,551	24,583
France [4]	191	(5)	(5)	(5)	(5)	(5)
Germany:						
East [6]	[6] 120,400	20,000	22,000	27,500	28,000	30,000
West [7]		225,749	206,746	233,328	258,271	286,306
Italy	72	204	193	236	685	314
Norway	9,424	9,542	11,033	13,342	14,205	14,876
Spain	6,677	5,506	5,070	6,590	6,374	6,482
Sweden	16,970	16,540	14,840	19,215	18,422	19,068
U.S.S.R. [6] [8]	200,000	280,000	325,000	334,000	352,000	385,000
Yugoslavia	36,468	35,286	36,177	34,381	33,394	31,151
Total [6] [8] [9]	414,000	620,000	649,000	701,000	746,000	810,000
Asia:						
China [6] [7]	1,800	6,600	6,600	8,800	8,800	9,900
India	6,969	7,933	6,808	5,510	8,020	8,155
Japan	34,029	48,334	54,353	70,080	75,914	89,353
Korea:						
North	[6] 1,500	(5)	(5)	(5)	(5)	(5)
Republic of	416	245	37	22	226	362
Taiwan (Formosa)	588	556	798	655	1,012	1,295
Turkey	11,925	14,436	25,717	25,901	27,042	26,234
Total [6] [8]	57,230	80,000	95,000	112,000	123,000	137,000
Africa:						
Angola	[10] 1,199	1,275	1,145	1,304	1,989	926
Belgian Congo	169,210	211,598	226,799	236,057	243,424	259,156
Rhodesia and Nyasaland, Federation of: Northern Rhodesia	251,767	346,239	349,837	406,087	424,045	383,220
Spanish Morocco	[11] 293	140	83	63		
Union of South Africa	10,538	36,290	37,702	38,575	45,152	47,480
Total	433,007	595,542	615,566	682,086	714,610	690,782
Oceania: Australia	[12] 17,652	17,070	22,409	38,258	42,613	41,932
World total (estimate)	2,505,000	3,085,000	3,105,000	3,275,000	3,275,000	3,640,000

[1] This table incorporates a number of revisions of data published in previous Copper chapters. Data do not add to totals shown due to rounding where estimated figures are included in detail.
[2] Smelter output from domestic and foreign ores, exclusive of scrap. Production from domestic ores only, exclusive of scrap, was as follows: 1946–50 (average) 794,858; 1951, 930,774; 1952, 927,365; 1953, 943,391; 1954, 834,381; and 1955, 1,007,311.
[3] United States imports.
[4] Exclusive of material from scrap.
[5] Data not available; estimate by authors of chapter included in total.
[6] Estimate.
[7] Includes scrap.
[8] Output from U. S. S. R. in Asia included with U. S. S. R. in Europe.
[9] Belgium reports large output of refined copper which is believed to be produced principally from crude copper from Belgian Congo; it is not shown here, as that would duplicate output reported under latter country.
[10] Average for 1949–50.
[11] Average for 1 year only, as 1950 was the first year of commercial production.
[12] Refined copper production; smelter output not available.

NORTH AMERICA

Canada.[34]—Mine output of copper in 1955 increased to 327,000 tons, 8 percent over 1954, and enabled copper to lead all metals in value. As usual, the largest production—45 percent of the total—came from the copper-nickel ores of the Sudbury district, Ontario. Quebec followed, with 31 per cent, and the remainder was supplied, in order, by Saskatchewan, British Columbia, Manitoba, Newfoundland, Nova Scotia, and New Brunswick.

Refined-copper production rose about 14 percent over 1954 to 289,000 tons, the highest annual rate in history. Two plants supplied the entire output—the refinery of the International Nickel Co. of Canada, Ltd., at Copper Cliff, Ontario; and the refinery of the Canadian Copper Refineries, Ltd., at Montreal East, Quebec.

Consumption of refined copper rose to 139,000 tons from 102,000 tons in 1954. The entire consumption virtually was by 2 rod and 2 brass mills.

TABLE 42.—Copper produced (mine output) in Canada, 1946–50 (average) and 1951–55, by Provinces, in short tons [1]

Province	1946–50 (average)	1951	1952	1953	1954	1955 (preliminary)
British Columbia	19,859	21,932	20,786	24,148	25,088	22,215
Manitoba	18,261	15,839	9,374	9,411	12,274	19,306
New Brunswick						25
Newfoundland	4,109	2,899	2,959	2,814	3,481	3,185
Northwest Territories		1	3			
Nova Scotia			383	788	991	1,101
Ontario	110,856	128,809	125,343	130,583	140,776	145,040
Quebec	53,397	68,866	68,846	54,920	83,930	100,882
Saskatchewan	31,905	31,625	30,344	30,588	36,192	32,850
Total	238,387	269,971	258,038	253,252	302,732	324,604

[1] Dominion Bureau of Statistics, Department of Trade and Commerce, Government of Canada, Preliminary Report on Mineral Production, 1955.

In *Ontario*, the International Nickel Co. of Canada, Ltd., mined 14,247,600 tons of nickel-copper ore. Deliveries of refined copper were 131,600 tons; about 60 percent went to Canadian customers with the United Kingdom ranking second. The underground Creighton, Frood-Stobie, Garson, Levack, and Murray mines accounted for 12,759,500 tons, and the Frood-Stobie open pit 1,488,100 tons. During the year two ore-haulage tunnels were completed at the Frood-Stobie open pit. These tunnels will permit the recovery of an additional 3.5 million tons of ore in the main ramp around the sides of the pit by surface rather than underground methods. At the end of the year, ore reserves were 262.4 million tons containing 7.9 million tons of nickel and copper

The Falconbridge Nickel Mines, Ltd., milled 1,679,600 tons of ore from company mines in Ontario. In addition, 65,600 tons of ore and concentrate was received for treatment from 2 independent mines in the Sudbury district. Production from the Falconbridge mine decreased from 1954 but accounted for 42 percent of the ore from

[34] Canada Department of Mines and Technical Surveys, Copper in Canada, 1955 (preliminary) principal source of information on individual operations: Ottawa, Canada, 11 pp.

company mines. The Mount Nickel, Hardy, and East mines completed their first full year of production. Because of the lower grade ore mined, the metal content of McKim production was slightly below previous years. The Longvack development was virtually complete at the year end, and production will begin during 1956. Other mines under development, in order of their anticipated production, are Boundary, Fecunis, and Onaping. All facilities operated at full capacity, and copper deliveries totaled 10,916 tons of refined metal. Ore and concentrate were smelted in the company plant and the matte refined in Norway. The developed ore reserve reached the highest level in the company history, 17.4 million tons containing 1.50 percent nickel and 0.83 percent copper. Indicated reserve totaled 22.4 million tons averaging 1.37 percent nickel and 0.65 percent copper.

Copper-nickel concentrates from Nickel Offsets, Ltd., and the Nickel Rim Mines, Ltd., in the Sudbury area were shipped to the Falconbridge smelter. Copper concentrate from the Min-Ore Mines, Ltd. (formerly the New Ryan Lake Mines, Ltd.,) in the Matachewan district was shipped to the Noranda smelter. In August, open-pit mining was started at a small high-grade copper deposit of the Temagami Mining Co., Ltd. Ore was shipped to the American Metal Co., Ltd., plant at Carteret, N. J., for treatment.

At the Geco Mines, Ltd., near Manitouwadge Lake, plant construction and mine development were continued. Production is scheduled for early 1957. Other developments in Ontario include drilling exploration by Willroy Mines, Ltd., adjoining Geco to the west; underground exploration by Eastern Mining & Smelting Corp., Ltd., on its Gordon Lake-Werner Lake property in the Kenora district; Consolidated Sudbury Basin Mines, Ltd.—diamond drilling and underground exploration at the former Vermilion and Errington mines in the Sudbury area; and the continued underground development of the Coldstream Copper Mines, Ltd., property in the Thunder Bay district.

The Horne mine of Noranda Mines, Ltd., in *Quebec* Province supplied 1,357,000 tons of ore during the year. Of the total, 473,000 tons assaying 2.09 percent copper was smelted direct, and 884,000 tons averaging 2.07 percent copper was concentrated before smelting. Estimated copper recovery from the Horne-mine ore and concentrate was 27,700 tons. The company smelter treated 1,280,000 tons of ore, concentrate, and secondary materials, including 647,700 tons from other companies on a toll basis. Estimated recovery from primary materials was 104,000 tons of copper.

The copper was refined at the electrolytic plant of Noranda's subsidiary, Canadian Copper Refiners, Ltd., Montreal East. Production of refined copper totaled 159,000 tons, compared with 127,000 tons in 1954. Although by June 1956 the annual capacity of the plant will have been increased to 210,000 tons, it is indicated that a further major expansion will be necessary.

Indicated ore reserves above the 2,975-foot level of the Horne mine were 13.2 million tons at the end of the year, consisting of 12,254,000 tons of sulfide ore averaging 2.30 percent copper and 940,000 tons of siliceous fluxing ore containing 0.15 percent copper.

Adjoining the Horne mine, the mine of the Quemont Mining Corp., Ltd., produced 842,800 tons of ore that yielded 11,300 tons of copper. The ore was the source of 67,800 tons of copper concentrate smelted at Noranda. Ore reserves were estimated at 8.4 million tons averaging 1.40 percent copper and containing zinc, gold, silver, and pyrite.

Output of Waite Amulet Mines, Ltd., a subsidiary of Noranda, totaled 402,300 tons with Waite Amulet accounting for 243,000 tons and Amulet Dufault 159,200 tons. Concentrates containing 19,900 tons of copper were produced from this ore, which averaged 5.16 percent copper and contained zinc, gold, and silver. The daily mill capacity was increased to 2,000 tons. The tonnage of ore from Waite Amulet and Amulet Dufault mines was reduced after operations were begun at the West Macdonald mine in August. This new operation produced 83,700 tons of ore during the year. At the Waite Amulet ore reserves were 512,000 tons of 3.68 percent copper and 105,000 tons of 4.2 percent copper; those at Amulet Dufault totaled 402,000 tons of 7.13 percent copper and 115,000 tons of 4.0 percent copper.

Milling operations were begun in April at the Gaspè Copper Mines, Ltd., a subsidiary of Noranda; a total of 474,600 tons of ore was mined and milled. Of the 34,400 tons of concentrate produced, 17,900 tons was shipped to the Noranda smelter, and 8,000 tons was smelted at Gaspè. The concentrate yeilded 6,700 tons of copper, 900 ounces of gold, and 81,200 ounces of silver. Hydroelectric power became available in November at Gaspè; and the first anodes were cast at the new smelter in December. Estimated ore reserves remain at 67 million tons, averaging 1.3 percent copper.

The Normetal Mining Corp., Ltd., milled 362,200 tons of ore assaying 2.41 percent copper. The concentrate, containing 8,100 tons of copper, was smelted at Noranda. At the end of the year ore reserves were 2,675,100 tons containing 2.41 percent copper and 8.24 percent zinc.

The East Sullivan Mines, Ltd., treated 958,200 tons to produce concentrate containing 8,100 tons of copper.

The Opemiska Copper Mines (Quebec), Ltd., milled 162,100 tons of ore that yielded 7,700 tons of copper, 6,400 ounces of gold, and 85,700 ounces of silver. The concentrator was expanded to a daily capacity of 800 tons.

The Campbell Chibougamau Mines, Ltd., milled 392,900 tons of ore following the start of operations on June 1. Concentrate containing 11,000 tons of copper was smelted at Noranda.

Several other smaller operations in Quebec Province also produced copper during the year. Many other properties were being explored, developed, or readied for production.

Saskatchewan and *Manitoba* together supplied 52,200 tons of copper, 16 percent of Canada's production.

The Flin Flon copper-zinc ore body of the Hudson Bay Mining & Smelting Co., Ltd., lies in both Provinces. Company facilities in this area consist of four mines, a concentrator, a copper smelter, and a zinc plant. Ore from the Schist Lake mine (3½ miles southeast of Flin Flon), the North Star mine (12 miles east of Flin Flon), and the Don Jon mine (1,600 feet east of the North Star) was trucked to Flin Flon for treatment.

457676—58——28

The concentrator produced 318,200 tons of copper concentrate from 1,642,900 tons of ore, most of which came from the Flin Flon mine. Blister copper produced at the smelter contained 46,900 tons of copper, 130,600 pounds of selenium, 109,300 ounces of gold, and 1,675,300 ounces of silver. The blister copper was electrolytically refined at the Canadian Copper Refiners, Ltd., plant, Montreal East, Quebec.

During the year, 761,600 tons of nickel-copper ore was mined and milled at Lynn Lake, Sherritt Gordon Mines, Ltd. Copper concentrate containing 5,700 tons of copper was shipped to a custom smelter. Ore reserves at the end of the year were reported to be 13,820,000 tons assaying 1.15 percent nickel and 0.59 percent copper.

At its Copper Mountain mine, 12 miles south of Princeton, *British Columbia,* The Granby Consolidated Mining, Smelting & Power Co., Ltd., mined 1,968,400 tons of 0.72-percent copper ore. The ore was milled at the company concentrator at Allenby, 8 miles north of the mine. Concentrate containing 10,400 tons of copper was shipped to Tacoma, Wash., for smelting. At the end of the year ore reserves were decreased to 1.2 million tons, but the high copper prices made it possible to treat low-grade material and resume the search for new ore.

The Britannia Mining & Smelting Co., Ltd., treated 878,700 tons of ore at its property on Howe Sound and produced about 27,500 tons of concentrate containing 8,100 tons of copper. An additional 379 tons of copper was recovered from mine waters. A new precipitation plant, scheduled for operation in early 1956, was installed to recover copper from mine waters.

In *New Brunswick* Province, the Keymet Mines, Ltd., produced a small quantity of copper from its lead-zinc-silver mine, 18 miles northwest of Bathurst. Development was continued at the properties of Brunswick Mining & Smelting Corp., Ltd., and Heath Steele Mines, Ltd.

Buchans Mining Co., Ltd., in central *Newfoundland,* milled 291,000 tons of zinc-lead-copper ore to produce concentrate containing 3,900 tons of copper. The newly developed Rothermere ore bodies supplied 63 percent of the total ore. Exploration and development were continued at other properties.

Of the other operations contributing to Canada's copper production, Mindamar Metals Corp., Ltd., Cape Breton Island, *Nova Scotia,* milled 244,300 tons of ore from its Stirling zinc-lead-copper mine and produced lead-copper concentrate containing 1,200 tons of copper.

Plans have been made by North Rankin Nickel Mines, Ltd., to construct a 250-ton mill at Rankin Inlet, *Northwest Territories,* where an ore body, estimated to contain 460,000 tons averaging 0.81 percent copper and 3.3 percent nickel, has been outlined.

In *Yukon Territory,* underground development was continued in the Kluane Lake district on the Wellgreen property of Hudson-Yukon Mining Co.

Exports of copper in ore, matte, regulus, etc., totaled 41,565 (47,411 in 1954) tons, of which the United States was the destination of 26,883 (34,073) tons, Norway 11,324 (10,547), West Germany 1,828 (1,716), the United Kingdom 1,130 (1,075), and Belgium 400 (none). In addition, 19,162 (9,758) tons of rods, strips, sheets, and tubing was shipped, of which 4,320 (1,144) went to the United States, 6,219 (4,953) to Switzerland, and 2,432 (none) to the United Kingdom. Copper-scrap slag skimmings and sludge totaling 18,293 (10,926) tons also were exported in 1955.

Imports of refined copper totaled 35 tons in 1955 compared with 1 ton in 1954.

Exports of ingots, bars, and billets from Canada in 1955, as compared with 1954, were as follows, by countries of destination, in short tons:

Destination:	1954	1955
United States	60, 814	67, 071
France	7, 728	8, 957
Germany, West	404	937
United Kingdom	77, 867	69, 198
India	2, 211	1, 724
Australia	1, 126	3, 993
Other	5, 980	1, 319
Total	156, 130	153, 199

Cuba.—Mine production of copper totaled 20,800 tons in 1955 and exceeded that of the preceding year by nearly 20 percent. The Minas de Matahambre, S. A., was the largest Cuban copper producer, with properties in the Matahambre district of the Province of Pinar del Rio. Concentrate is shipped to the United States for treatment.

A domestic market for Cuban copper ore was realized in July, with the first milling of copper ore on a custom basis in Cuba. Also, during the year, another of Cuba's old copper mines resumed production—the fifth such mine recently rehabilitated.

SOUTH AMERICA

Chile.—Copper production for the year reached 477,900 tons, a 19-percent increase over 1954 and the highest annual production since 1948. Labor disturbances at the three major mines in September and December prevented even higher copper production.

Output at small and medium copper mines was encouraged by the high copper prices. As a result, large deliveries of ore, concentrate, and precipitate were made to the Government smelter at Paipote.

According to the annual report to stockholders of The Anaconda Company, legislation sponsored by the administration and passed by the Chilean Congress became effective May 5, 1955. It provided for a free-bank exchange rate and created a Copper Department, with representatives of the copper-producing companies, designed to cooperate with the companies in the development of the industry. Under the new law, the copper companies control the sales of their copper, and the full sales price applies to all calculations for determining taxes and profits.

Output at the Braden mine of the Braden Copper Co., a subsidiary of the Kennecott Copper Corp., totaled 156,228 tons of copper and exceeded the previous year's production by 44 percent. The large increase was due to the unusually low production in Chile in 1954 and longer strikes in that year than in 1955. Ore mined in 1955 contained 40.92 pounds of copper per ton compared with 42.16 pounds in 1954.

Copper production at the Chuquicamata mine of the Chile Exploration Co., a subsidiary of The Anaconda Company, rose approximately 12 percent over 1954 to 230,740 tons. Output was curtailed by 2 strikes during the year, 1 of 8 days during September and the other of 18 days during December. A project for expanding operations and facilities of mines, plants, and townsites was presented by the Chile Exploration Co. to the Government of Chile in September. An increase in annual capacity of 50,000 tons of copper of the Chuquicamata property is expected to be attained by the end of 1956.

Operations at the Andes mine of the Andes Copper Mining Co., another subsidiary of The Anaconda Company, were interrupted also by an 18-day strike during December. Output totaled 44,616 tons, an increase of about 6 percent over the preceding year.

In 1955 Andes Copper Mining Co. acquired options to all mining claims, concessions, and other rights in connection with the properties known as the Indio Muerto. Although the limits of the ore body have not been determined, drilling has developed reserves of 78 million tons averaging 1.66 percent copper.

The new mine, which will be known as the El Salvador, will be brought into production in about 4 years to supplement and eventually replace production from the Potrerillos mine. At the present rate of production, the Potrerillos ore will be exhausted in less than 5 years. Block-caving methods will be used to mine the El Salvador ore body. Ore will be treated at the Potrerillos plant, and copper production is expected to increase to approximately 100,000 tons annually when El Salvador ore is treated as this ore is higher grade than that now being mined.

Another subsidiary of The Anaconda Company, the Santiago Mining Co., continued development of its La Africana copper mine about 15 miles west of Santiago. A new plant, a 400-ton concentrator, the townsite, and auxiliary facilities were being constructed. Production at the rate of about 4,000 tons of copper annually is expected to begin early in 1957.

TABLE 43.—Principal types of copper exported from Chile, in 1955, by countries, in short tons

	Refined		Standard (blister)	Total
	Electrolytic	Fire-refined		
Argentina	2,205			2,205
Australia	1,512			1,512
Belgium	1,427	56		1,483
Brazil	44	330		374
Denmark		336		336
Germany	9,314	4,867	26,499	40,680
India	1,652			1,652
Italy	18,833	667	15,643	35,143
Netherlands	29,721	409	392	30,522
Spain			1,764	1,764
Sweden	1,167			1,167
Switzerland	224	2,603		2,827
United Kingdom	49,855	39,387	7,941	97,183
United States	2,134	64,449	141,059	207,642
Other countries	305	168		473
Total	118,393	113,272	193,298	424,963

The Empresa Nacional de Fundiciones, a Government agency, which operates the national smelter at Paipote, produced 15,600 tons of blister copper in 1955 compared with 16,700 tons in 1954.

In addition to the exports shown in table 43, 5,509 tons of ores and concentrates was shipped; 2,813 went to the Union of South Africa, 1,518 to the United States, 896 to West Germany, 266 to Sweden, and 16 to the United Kingdom.

Peru.—Production of copper at Peruvian mines totaled 52,300 tons in 1955, over 10,000 tons more than in 1954. The Cerro de Pasco Corp. continued as the leading copper producer, with 34,700 tons.

According to the annual report of the American Smelting & Refining Co., final approval was announced on September 30 by the Export-Import Bank of the $100 million loan for the development of the Toquepala project by the Southern Peru Copper Corp. One billion tons of ore averaging about 1 percent copper is estimated for the combined Toquepala, Quellaveco, and Cuajone copper deposits.

This corporation, consisting of the American Smelting & Refining Co., the Cerro de Pasco Corp., the Newmont Mining Corp., and the Phelps Dodge Corp., will develop the Toquepala deposit as an open-pit mine. About 5 years will be required to complete the mine development and construction of the plants. The estimated production of blister copper will average about 120,000 tons per year for the first 10 years of operation; following that, production is expected to be lower because of differences in grades of ore.

Construction was begun on a 50-ton leaching plant for treatment of oxide copper ores, which previously had been exported. The plant being built for Cia. Minera Chapi near Arequipa was expected to be completed in 1956.

EUROPE

France.—Production of brass-mill products in 1955 totaled 138,700 tons, of which 47,600 tons was brass and copper plates, sheets, and strips, 70,100 tons brass bars and shapes, 5,300 tons brass tubing, and 15,700 tons copper pipes. Copper wire produced for electrical purposes was 84,700 tons. Data on the output of bare wire as distinguished from wire-mill products was not available.[35]

Ireland.—In September an agreement was entered into between the Irish Government and Canadian mining interests for the latter to develop copper and other mineral deposits at Avoca, County Wicklow, about 44 miles south of Dublin.[36] The State mining company, Mianrai Teoranta, reported that 12 million tons of ore has been proved, and an additional 24 million tons is believed to exist. The agreement is said to provide for exportation of ore and concentrate to world markets or to the parent company in Canada; there are no plans to smelt the material in Ireland. Exploration for other minerals, outside of the Avoca area is also provided for in the agreement.

United Kingdom.—The consumption of primary and secondary refined copper increased 14 percent in 1955 and exceeded that in every other year since 1943. As in recent years, the United Kingdom ranked as

[35] Moseley, Harold W. (first secretary of Embassy), French Brass-Mill Production-Capacity Data: State Dept. Dispatch 1753, Paris, France, Mar. 6, 1956, 1 p.
[36] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 6, December 1955, p. 7.

the second largest world consumer of copper. Of a total consumption of 738,700 short tons in 1955, 537,200 tons was refined copper and 118,200 tons scrap for wrought products; 18,900 tons of refined and 64,400 tons of scrap was used for castings, sulfate, and miscellaneous products.

In early January copper mining in Northern Rhodesia was virtually halted by a strike, and loss of this metal, together with large world requirements, caused a shortage of supplies. On April 13 the Board of Trade announced the release of 45,000 long tons (equivalent to 50,000 short tons) of electrolytic copper to be sold from stocks over the remainder of 1955, and on April 21 it announced the sale of 20,000 long tons (22,500 short) of blister to the Rhodesian Selection Trust Group.

According to the British Bureau of Nonferrous Metal Statistics, imports of copper into the United Kingdom in 1954 and 1955 were as follows:

TABLE 44.—Copper imported into the United Kingdom, 1954–55, in short tons

Country	1954			1955		
	Blister	Electrolytic	Fire-refined	Blister	Electrolytic	Fire-refined
Belgian Congo		9,183			5,684	
Belgium		16,222			7,578	
Canada		72,241			71,434	
Chile	7,131	21,491	12,117	8,000	30,661	27,347
Germany, West		12,876			8,678	
Japan		28			1,947	
Northern Rhodesia	140,039	124,914		124,504	117,785	
Norway		1,327			3,147	
Peru		3,044			6,356	1,568
Sweden		614			3,090	
Turkey	224			3,348		
Union of South Africa			2,134			1,519
United States		16,785	4,733		28,172	3,839
Other countries	1,206	1,641	692	646	1,854	533
Total	148,600	280,366	19,676	136,498	286,386	34,806

Exports and reexports of refined copper were 29,634 tons (29,046 in 1954), of which 12,275 (none) went to the United States, 6,981 (9,931) to Germany, 2,363 (1,061) to the Netherlands, 1,551 (88) to Belgium, 1,278 (4,803) to France, and 1,150 (1,456) to Australia. In 1955 the 560 tons (17,517 tons) of blister and "rough" copper exported and reexported went to the United States.

ASIA

Copper deposits in the Far East are described in a publication.[37]

Cyprus.—The principal producer, the Cyprus Mines Corp., produced 96,700 tons of copper concentrate containing 22.75 percent copper, 3,600 tons of precipitate averaging 77 percent copper, and 112,000 tons of cupreous pyrite containing 2.75 percent copper. In addition, 560,900 tons of flotation pyrite averaging 50.85 percent sulfur was produced. An article [38] states that copper was first found in Cyprus at least 5,000 years ago.

[37] Sholey, George. T., Far East Copper Tied to Firebelt?: Eng. and Min. Jour., vol. 156, No. 6, June 1955, pp. 82–83.

[38] Murray, John, The Island of Copper: South African Min. and Eng. Jour., vol. 66, No. 3271, Oct. 22, 1955, p. 257.

Japan.—Mine production of copper has trended upward without interruption since 1946, and output in 1955 was 7 percent over that in 1954.

The following information was taken [39] from a report on the Japanese mining industry:

The increased production was said to be due mainly to completion of mill construction and development of the new copper mines of Kamaishi, Yaso, and Akagane. The report states that, of the 200 mines producing, only 40 currently produce over 500 tons of copper annually. The 11 smelters in Japan can treat 127,000 tons of ore per month, and the 8 refineries have an output of 12,000 tons of electrolytic copper per month.

Production of electrolytic copper was about 125,000 tons in 1955, of which 81,600 tons was from domestic materials, 7,000 tons from foreign materials, and 36,400 tons from scrap. With increased imports of concentrates from the Philippines, production from foreign materials was expected to increase to about 28,000 tons, and a total output of over 130,000 tons of electrolytic copper was planned.

Philippines.—Copper production rose 22 percent in 1955, despite mining of relatively low-grade ores. Production of ore at the Lepanto mine of the Lepanto Consolidated Mining Co. was larger than in 1954, but a drop from 4 to 3 percent in the copper content resulted in about a 10,000-ton decrease in production of concentrate. The average copper content of the concentrate was 21.5 percent compared with 23.2 in 1954, and copper output declined from 15,700 tons in 1954 to 12,300 in 1955. Ore reserves at the end of the year were 3.5 million tons averaging 3.62 percent copper. During the year Lepanto signed a 5-year contract with the American Smelting & Refining Co. for treating its concentrate at the Tacoma, Wash., smelter. Metallurgical improvements at Lepanto included a heavy-media pilot plant.[40]

The new open-pit copper mine and flotation mill at the Toledo mine of the Atlas Consolidated Mining & Development Corp., Cebu Island, began operating in early 1955. The mill treated 1,013,600 tons of ore and produced 30,300 tons of concentrate. Copper production was 6,700 tons. The mill was originally designed to treat 4,000 tons per day; but soon after operations were begun, it was decided to increase capacity to 6,000 tons daily.[41] Additional expansion was planned later in the year, and it was expected that a daily output of 10,000 tons would be attained by the last quarter of 1956. Ore reserves of 37.6 million tons averaging 1.02 percent copper at the beginning of the year were increased to 68 million tons averaging 1.01 percent copper.

Turkey.—Virtually all of Turkey's output came from the Ergani and Murgul mines, but copper has been found in other Provinces of the country.[42] Of the 26,200 tons of blister copper produced in 1955, the Ergani and Murgul mines accounted for over 50 and 35 percent, respectively, of the total.

---

[39] Ministry of International Trade and Industry, Japan, Japanese Mining Industry 1955: June 1956, pp. 61–68.

[40] Mining World, Metallurgical Testing Underway for Lepanto Copper Expansion: Vol. 17, No. 10, September 1955, p. 75.

[41] Mining World, Atlas Sets Pace for Copper Boom by Expanding to 6,000 Tons Daily: Vol. 17, No. 10, September 1955, pp. 54–60, 99.

[42] Kromer, H. Ferid, Turkey's Mineral Potential Expands: Eng. and Min. Jour., vol. 157, No. 1, January 1956, p. 90.

AFRICA

Belgian Congo.—Copper production rose 6 percent in 1955 and established a new production record for the sixth successive year. The Union Minière du Haut Katanga again was the only copper producer. According to the annual company report to stockholders, 9,816,000 tons of ore was produced in 1955. The Musonoi and Ruwe mines, both open-pit operations, supplied 54 and 31 percent, respectively, of the total output.

The Kolwezi concentrating plant treated 3,184,000 tons of copper and mixed ores and produced 556,000 tons of concentrate assaying 26.98 percent copper and 1.04 percent cobalt and 36,200 tons of concentrate assaying 10.33 percent copper and 7.89 percent cobalt. The capacity of the Kolwezi plant was increased to 298,000 tons per month by the end of the year, and additional capacity is planned.

The Kipushi concentrator treated 1,198,000 tons of copper and copper-zinc ore from the Prince Leopold mine and produced 68,700 tons of concentrate with 22.71 percent copper from straight copper ore and 257,100 tons of 29.02-percent copper concentrate and 125,800 tons of 59.59-percent zinc concentrate from the copper-zinc ore.

The Ruwe concentrating plant treated 1,734,500 tons of material from the Ruwe mine and produced 129,000 tons of 25.54-percent copper concentrate and 131,900 tons of 7.53-percent copper of intermediate products requiring further treatment.

The Kamoto washery treated 239,800 tons of copper-cobalt ores from various mines of the Western Group and recovered 5,500 tons of concentrate running 6.46 percent cobalt. In addition, 55,000 tons of intermediate products destined for further treatment was produced. The Ruashi washery treated 50,100 tons of copper ore from the small mines in the southeast region and produced 12,000 tons of 12.53-percent copper. The Ruashi plant was inactive for part of the year.

Production of copper at the Lubumbashi smelter and Shituru electrolytic plant increased in 1955. At Lubumbashi two water-jacket furnaces were put into operation at the works and enabled the company to increase the quantity of oxidized ore added to the furnace charge. The electrolytic plant at Shituru was able to maintain and even increase its production despite a shortage of hydroelectric power. The plant was given priority in distributing available power.

The output of copper in short tons was distributed as follows:

	1954	1955
Lubumbashi smelter (blister)	118,300	129,099
Jadotville–Shituru (electrolytic plant)	123,177	126,502
Jadotville-Panda (electric copper-cobalt alloy furnaces)	712	750
Copper recoverable contained in zinc concentrates exported	4,498	2,330
Copper contained in anode slimes		1
Total	246,687	258,682

The company produced a total of 5,249,000 tons of copper from the beginning of operations through 1955.

French West Africa.—Mining operations were begun at the Akjoujt mine. Ore reserves were estimated at 8 million tons of oxide ore averaging 2.75 percent copper and 17 million tons of sulfide ore averaging 1.9 percent copper. A pilot plant for treating the sulfide ore has started operations, and an eventual output of 15,000 tons of copper a year is expected.

Kenya.—During 1955 the Macalder-Nyanza Mines, Ltd., continued preparation for mining operations at the Macalder mine. Ore reserves were estimated at 1.6 million tons averaging over 2 percent copper. A concentrating plant and a leaching plant were under construction, and production was expected in April 1956. It was planned to treat 10,000 tons of ore a month, from which 200 tons of copper, 830 ounces of gold, and 6,200 ounces of silver would be recovered. The copper and precious-metal precipitates will be treated in the electric smelter under construction by the Kilembe Mines, Ltd., at Jinja.

Northern Rhodesia.—Copper-mine production in 1955 dropped 10 percent from the alltime peak established in 1954. Production was adversely affected by strikes lasting from January 3 until March 2 at properties of major producers, and the trend of the previous 5 years for consecutive new-record annual-production rates was halted. The coal-supply situation continued to hamper operations. During the strike in January and February the mines were able to build up unprecedented stocks of coal; but the stocks diminished during the year, and it was necessary to augment the fuel supply with wood. The usual coal shortage was expected to be eased somewhat with importations of hydroelectric power from the Belgian Congo, which were to start in mid–1956 instead of 1957 as originally planned.

In May the Rhodesian Selection Trust Co. announced that it would offer copper at fixed prices to those of its customers who were willing and able to instill a degree of stability into their resale prices for copper and brass products. Details are given in the section under Prices.

On May 31, 1955, Rhodesian Selection Trust, Mufulira, Chibuluma, and Roan Antelope transferred their main office from Lusaka, Northern Rhodesia, to Salisbury, Southern Rhodesia.

A total of 5,099,600 short tons of ore containing 2.16 percent copper was mined by Roan Antelope Copper Mines, Ltd., in the fiscal year ended June 30, 1955. Company concentrates smelted yielded 92,600 tons of blister compared with 99,300 in 1954. Roan Antelope's smelter cast 31 tons of blister from 70 tons of Mufulira concentrate for Mufulira Copper Mines, Ltd., and treated 5,900 tons of Nchanga concentrate and produced 2,700 tons of blister copper. In addition, 615 tons of blister was produced for Nchanga from Nchanga ore used as a flux. Ore reserves at the end of June 1955 were 90 million tons averaging 3.20 percent copper. Construction of the electrolytic refinery at Ndola, to be operated by Ndola Copper Refineries, Ltd., continued during the year. The initial capacity of 67,200 tons of copper will be increased to 123,200 tons, and the plant is expected to come into production in the second half of 1958.

Mufulira Copper Mines, Ltd., produced 3,391,200 short tons of ore averaging 3.38 percent copper in the fiscal year ended June 30, 1955; a total of 3,379,900 tons was milled and 93,200 tons of copper produced, of which 52,900 tons was blister and 40,300 tons electrolytic cathode copper. Construction of the first tankhouse extension was completed early in 1955, and one-half of the extension began operations in May. Capacity of the tankhouse currently operated was equivalent to nearly 71,000 tons of cathodes. Work was continued on the refined-copper casting plant and the first wirebar production anticipated early in 1956. The capacity of the refinery will nearly equal the capacity of the entire Mufulira operation, and production of most refinery shapes is planned. Ore reserves on June 30, 1955, were estimated at 135.6 million tons averaging 3.35 percent copper.

Ore hoisting at the Chibuluma mine of Chibuluma Mines, Ltd., was begun in October, but operations at the concentrator were delayed because construction material arrived late; production was expected about April 1956. The mill will produce a copper concentrate, which will be smelted at smelters in the Copperbelt; and a cobalt concentrate, which will be sent to the Chibuluma cobalt plant under construction at Ndola. Estimated ore reserves remained at 7.3 million tons averaging 5.23 percent copper, on June 30, 1955.

In January Bancroft Mines, Ltd., announced plans for increasing the production rate from 48,000 tons, beginning in 1957, to 96,000 tons by the beginning of 1960. Ore reserves were estimated at 92 million tons averaging 3.67 percent copper.

The Rhokana Corp. Ltd., mined 3,608,400 tons of ore from the Nkana and Mindola mines in the fiscal year ended June 30, 1955. The concentrator treated 3,618,000 tons averaging 2.55 percent copper and produced 252,045 tons of concentrates averaging 33.51 percent copper and 1.379 percent cobalt. Finished copper produced was 30,000 tons of blister and 49,800 tons of electrolytic copper. The smelter produced 163,000 tons of copper, of which 30,000 was blister and 51,000 anode copper for Nkana, 28,900 blister and 53,100 anode copper for Nchanga, and 20 tons blister for Broken Hill. Ore reserves at the end of June 1955 were as follows:

Ore body:	*Short tons (millions)*	*Copper (percent)*
Nkana, north	31	3.00
Nkana, south	19	2.82
Mindola	50	3.40
	100	3.16

In the year ended March 31, 1955, 2,498,200 tons of ore was milled by Nchanga Consolidated Copper Mines, Ltd. Production of finished copper was 31,900 tons of blister and 83,300 tons of electrolytic. In 1955 the company decided to mine its upper low-grade ore body by open-pit methods. Mining has been mainly from the high-grade Nchanga ore body. By mining mill ore from both ore bodies, the average grade of ore milled would be brought down to the average grade of the total reserves without a decrease in copper production. The open pit was to be in production by late 1956 or early 1957. The Nchanga mill was being enlarged to handle the increased tonnage of ore. Total ore reserves on April 1, 1955 were estimated at 142.8 million tons averaging 4.73 percent copper.

Work on reopening the Kansanshi mine, of Kansanshi Copper Mining Co. Ltd., about 100 miles west of Nchanga and 6 miles south of the Belgian Congo border, was started in March; production is to begin in 1957. The output of 500 tons of copper concentrate per month will be smelted by Rhokana.

The Rhodesia Copper Refineries, Ltd. produced 136,000 tons of electrolytic copper in the fiscal year ended June 30, 1955, compared with 143,000 tons in the 1954 fiscal year. Production of vertically cast shapes was begun in 1955, and output was 4,000 tons. Following trial shipments, the vertical-cast plant was put into regular production.

Exports of copper from the Federation of Rhodesia and Nyasaland in 1955 are shown in table 45.

TABLE 45.—Copper exported from Federation of Rhodesia and Nyasaland in 1955, in short tons [1]

Destination	Blister	Electrolytic			Copper slimes
		Bar and ingot	Cathodes	Wirebars	
Australia	------	17	------	1,120	------
Austria	------	------	320	------	------
Belgium	1,303	110	868	3,281	29
Denmark	------	------	------	168	------
France	30	2,883	112	12,339	------
Germany, West	21,413	------	2,290	------	------
Italy	336	------	------	11,585	------
Netherlands	337	336	924	839	------
Sweden	------	------	------	16,432	------
Switzerland	------	------	280	280	------
Union of South Africa	115	343	------	10,203	------
United Kingdom	110,734	------	41,895	75,272	115
United States	59,350	------	7,277	------	------
Other countries	28	------	------	------	------
Total	193,646	3,689	53,966	131,519	144

[1] Bureau of Mines, Mineral Trade Notes: Vol. 43, No. 3, September 1956, p. 10.

Southern Rhodesia.—Mine production of copper rose substantially in 1955 mainly from bringing into production in May the Umkondo mine of The Messina (Transvaal) Development Co., Ltd. Output of the company was expected to be increased 2,200 tons a year. Work was continued on the development of the Mollie section of a new mine in the Sinoia district. Ore reserves were estimated at 16 million tons averaging 1.6 percent copper.

South-West Africa.—A new production peak was established in South-West Africa in 1955; output exceeded that in 1954 by 50 percent. At the Tsumeb mine of the Tsumeb Corporation, Ltd., production of copper in copper-lead concentrate rose from 15,700 tons in 1954 to 23,600 in 1955.

Union of South Africa.—Production of blister copper by the O'okiep Copper Co., Ltd., in the fiscal year ended June 30, 1955, was the largest in the history of the company. Output was 29,428 tons, compared with 27,554 tons in the 1954 fiscal year. A total of 1,215,850 tons of ore averaging 2.34 percent copper was mined from the Nababeep, East O'okiep, West O'okiep, and Wheal Julia mines. During 1955, a heavy-media separation plant, reportedly the first in the world designed and built for the express purpose of upgrading copper ore, was placed in operation. The other copper producer in the Union, The Messina (Transvaal) Development Co., Ltd., produced nearly 16,000 tons of fire-refined copper from 806,800 tons of ore averaging 1.73 percent copper.

OCEANIA

Australia.—Mine production of copper rose 11 percent in 1955, but output of blister copper was 2 percent less. The Mount Isa Mines, Ltd., Queensland, the leading producer of blister copper, treated 643,000 tons of ore and produced 24,200 tons of blister copper in the fiscal year ended June 30, 1955. Ore reserves during 1955 were increased from 4.1 million tons averaging 4.2 percent copper to 5.7 million averaging 4 percent copper. It was said [43] that the company considered construction of a copper refinery at Stuart, near Townsville. Other producers in Australia were Mount Morgan, Ltd., Queensland, and Mount Lyell Mining & Railway Co., Ltd., Tasmania. Articles on the three producers were published [44] in 1955.

[43] Mining Journal (London), Annual Review, 1956 ed.: May 1956, p. 207.
[44] Simmons, A. L., The Copper Industry in Australia: Metal Prog., vol. 67, No. 1, January 1955, pp. 87–92. Mining Journal (London), Development of Mount Lyell, Tasmania: Vol. 245, No. 6260, Aug. 12, 1955, p. 183.

Diatomite

By L. M. Otis[1] and Annie L. Marks[2]

THE 1955 DOMESTIC diatomite output increased over 1954, and the average unit value rose 34 percent.

DOMESTIC PRODUCTION

In 1955 California led in the production of diatomite, followed, in order, by Nevada, Oregon, Washington, Arizona, and New Mexico. Increasing activity in Oregon was reported. Several large mining companies explored for diatomite in central and southern Oregon during 1954 and negotiated for properties. A new company obtained control of a large area in the Harper-Westfall district, northern Malheur County.[3]

The 3-year production and average value of all combined grades and qualities of diatomite produced is shown in table 1.

TABLE 1.—Production of diatomite in the United States, for 3-year periods, 1930–53, in short tons

Period	3-year production	Average per year	Average price
1930–32	248,273	82,758	$15.72
1933–35	244,342	81,447	14.81
1936–38	279,645	93,215	15.65
1939–41	360,502	120,167	15.94
1942–44	524,872	174,957	18.85
1945–47	640,764	213,588	20.17
1948–50	722,670	240,890	25.55
1951–53	908,448	302,816	29.97

A Bureau of Census preliminary statistical report on nonmetallic minerals, including diatomite, was issued.[4]

CONSUMPTION AND USES

Research by producers continued to increase the many uses for diatomite and also to improve and standardize the product. Uniformity in purity, preparation, and even shape and variety of the diatoms is said to be essential for certain markets, particularly in the filtration field.

[1] Commodity specialist.
[2] Statistical assistant.
[3] The Ore Bin, vol. 17, No. 1, January 1955, p. 5.
[4] Bureau of Census, 1954 Census of Mineral Industries, Gypsum, Mica, Vermiculite, Asbestos, Diatomite, Perlite and Misc. Nonmetallic Minerals: Series: MI-14-9-2, May 1956, pp. 3-8.

For many years the principal market for diatomite has been as filtering material. In 1955, 50 percent of the tonnage of diatomite consumed was used in purifying water, sugar liquor, beer, wine, whiskey, other beverages, pharmaceuticals, antibiotics, oils, and solvents.

Its next ranking market, as a filler or extender, included: Hard-rubber products, asphaltic tile, paper, paints and varnishes, plastics, soaps, phonograph records, oil cloth, linoleum, matches, and insecticides and as an anticaking agent in fertilizers and detergents. In 1955, 30 percent of the diatomite tonnage was sold for these purposes.

Insulation against sound and temperature was the third-ranking consumption category; uses were: Insulation for ovens, industrial furnaces, kilns, boilers, steam and water pipes, flues, driers, stills, safes, storage tanks, refrigerators, and cold-storage warehouses. Diatomite was also used in construction for loose-fill insulation, sound-deadening panels, composition roofing, siding and plasters and concrete. Seven percent of the total quantity used in 1955 went into this market.

The remaining 13 percent of the total quantity used included: Absorbents, abrasives, catalyst carriers, for ceramics, glazes, enamels, flatting agent for paints, and the manufacture of sodium and calcium silicates. The proportions of sales according to general usage during recent years is indicated in figure 1.

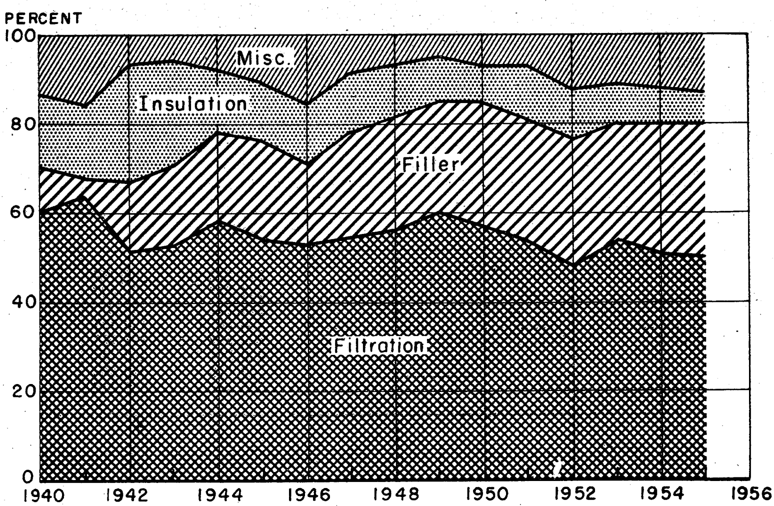

FIGURE 1.—Proportion of diatomite sales in the United States for each of principal uses, 1940–55.

PRICES

The value per ton of diatomite sales in the United States was much higher in 1955 than in 1954. Following are the average values per ton at domestic producers' plants for various uses in 1955 as reported to the Bureau of Mines: Filtration, $46.29; insulation, $42.19; abrasives, $115; fillers, $40; other uses, $25.29. The average mill value of all diatomite produced and sold in 1955 was $41.47 per short ton.

FOREIGN TRADE

Because exports and imports of diatomite are not reported separately by the United States Department of Commerce, reliable statistics are lacking. Crude may be imported into the United States duty-free under paragraph 1775 of the Tariff Act of 1930. Refined diatomite, principally of filtering quality, is exported to various countries from the United States.

TECHNOLOGY

A $4 million plant was under construction at Lompoc, Calif., for manufacturing special forms of calcium silicates using lime and diatomite as raw materials. The plant will have an annual capacity of 14,000 tons. A striking characteristic of calcium silicate products is high absorption—said to be 1 to 2½ times their weight of liquids yet the powders remain free flowing. They are used to increase the bulk of dry powders, as paint extenders, as an ingredient of insecticides, as an anticaking agent in prepared fertilizers, and in many other ways. The properties and uses of these compounds have been described.[5]

The varieties of diatoms and their characteristics were described in an article [6] illustrated with reproductions of photomicrographs taken with an electron microscope.

Diatomite beds were studied by the Great Lakes Carbon Corp. by sinking 30-inch-diameter holes so that field geologists, lowered into the holes, could observe and sample.[7]

WORLD REVIEW

Except for the United States, Denmark, in 1955 produced the largest quantity of diatomite, from the Islands of Mors and Fur in the Limfjord in North Jutland. West German production from the Lüneburger Heide district of Hanover, with minor tonnages from Hesse, Anhalt, and Saxony, was about the same as France, which had comparable production from the Department of Cantal. These countries each mined roughly half that of Denmark. Table 2 gives the available statistics on world production of diatomite.

Algerian production of diatomite in 1953 was 28,334 short tons valued at $18 per ton United States currency. Exports increased 32 percent over 1952 to 13,817 short tons of which 42 percent was shipped to France, 29 percent to United Kingdom, and 15 percent to the Netherlands.[8]

Production in Kenya decreased from 5,932 long tons in 1952 to 4,378 tons in 1953. The 1953 production was valued at $28.80 per long ton United States currency.[9]

---

5 Paint, Oil and Chemical Review, Development of a Product . . . Johns-Manville's "Micro-Cel": Vol. 118, No. 23, Nov. 17, 1955, pp. 6–7.
Chemical and Engineering News, Absorb It With Silicates: Vol. 33, No. 45, Oct. 31, 1955, p. 4690.

6 Rapier, Pascal M., The Indomitable Diatom: Eng. and Min. Jour., vol. 156, No. 12, December 1955, pp. 90–93.

7 Engineering and Mining Journal, vol. 156, No. 8, August 1955, p. 142.

8 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 6, June 1954, p. 47.

9 Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 5, May 1954, p. 38.

TABLE 2.—World production of diatomite, by countries,[1] 1946–50 (average) and 1951–55 in short tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	69	91	28	103	104	16
Costa Rica	37	500	750	430	595	3,000
United States	250,000	[3] 302,816	[3] 302,816	[3] 302,816	(4)	(4)
South America:						
Argentina	[5] 1,300	(4)	(4)	(4)	(4)	2,756
Chile	1,027	(4)	(4)	(4)	(4)	(4)
Europe:						
Austria	3,186	4,292	4,300	3,435	3,532	4,445
Denmark:						
Diatomite	4,514	5,356	15,023	12,454	30,337	(4)
Moler [5] [6]	68,000	105,000	110,000	110,000	120,000	120,000
Finland	1,154	1,483	1,236	1,985	1,367	2,059
France	37,772	43,155	37,159	58,422	66,690	(4)
Germany, West	[7] 34,187	48,449	52,748	55,501	59,745	67,725
Italy	6,367	11,646	10,505	11,023	11,261	11,314
Sweden	1,927	2,036	1,733	1,504	1,619	1,625
United Kingdom:						
Great Britain	5,749	10,304	19,040	13,974	10,778	[5] 11,000
Northern Ireland	8,238	9,773	9,742	8,139	4,675	7,293
Asia: Korea, Republic of	(4)	(4)	(4)	(4)	1,377	3,393
Africa:						
Algeria	10,626	23,140	22,064	28,162	37,283	30,384
Egypt	1,394	3,034	784	131	173	220
Kenya	1,571	4,725	6,644	4,903	3,649	3,304
Union of South Africa	832	96	1,190	120	1,047	850
Oceania:						
Australia	5,649	9,776	7,130	4,973	6,091	4,054
New Zealand	247	133	228	115	188	[5] 200
World total (estimate) [1]	500,000	640,000	660,000	670,000	(4)	(4)

[1] Diatomaceous earth believed to be also produced in Brazil, Hungary, Japan, Mozambique, Norway, Portugal, Rumania, Spain, and U. S. S. R., but complete data are not available; estimates by senior author of chapter included in the total, for the years 1946–53.
[2] This table incorporates a number of revisions of data published in previous Diatomite chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[3] Average annual production, 1951–53.
[4] Data not available; estimate by senior author of chapter included in total for 1946–53.
[5] Estimate.
[6] A clay-contaminated diatomite used principally for lightweight building brick.
[7] Average, 1948–50.

Although some diatomite was recovered from peat bogs in Finland, imports were needed to meet home-market requirements. Production in 1952 reached 1,121 metric tons, and this quantity was supplemented by imports of 343 tons.[10]

Diatomite production in Australia in 1952 was said to be adequate to meet domestic requirements.[11]

[10] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 2, February 1954, p. 58.
[11] Bureau of Mines, Mineral Trade Notes: Vol. 38, No. 3, March 1954, p. 69.

Feldspar, Nepheline Syenite, and Aplite

By Brooke L. Gunsallus[1] and Gertrude E. Tucker[2]

FELDSPAR

PRODUCTION of crude feldspar and flotation concentrate in 1955 increased 13 percent in tonnage and 9 percent in value from 1954. Ground-feldspar sales increased 12 percent in quantity and 18 percent in value. Of the three major feldspar-consuming industries, pottery and enamel showed substantial increases and glass a decrease. The increase in the pottery and enamel industries was attributed, principally, to the high level of building activity. The floor, wall-tile, and sanitary-ware industries had a good year. Feldspar consumption in the glass industry declined owing partly to slackening demand for flat glass, especially in the automobile industry. Flotation of feldspathic ores supplied 40 percent of marketable feldspar in 1955, compared with 37 percent in 1954.

TABLE 1.—Salient statistics of the feldspar industry in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Crude feldspar:[1]						
Domestic sales:						
Long tons	441,261	400,439	420,831	452,600	411,018	465,378
Value	$2,481,251	$2,815,587	$3,696,018	$4,594,450	$3,490,466	$3,801,291
Average per long ton	$5.62	$7.03	$8.78	$10.15	$8.49	$8.17
Imports:						
Long tons	18,458	17,128	5,576	5,901	79	105
Value	$132,790	$146,565	$53,016	$60,501	$3,357	$9,346
Average per long ton	$7.19	$8.56	$9.51	$10.25	$42.49	$89.01
Ground feldspar: Sales by merchant mills:						
Short tons	458,516	454,615	458,920	463,876	428,895	479,567
Value	$5,924,440	$6,932,878	$6,712,481	$7,148,689	$6,517,458	$7,698,905
Average per short ton	$12.92	$15.25	$14.63	$15.41	$15.20	$16.05

[1] Includes flotation concentrate, 1951–55.

In 1955, Feldspar Corp. of Spruce Pine, N. C., purchased feldspar properties in North Carolina and Georgia and became one of the large feldspar producers in the United States.

[1] Commodity specialist.
[2] Statistical assistant.

457676—58——29

Imports of crude feldspar and crude nepheline syenite in 1955 were negligible, as in 1954. In 1955 imports of ground nepheline syenite increased 17 percent over 1954, and aplite production increased 1 percent.

DOMESTIC PRODUCTION

Crude Feldspar.—Crude feldspar (including concentrate obtained by flotation of feldspathic rocks and sands) sold or used by domestic producers in 1955 increased 13 percent in quantity and 9 percent in value compared with 1954. The tonnage and value for 1955 were the second largest in the history of the industry. Production was reported from 11 States, the same as in 1954.

In 1955 South Dakota and Texas were the only States that reported decreases in production. North Carolina continued to be the largest producer, with 52 percent of the quantity compared with 56 percent in 1954.

The tonnage of feldspar and feldspathic rock treated in flotation plants became significant in 1951, increased steadily through 1952–54, and in 1955 40 percent of all marketable feldspar was obtained by flotation compared with 37 percent in 1954.

TABLE 2.—Crude feldspar sold or used by producers in the United States, 1946–50 (average) and 1951–55 [1]

Year	Long tons	Value		Year	Long tons	Value	
		Total	Average per ton			Total	Average per ton
1946–50 (average)	441,261	$2,481,251	$5.62	1953	452,600	$4,594,450	$10.15
1951	400,439	2,815,587	7.03	1954	411,018	3,490,466	8.49
1952	420,831	3,696,018	8.78	1955	465,378	3,801,291	8.17

[1] Includes flotation concentrate.

TABLE 3.—Crude feldspar [1] **sold or used by producers in the United States, 1953–55, by States**

State	1953		1954		1955	
	Long tons	Value	Long tons	Value	Long tons	Value
Colorado	43,508	$267,642	(2)	(2)	46,114	$313,716
Connecticut	9,829	63,049	9,280	$60,463	44,064	366,383
New Hampshire	28,961	286,069	44,990	375,087		
Maine	17,637	117,090			26,282	188,961
North Carolina	268,042	3,290,495	230,744	2,220,707	242,724	2,184,793
South Dakota	50,601	321,026	(2)	(2)	42,164	267,286
Other States [3]	34,022	249,079	126,004	834,209	64,030	480,152
Total	452,600	4,594,450	411,018	3,490,466	465,378	3,801,291

[1] Includes flotation concentrate.
[2] Included with "Other States" in order to avoid disclosure of individual company confidential data.
[3] Includes Arizona, California, Colorado (1954), Georgia (1954–55), South Dakota (1954), Texas (1954–55), Virginia, and Wyoming (1953).

Ground Feldspar.—Ground feldspar sold by merchant mills in the United States increased 12 percent in quantity and 18 percent in value in 1955 compared with 1954. The number of producing States was 13 in 1955 compared with 15 in 1954 and 13 in 1953.

As for the past several years, North Carolina again was by far the leading producer of ground feldspar in 1955, followed by Colorado, South Dakota, New Hampshire, and Maine. Ground-feldspar production in each of the large producing States increased in 1955 compared with 1954.

The foremost realignment of feldspar production interests since 1952 occurred in 1955 when Feldspar Corp. of Spruce Pine, N. C., purchased Feldspar Flotation Corp., also of Spruce Pine, and its affiliates, Feldspar Milling Co., Burnsville, N. C.; North Carolina Feldspar Corp., Erwin, Tenn.; and Appalachian Minerals Co., Monticello, Ga. Feldspar Corp. is a wholly owned subsidiary of Pacific Tin Consolidated Corp. of New York, N. Y. Feldspar Corp., after acquiring the new companies, continued to develop new reserves and added materially to mining and refining equipment acquired with the purchase.

TABLE 4.—Ground feldspar sold by merchant mills [1] in the United States, 1946–50 (average) and 1951–55

Year	Active mills	Domestic feldspar			Canadian feldspar			Total	
		Short tons	Value		Short tons	Value		Short tons	Value
			Total	Average		Total	Average		
1946–50 (average)	26	441,146	$5,529,246	$12.53	17,370	$395,194	$22.75	[illegible]58,516	$5,924,440
1951	23	441,816	6,633,378	15.01	12,799	299,500	23.40	[illegible]4,615	6,932,878
1952	24	448,839	6,473,203	14.42	10,081	239,278	23.74	[illegible]920	6,712,481
1953	22	454,692	6,909,177	15.20	9,184	239,512	26.08	[illegible]876	7,148,689
1954	24	427,161	6,471,621	15.15	1,734	45,837	26.43	[illegible],895	6,517,458
1955	23	479,567	7,698,905	16.05	-------	-------	-------	479,567	7,698,905

[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, 1953–55, by States

State	1953			1954			1955		
	Active mills	Short tons	Value	Active mills	Short tons	Value	Active mills	Short tons	Value
Arizona	1	60,204	$766,832	(2)	(2)	(2)	(2)	(2)	(2)
Colorado	2			(2)	(2)	(2)	(2)	(2)	(2)
Connecticut	2	11,647	226,300	(3)	(3)	(3)	(2)	(2)	(2)
Illinois	(2)	(3)	(2)	(2)	(2)	(2)	1	5,636	$125,796
Maine	3	17,901	354,639	(4)	(4)	(4)	(4)	(4)	(4)
New Hampshire	2	32,397	700,653	[5] 5	[5] 38,444	[5] $725,852	[5] 5	[5] 46,505	[5] 922,579
New York	1			[6] 4	[6] 14,149	[6] 260,257			
North Carolina	2	272,059	3,891,684	2	254,781	3,763,211	4	284,660	4,522,121
Tennessee	1			1			1		
Virginia	(2)	(2)	(2)	(2)	(2)	(2)	1		
Texas	-------	-------	-------	1	1,604	10,524	-------	-------	-------
Other States [7]	8	69,668	1,208,581	11	119,917	1,757,614	11	142,766	2,128,409
Total	22	463,876	7,148,689	24	428,895	6,517,458	23	479,567	7,698,905

[1] Excludes potters and others who grind for consumption in their own plants.
[2] Included with "Other States" in order to avoid disclosure of individual company confidential data.
[3] Included with New York.
[4] Included with New Hampshire.
[5] Includes 3 active mills in Maine.
[6] Includes 2 active mills in Connecticut and 1 in New Jersey.
[7] Includes (number of active mills in parentheses) Arizona (1 in 1954–55), California (2), Colorado (2 in 1954–55), Connecticut (2 in 1955), Georgia (1 in 1954–55), Illinois (1 in 1953–54), New Jersey (1 in 1953 and 1955), South Dakota (2), and Virginia (2 in 1953–54).

Appalachian Minerals Co., Monticello, Ga., the first company in the United States to produce high-potash feldspar by froth flotation from pegmatites, reached full production in 1955. The output was shipped to the glass, electrical, porcelain, and sanitary-ware industries, and to other manufacturers of ceramics.

Del Monte Properties Co., a beach-sand flotation plant at Pacific Grove, Calif., from which high-grade feldspar was obtained, reported its best year in 1955 and expected to install additional plant capacity in 1956.

CONSUMPTION AND USES

Crude Feldspar.—Many merchant grinders also mined feldspar, either themselves or through affiliated firms. A large part of their supply of crude feldspar, however, was purchased from small, independent operations.

Most feldspar consumers bought material already ground, sized, and ready for use in their manufactured products. Some pottery, enamel, and soap manufacturers, however, purchased crude feldspar for all or part of their requirements and ground it to company specification in their own mills.

Ground Feldspar.—Glass, pottery, and enamel industries in 1955 consumed 95 percent of the ground feldspar sold by merchant mills, compared with 96 percent in 1954, 97 percent in 1953, and 99 percent in both 1952 and 1951. In 1955, glass consumed 43 percent (53 percent in 1954); pottery, 47 percent (39 percent in 1954); and enamel, 5 percent (4 percent in 1954). In 1955 other industries consumed 5 percent of the ground feldspar sold, whereas, as late as 1952, only 1 percent of total sales went to these industries. This represents a fourfold increase in the quantity sold for other uses. Of the tonnage shipped to the three principal classes of consumers, enamel showed a 43-percent increase and pottery a 34-percent increase, but glass a 9-percent decrease.

TABLE 6.—Ground feldspar sold by merchant mills in the United States, 1946–50 (average) and 1951–55, in short tons, by uses

Year	Glass	Pottery	Enamel	Other [1]	Total
1946–50 (average)	247,735	179,422	26,066	5,293	458,516
1951	197,483	231,725	21,778	3,629	454,615
1952	251,489	179,469	21,809	6,153	458,920
1953	253,596	179,323	14,383	16,574	463,876
1954	226,157	167,824	18,088	16,826	428,895
1955	204,757	224,162	25,919	24,729	479,567

[1] Includes other ceramic uses, soaps, and abrasives

TABLE 7.—Ground feldspar shipped, by States of destination, from merchant mills in the United States, 1951–55, in short tons

Destination	1951	1952	1953	1954	1955
California	(1)	(1)	11,386	(1)	(1)
Illinois	53,940	51,808	61,751	60,391	37,305
Indiana	25,692	30,976	20,024	13,864	(1)
Maryland	19,109	17,214	16,871	16,324	15,016
Massachusetts	6,176	4,715	5,010	4,764	5,539
New Jersey	54,968	47,046	45,835	32,465	38,125
New York	31,086	31,614	30,950	28,923	52,354
Ohio	70,245	60,884	63,410	58,198	72,161
Pennsylvania	60,306	65,167	66,302	79,688	62,072
Tennessee	10,679	13,392	14,468	12,618	(1)
West Virginia	37,062	52,421	51,029	46,636	36,677
Wisconsin	11,558	9,880	8,617	6,534	10,674
Other destinations [2]	73,794	73,803	68,223	[3] 68,490	[3] 149,644
Total	454,615	458,920	463,876	428,895	479,567

[1] Included with "Other destinations."
[2] Includes Arkansas, California (1951–52 and 1954–55), Colorado, Connecticut (1951–54), Indiana (1955); Kentucky, Louisiana, Michigan, Minnesota, Mississippi, Missouri, Oklahoma, Puerto Rico (1952–55), Rhode Island, Tennessee (1955), Texas, Washington (1952 and 1954–55), shipments that cannot be segregated by States, and small shipments to Belgium (1952–53), Canada, Cuba (1953), and Mexico. Also includes specified shipments to Alabama (1952–54), Arizona (1952), Florida (1952–54), Georgia (1952–54), Kansas (1952 and 1954), Maine (1953), New Hampshire (1953–54), New Mexico (1955), North Carolina (1952–54), North Dakota (1952), and Virginia (1952).
[3] Also includes small shipments to Panama, Peru, and Philippines in 1954 and to England and Venezuela in 1954–55.

The percentage of total consumption by States in 1955 (comparable figures for 1954 shown in parentheses) was as follows: Ohio, 15 percent (14 percent); Pennsylvania, 13 percent (19 percent); New York, 11 percent (7 percent); New Jersey, 8 percent (8 percent); Illinois, 8 percent (14 percent); West Virginia, 7 percent (11 percent).

TABLE 8.—Feldspar grinders in 1955, by State, county, and location of grinding plant

State	County	Nearest town	Company
Arizona	Mohave	Kingman	Consolidated Feldspar Dept., International Minerals & Chemical Corp.
California	Los Angeles	Claremont	Gladding, McBean & Co.
Do	Monterey	Pacific Grove	Del Monte Properties Co.
Colorado	Chaffee	Salida	Western Feldspar Milling Co.
Do	Denver	Denver	Consolidated Feldspar Dept., International Minerals & Chemical Corp.
Connecticut	Middlesex	Cobalt	Worth Spar Co.
Do	do	Portland	Eureka Feldspar Mining & Milling Co.
Georgia	Jasper	Monticello	Appalachian Minerals Co.
Illinois	Knox	Abingdon	Abingdon Potteries, Inc.
Maine	Oxford	West Paris	Bell Minerals Co.
Do	Sagadahoc	Topsham	Consolidated Feldspar Dept., International Minerals & Chemical Corp.
Do	do	do	Topsham Feldspar Co.
New Hampshire	Cheshire	Cold River	J. F. Morton, Inc.
Do	do	Alstead	Golding-Keene Co.
New Jersey	Mercer	Trenton	Do.
North Carolina	Mitchell	Kona	Consolidated Feldspar Dept., International Minerals & Chemical Corp.
Do	do	Spruce Pine	Do.
Do	do	do	The Feldspar Corp.
Do	Yancey	Burnsville	Do.
South Dakota	Custer	Custer	Consolidated Feldspar Dept., International Minerals & Chemical Corp.
Do	Pennington	Keystone	Do.
Tennessee	Unicoi	Erwin	The Feldspar Corp.
Virginia	Bedford	Bedford	Clinchfield Sand & Feldspar Corp.

PRICES

Price quotations for crude feldspar do not appear in the trade press. The average value, computed from the returns of producers to the Bureau of Mines, was $8.17 per long ton compared with $8.49 in 1954 (see table 2).

According to reports from merchant grinders, the average selling price for ground feldspar in 1955 was $16.05 per short ton—a 6-percent increase from 1954. The producing States having the highest selling price per short ton were as follows: Illinois, $22.32; New Jersey, $22; Arizona, $20; Maine, $19.97; New Hampshire, $19.73; and Tennessee, $19.66. North Carolina, by far the largest producer, received only $15.41 per short ton in 1955.

Quotations on ground feldspar appearing in E&MJ Metal and Mineral Markets for December 1955 were the same as in each previous year, beginning 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 per ton to bulk quotation for bags and bagging). The average selling price per short ton (see table 4) was $16.05 in 1955 according to producers reports to the Bureau of Mines.

FOREIGN TRADE [3]

Crude-feldspar imports for consumption in 1955 totaled 105 long tons (all from Canada) valued at $9,346 compared with 79 long tons valued at $3,357 in 1954.

According to grinders reporting to the Bureau of Mines, ground-feldspar exports from the United States in 1955 totaled 4,966 short tons, a 17-percent increase over 1954. Countries of destination were Mexico, Puerto Rico, Venezuela, Canada, and England.

Cornwall Stone.—Beginning January 1, 1954, import statistics of unmanufactured cornwall stone were not separately classified. Imports of ground cornwall stone in 1955 amounted to 67 tons valued at $1,913.

TABLE 9.—Feldspar imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Crude		Ground		Year	Crude		Ground	
	Long tons	Value	Long tons	Value		Long tons	Value	Long tons	Value
1946–50 (average)	18,458	$132,790	(1)	$66	1953	5,901	$60,501	98	$2,740
1951	17,128	146,565	(1)	26	1954	79	3,357	898	22,449
1952	5,576	53,016			1955	105	9,346	1,254	31,737

[1] Less than 1 ton.

TECHNOLOGY

Bell Minerals Co., developed four new mines in Maine during 1955 and, by increased plant modernization and mechanization, expanded production capacity 40 percent.

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

TABLE 10.—Cornwall stone imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Unmanufactured		Ground		Year	Unmanufactured		Ground	
	Long tons	Value	Long tons	Value		Long tons	Value	Long tons	Value
1946–50 (average)	837	$10,836	95	$2,076	1953	655	$7,018	53	$1,376
1951	944	9,453	110	3,462	1954	(1)	(1)	61	1,758
1952	300	3,170	30	800	1955	(1)	(1)	67	1,913

[1] Beginning January 1, 1954, not separately classified.

International Minerals & Chemical Corp. installed an electrostatic concentrating tower at its Topsham, Maine, plant to test on a commercial scale a method of dry beneficiation. The process is said to eliminate part of the silica and soda feldspar, resulting in a product with a substantially higher potash-soda ratio.

WORLD REVIEW

The estimated Free World production in 1955 increased 14 percent compared with 1954. The outputs of China and U. S. S. R., for which no data are available, are not included in the total. The United States continued to furnish about half of Free World output.

Canada.—Canadian production, imports, and exports of feldspar in 1955 compared with 1954 are shown in table 12.

Late in 1955 Spar-Mica Corp.,[4] Montreal, Canada, began a large mining and milling project at Baie Johan Beetz, Quebec, to produce high-potash feldspar from pegmatities by a patented process. Daily production capacity was expected to be about 300 short tons of feldspar concentrate. The output was to be shipped by boat to Camden, N. J. It was planned to sell part of the concentrate to the glass trade without further processing and to grind the remainder to finer sizes for sale to other branches of the ceramic industry.

[4] Engineering and Mining Journal, vol. 156, No. 11, November 1955, p. 162.

TABLE 11.—World production of feldspar, by countries,[1] 1946–50 (average) and 1951–55, in long tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada (sales)	35,481	36,383	18,096	18,970	14,371	16,207
United States (sold or used)	441,261	400,439	420,831	452,600	411,018	465,378
Total	476,742	436,822	438,927	471,570	425,389	481,585
South America:						
Argentina	6,247	(3)	(3)	(3)	(3)	4,920
Brazil [4]	4,600	11,800	(3)	(3)	(3)	(3)
Chile	421	1,181	592	2,047	(3)	(3)
Peru	141	129				
Uruguay	1,527	664	884	779	696	381
Total [4]	13,000	19,000	20,000	21,000	22,000	20,000
Europe:						
Austria	1,703	3,692	2,537	1,332	2,137	2,510
Czechoslovakia	[4] 7,500	(3)	(3)	(3)	(3)	(3)
Finland	6,799	8,069	9,635	9,180	12,062	12,529
France	43,872	58,830	63,974	59,053	61,021	71,847
Germany, West	38,806	96,680	101,284	94,190	138,323	169,718
Italy	12,871	28,684	21,249	24,342	30,373	42,687
Norway	22,000	30,627	28,834	18,411	27,764	26,574
Portugal	944	463	689	59		
Spain (quarry) [5]	2,446	1,732				(3)
Sweden	34,822	40,423	47,115	37,333	48,494	50,102
Total [4]	173,100	274,000	280,000	249,000	325,000	381,000
Asia:						
India	1,323	3,385	2,020	3,881	6,476	[4] 5,900
Israel	14					
Japan [6]	16,820	26,109	23,812	24,682	33,627	30,619
Total	18,157	29,494	25,832	28,563	40,103	[4] 36,519
Africa:						
Eritrea	138			3	6	
Kenya	22					
Madagascar	3			24		
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	[7] 3,464	1,130				
Union of South Africa	3,023	3,290	7,361	5,480	3,525	6,421
Total	6,650	4,420	7,361	5,507	3,531	6,421
Oceania: Australia [8]	9,940	14,842	13,589	6,883	16,384	20,589
World total (estimate) [1]	700,000	780,000	790,000	780,000	830,000	950,000

1 In addition to countries listed, feldspar is produced in China, Rumania, and U. S. S. R., but data are not available; no estimates are included in the total.

2 This table incorporates a number of revisions of data published in previous Feldspar chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.

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 are no crude production data to support these ground figures: 1951, 10,869 tons; 1952, 10,195 tons; 1953, 10,495 tons; 1954, 8,160 tons; 1955, data not available.

6 In addition, the following quantities of aplite and other feldspathic rock were produced: 1951, 58,973 tons; 1952, 70,287 tons; 1953, 71,263 tons; 1954, 74,817 tons; 1955, data not available.

7 Average for 1 year only, as 1950 was 1st year of commercial production.

8 Includes some china stone.

TABLE 12.—Production, imports, and exports of feldspar in Canada, 1954–55 [1]

	1954		1955	
	Short tons	Value	Short tons	Value
Production:				
Quebec	14,305	$278,997	17,844	$356,968
Ontario	1,791	22,052	1,000	14,000
Total	16,096	301,049	18,844	370,968
Imports, ground:				
United States	398	8,078	137	3,106
Exports:				
United States	1,053	27,946	1,419	37,553
Germany, West	1	80	7	572
Colombia	2	180		
Total	1,056	28,206	1,426	38,125

[1] Canada Department of Mines and Technical Surveys, Feldspar in Canada, 1955 (Preliminary): Ottawa, 1955, p. 3.

NEPHELINE SYENITE

Although nepheline syenite occurs in several States, no domestic commercial production has been reported. Domestic consumption of nepheline syenite increased progressively from 1944 through 1955 owing mainly to increased requirements in the glass-container industry.

Prices.—Prices of processed nepheline syenite were as follows, at the close of 1955 f. o. b. Nephton or Lakefield, Ontario, Canada, carlots, in bulk: Glass grade (28-mesh) $14.50; Pottery grade (200-mesh) $18.50; Pottery grade (270-mesh) $19; and B grade (100-mesh) $10. There is an additional charge of $3 per ton for bagged material. All classes of nepheline syenite enter the United States duty free.[5]

TABLE 13.—Nepheline syenite imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Crude		Ground		Year	Crude		Ground	
	Short tons	Value	Short tons	Value		Short tons	Value	Short tons	Value
1946–50 (average)	41,997	$163,933	16,323	$218,646	1953	181	$659	89,195	$1,308,058
1951			65,773	936,256	1954			95,782	[1] 1,436,325
1952	4	125	68,398	984,050	1955			111,863	1,856,062

[1] Owing to changes in tabulating procedures by U. S. Department of Commerce data known to be not comparable with other years.

Foreign Trade.—Imports of ground nepheline syenite increased 17 percent in 1955 over 1954. The average value per ton (foreign market value) of ground nepheline syenite imported was $16.59 in 1955 compared with $15 in 1954. Except for 20 long tons imported from France, Canada was the only supplier.

World Review.—The nepheline syenite plant of International Minerals & Chemical Corp. at Blue Mountain, Ontario, Canada, was expected to be placed in operation in early 1956. The plant, repre-

[5] Janes, T. H., Nepheline Syenite in Canada, 1955 (Preliminary): Canada Department of Mines and Technical Surveys, Ottawa, 1955, p. 4.

senting an investment of $1.5 million, had an estimated capacity of about 100,000 short tons of ground nepheline syenite per year. Table 14 shows the Canadian production, trade, and consumption of nepheline syenite.

TABLE 14.—Canadian production, trade, and consumption of nepheline syenite, 1954–55 [1]

	1954		1955	
	Short tons	Value	Short tons	Value
Production, crude (crude ore mined)	159,885	(2)	194,205	(2)
Shipments:				
Ground:				
Glass grade	86,098	(2)	99,651	(2)
Pottery grade	27,365	(2)	33,551	(2)
Miscellaneous	8,639	(2)	10,694	(2)
Total	122,102	(2)	143,896	(2)
Crude	1,567	(2)	2,172	(2)
Total shipments	123,669	$1,770,529	146,068	$2,099,512
Exports, crude and processed materials:				
United States	79,967	1,197,031	114,297	1,682,372
Netherlands	1,658	29,841	1,832	32,960
United Kingdom	824	14,776	848	14,669
Puerto Rico	800	14,000	720	12,480
Other countries	703	13,450	578	10,636
Total	83,952	1,269,098	118,275	1,753,117

[1] Canada Department of Mines and Technical Surveys, Nepheline Syenite in Canada, 1955 (Preliminary): Ottawa, 1955, p. 4.
[2] Data not available in detail; included in total.

APLITE

The tonnage of aplite produced in the United States in 1955 increased 1 percent, and the sales of ground aplite increased 7 percent. The only aplite producers were: Dominion Minerals Division, Riverton Lime & Stone Co., Inc., in Amherst County and Consolidated Feldspar Department, International Minerals & Chemical Corp., in Nelson County, both near Piney River, Va.

Ferroalloys

By P. H. Royster[1] and Hilda V. Heidrich[2]

DOMESTIC steel production reached an alltime high of 117.0 million tons of ingots in 1955, an increase of 32.5 percent over the 88.3 million tons of 1954.

Responding to the expanded market, ferroalloy production in 1955 reached its alltime high of 2.4 million short tons, up 33.8 percent from the 1.8 million tons produced in 1954. In spite of increased production, shipments of ferroalloys to consumers outran production by 126,700 tons. Apparent consumption of all ferroalloys averaged 42.36 pounds per ton of ingots in 1955 compared with 41.94 pounds for the 5-year period, 1950–54. Imports of ferroalloys in 1955 remained relatively unchanged at approximately 5 percent of apparent consumption, a figure similar to the one reported in 1954.

The 1955 output of alloy-steel ingots of all classes, types, and grades was 10.69 million tons, up 48 percent from the 7.22 million tons reported in 1954. Consumption of four elements—manganese, silicon, chromium, and nickel—composed an estimated 92.3 percent of all ferroalloying elements used in 1955.

The so-called secondary alloying elements, in order of decreasing tonnage used, were: Aluminum, molybdenum, copper, phosphorus, tungsten, lead, titanium, vanadium, cobalt, zirconium, columbium, tantalum, selenium, boron, calcium, and cerium. Consumption figures for calcium, cerium, the rare-earth metals, sulfur, nitrogen and tellurium, used on occasion in steelmaking, are not compiled.

DOMESTIC PRODUCTION AND SHIPMENTS

Production and shipments of ferroalloys in 1954 and 1955 are given in table 1. In this table ferromanganese includes the three carbon grades of ferromanganese (high, medium, and low) as well as the high-silicon alloy, silicomanganese. Iron-silicon alloys appear in lines 2 and 3 under the headings Ferrosilicon and Silvery Iron. Ferrosilicon includes the conventional grades containing 50, 65, 75, 85, and 95 percent silicon. All known commercial production, in the United States, was in the electric furnace. Silvery iron data refer to the two grades of high-silicon pig iron—the 10-percent silicon product made exclusively in the blast furnace and the higher grade (15-odd-percent-silicon) alloy made exclusively in the electric furnace. Ferrochromium data include the high-carbon, low-carbon, and high-silicon alloys, as well as those for ferrochromium briquets.

[1] Metallurgist.
[2] Statistical assistant.

The ferroalloys as a group differ greatly in composition, character, price and use. The score or more ferroalloying elements covered in this chapter are discussed individually in the following sections.

Manganese Alloys.—During 1955, 974,900 short tons of ferromanganese of all grades, including silicomanganese and manganese briquets, was produced, with an average manganese content of 75.91 percent. Shipments ran 3.97 percent above production. The average value of the entire tonnage of ferromanganese shipments of all grades was $195.36 per short ton of alloy, equivalent to 12.87 cents per pound of contained manganese. The average value of the 126,733 tons of silicomanganese sold by 8 producers was reported as $198.52 per ton of alloy. The average manganese content of the silicomanganese sold was 66.62 percent, indicating a value of 14.90 cents per pound of contained manganese.

TABLE 1.—Ferroalloys produced and shipped from furnaces in the United States, 1954–55

	1954				1955			
	Production		Shipments		Production		Shipments	
	Gross weight (short tons)	Alloy element contained (avg. percent)	Gross weight (short tons)	Value	Gross weight (short tons)	Alloy element contained (avg. percent)	Gross weight (short tons)	Value
Ferromanganese [1]	827,235	73.86	799,710	$159,341,957	974,902	75.91	1,013,619	$198,022,243
Ferrosilicon	286,350	54.88	266,584	38,292,436	382.699	55.74	424,744	67,310,237
Silvery iron	363,600	12.90	328,803	24,505,679	459,291	12.74	488,292	35,501,323
Ferrochromium [2]	181,673	66.39	187,780	72,805,903	407,703	65.45	421,867	141,344,460
Ferrotitanium	4,409	23.54	4,805	1,997,971	6,565	23.37	6,881	3,326,047
Ferrophosphorus	74,121	22.94	36,089	1,200,608	77,115	24.30	75,862	2,058,932
Other [3]	67,210	29.82	83,534	45,893,202	106,514	26.72	110,224	52,320,868
Total	1,804,598	53.96	1,707,305	344,037,756	2,414,789	54.97	2,541,489	499,884,110

[1] Includes silicomanganese and manganese briquets.
[2] Includes ferrochrome silicon, chrom-X, and chrom sil-X.
[3] Includes alsifer, ferroboron, ferrocolumbium, ferronickel, ferrotantalum-columbium, ferrotungsten, ferromolybdenum, simanal, spiegeleisen, ferrosilicon zirconium, ferrovanadium, and a small quantity of miscellaneous alloys.

Standard high-carbon ferromanganese was produced in 5 blast furnaces operated by 3 companies in 3 States. Blast-furnace production totaled 601,111 tons, with an average grade of 76.66 percent manganese. Shipments of the blast-furnace alloy exceeded production by 2,931 tons. The reported price of the blast-furnace grade was $190.76 per ton, corresponding to 12.44 cents per pound of manganese.

Nine companies, operating 13 electric-furnace plants in 10 States, produced 373,791 tons of ferromanganese of all grades, including silicomanganese, averaging 74.70 percent manganese. Production of the electric-furnace alloy fell 8.74 percent below shipments, 35,786 tons being withdrawn from producers' stocks.

Imports of all grades of ferromanganese (excluding silicomanganese) during the year were reported as 65,672 tons, this being 15.68 percent more than the 56,772 tons imported in 1954.

Ferrosilicon.—Eleven companies operating 21 electric furnace plants in 11 States produced 382,699 short tons of ferrosilicon, containing 213,312 short tons of silicon. In addition to production, 42,054 short tons was withdrawn from producers' stocks to meet shipments of 424,744 short tons of alloy with a 55.7-percent silicon content. The reported average value of alloy was $158.47 per ton, corresponding to 14.22 cents per pound of contained silicon.

Silvery Iron.—High-silicon pig iron containing 9 to 20 percent silicon was produced in 4 electric furnace plants and 3 blast-furnace plants operated by 5 companies in 5 States. The average silicon content of the 459,300 tons of this alloy produced was 12.7 percent. The silicon content of the electric-furnace product averaged 15.92 percent, while the blast-furnace product averaged 10.08 percent. The 488,300 tons shipped was valued at $72.71 per short ton.

Chromium Alloys.—In 1955 ferrochromium was produced in 15 electric-furnace plants operated by 9 companies in 9 States. A total of 969,570 short tons of chrome ore was used in ferroalloys and metal. The chromic oxide content of this ore was 46.49 percent. The 407,700 tons of chromium alloys produced averaged 65.4 percent chrome and contained 266,832 tons of the element.

Shipments of chromium alloys were valued at $335.05 per ton, equivalent to 25.61 cents per pound of contained chromium.

Imports of ferrochromium were reported as 20,160 tons of high-carbon ferrochromium (59.89 percent chromium) and 10,140 tons of low-carbon alloy (72.22 percent chromium) valued at 17.34 and 26.10 cents per pound of chromium, respectively.

Nickel.—In terms of quantity, nickel ranked second to chromium in importance as an alloying element used by the steel industry. It was added to steel chiefly as the relatively pure metal and as nickel oxide sinter. Ferronickel was produced at Riddle, Oreg., in 1955 by the Hanna Nickel Smelting Co. from nickel silicate ore, but most nickel was imported.

Reports to the Bureau of Mines indicate that 44,701 short tons of nickel was used in producing steel. This tonnage excludes nickel-bearing scrap. The AISI reported 44,021 net tons was used by the industry, a total falling about 2 percent under the tonnage reported to the Bureau.

Ferrophosphorus.—Ferrophosphorus (77,115 tons) was produced as a byproduct by 6 companies operating 11 electric-furnace plants producing elemental phosphorus in 7 States in 1955.

During the year, 75,860 tons of the alloy, averaging 24.30 percent phosphorus, was shipped at a reported average value of $27.14 per short ton. According to AISI reports, only 21.4 percent (16,244 tons) of this was used in producing steel ingots. Exports in 1955 totaled 53,055 tons. The remaining 6,563 tons was used in large measure by iron foundries in producing iron castings.

Molybdenum Products.—Principal molybdenum products used in steel are molybdic oxide and ferromolybdenum. Molybdic oxide was produced in Pennsylvania, Ohio, Colorado, Arizona, California, and New Jersey. Ferromolybdenum was produced by two firms in Pennsylvania. Production and shipments data of molybdenum products in 1955 are given in the Molybdenum chapter. Data on consumption were not collected by the Bureau in that year.

The AISI reported a 1955 consumption of 10,659 tons of molybdenum, appearing as 3,590 tons of ferromolybdenum and 12,633 tons of molybdic oxide, indicating a total of 16,223 tons of "molybdenum products" used by the steel industry. These products were proportioned 22.09 percent as ferromolybdenum and 77.91 percent as molybdic oxide.

The prices quoted for molybdic oxide and ferromolybdenum were increased about 5 percent during the year and at the years end were $1.30 and $1.54, respectively, per pound of contained molybdenum.

Ferrovanadium.—Ferrovanadium was produced in two conventional forms in 1955. These products were 59-percent vanadium ferroalloy and a 55-percent alloy. Ferrovanadium was produced and marketed by two companies.

Titanium Alloys.—Alloys containing titanium were produced and marketed principally as relatively low grade ferro-alloys. Ferrocarbon titanium, a high-carbon product, represented 43.83 percent of the 1955 production and averaged 18 percent titanium. This product sold at an average price of 48.76 cents per pound of titanium contained. Other grades of titanium alloy contained less carbon and averaged about 27.55 percent titanium. The average value of low-carbon alloys was $1.31 per pound of contained titanium, a figure that varied from 47 cents to $2.84. Titanium content of the alloys ranged from 16 to 70 percent.

Zirconium Alloys.—Zirconium was produced in the electric furnace by one firm in the form of a high-silicon alloy containing about 14 percent zirconium. Consumption of the element, as reported by the AISI, was 756 tons, a 52-percent increase over the 498 tons reported as the 1954 consumption.

Ferrozirconium was sold at $156.87 per short ton in 1955, corresponding to a value of 56.02 cents per pound of the element, a decline of about 6 percent from the 59.40 cents per pound in 1954.

Ferrocolumbium.—Ferrocolumbium was produced by one company in 1955. The alloy averaged 57 percent columbium and was valued at $6.15 per pound of the element.

Ferrocolumbium-Tantalum.—Consumption of both elements, columbium and tantalum, in 1955 was 178.4 tons according to the AISI. The tantalum-free ferrocolumbium accounted for about 22 percent of the twin ferroalloys. The average analysis of the combined alloys was approximately 42 percent columbium and 20 percent tantalum, a total alloy content of 62 percent. The average reported value in 1955 of the 57-percent-grade tantalum-free ferrocolumbium was $8.76 per pound of contained columbium. The value of the ferrocolumbium-tantalum alloy was $3.43 per pound of the alloy itself, the value of the columbium being $8.18 per pound. For the two elements combined, the value was $5.54 per pound.

Ferroboron.—Three producers shipped boron alloys in 1955. The average boron content of the alloy was 15.28 percent, unchanged from 1954. The alloy was valued at $6.82 per pound of contained boron, but the several grades sold from $5.64 to $7.24 per pound of the elements.

According to the AISI statistical report, consumption of boron declined from 13.6 short tons in 1954 to 9.3 tons in 1955, a 32-percent decrease.

Ferrotungsten.—The tungsten content of the ferrotungsten produced was 79.23 percent. Tungsten was consumed by the steel industry in the form of ferrotungsten, scheelite (calcium tungstate), scrap, and metal powder. According to the AISI, 2,160 tons of ferrotungsten was consumed in manufacturing steel, with an estimated tungsten content of 1,711 tons. The institute reported a total of 1,803 tons of tungsten consumed in the manufacture of steel, indicating that 92 tons was used in other forms.

The value of the tungsten in the ferrotungsten was $3.26 per pound of the element contained.

Cobalt.—Consumption of cobalt in the United States was 4,870 short tons in 1955, an increase of 33 percent over 1954.

Special Deoxidizers.—Aluminum and calcium are added in certain types of steel to control the extent of deoxidation. In 1955 aluminum, or alloys containing aluminum, silicon, iron, manganese, zirconium, and titanium, were used for this purpose. Owing to its low density and high vapor pressure, calcium metal was not added directly to molten steel. The customary method of adding this element to steel was as a calcium silicide, a calcium-silicon alloy containing approximately 32 percent calcium and 62 percent silicon. Manganese was often used in several calcium deoxidants. Alloys of this type contained about 16 percent manganese, 18 percent calcium, and 56 percent silicon.

CONSUMPTION AND USES

Steel-ingot production in 1955 increased 28.7 million tons over 1954 to establish a new alltime high of 117 million tons. Conforming to this increase in steel production, overall production of ferroalloys increased about 34 percent. The average value of all ferroalloys shipped in 1955 was $196.69 per short ton, which is $4.82 less than the 1954 average of $201.51. Imports of ferroalloys in 1955 were valued at $24.9 million, while imports in 1954 were $17.7 million, or approximately 40 percent greater.

TABLE 2.—Consumption, stocks, imports, and exports of ferromanganese in 1955, in short tons [1]

Consumed in producing—	High-carbon grade	Medium and low-carbon grade	High-silicon (silicomanganese)	Briquets, all grades	Manganese metal	Total
Ingots	798,660	72,079	95,432	64	3,341	969,576
Steel castings	23,516	3,414	9,148	1,426	234	37,738
Other products	31,849	4,933	7,403	12,204	922	57,311
Total consumption	854,025	80,426	111,983	13,694	4,497	1,064,625
Stocks:						
Jan. 1, 1955	166,056	9,291	13,689	3,972	409	193,417
Dec. 31, 1955	134,489	17,555	21,127	3,459	829	177,459
Imports	48,353	17,319	4,500			70,172
Exports	1,654	135				1,789
Receipts from domestic producers	775,759	71,506	114,921	13,181	4,917	980,284

[1] Basic data in this table are from reports from consumers of alloys and from the Bureau of Census, Department of Commerce. None are taken from reports from ferromanganese producers.

Manganese Alloys.—The manganese content of all manganese alloys used by ingot producers in 1955 was 752,000 short tons. This manganese was contained in 870,739 tons of low-silicon ferro-manganese (average grade, 77.25 percent); 95,430 tons of high-silicon alloy (silicomanganese) (average grade, estimated at 66.6 percent); 60,481 tons of spiegeleisen (average grade, estimated at 19.9 percent); and 3,341 tons of 99-percent manganese. The metallic manganese content of the alloying metals used in producing 117 million tons of ingots corresponds to an average addition of 12.91 pounds per short ton of steel. The distribution on a manganese content basis was: 89.5 percent ferromanganese, 8.5 percent silicomanganese, 1.6 percent spiegeleisen, and 0.4 percent metallic manganese.

Ferrosilicon.—Ferrosilicon continued to be the accepted deoxidizing agent for producing killed and semikilled steels, as distinguished from the nondeoxidized rimmed and mechanically capped steels, to which little or no silicon is added. Although the main use of silicon in steel was as a deoxidizing agent, it also was used as an alloying agent, such as in electrical sheets for manufacturing electrical transformers.

Reported consumption, stocks, and receipts of ferrosilicon to the Bureau are shown in table 3, where consumption figures for the standard grades of alloy are given. Silicon content of these alloys averaged 59.10 percent.

Silvery Iron.—Silvery pig iron was widely used by the steel industry in securing closer control of the chemical composition of steel. For example, it was added to the steel furnace to arrest or "block" the carbon drop during the last stages of the refining period.

Silvery iron or high-silicon pig iron was produced largely in 2 grades, 1 containing about 15 percent and the other about 10 percent silicon. There were no exports of silvery pig iron in 1955. Imports of the alloy contributed 11.5 percent to the total silicon contained in the silvery iron used. Besides the tonnage of alloy itself, the tonnage of silicon contained in the alloy is reported for each of the two grades. Consumption by domestic consumers was 395,800 tons of silvery pig iron, with an estimated silicon content of 51,990 tons. When this quantity of silicon is added to the estimated 219,830 tons of silicon contained in ferrosilicon and other silicon alloys, (table 3), the total apparent consumption by the iron and steel industry is calculated as 271,820 tons.

TABLE 3.—Consumption and stocks of ferrosilicon and other silicon alloys in 1955, in short tons

Consumed in producing—	(Percent Ferrosilicon)					Metallic silicon	Briquets	Other silicon alloys	Total
	50	65	75	85	95				
Ingots	143,503	33,504	40,349	2,912	6,204	62	328	25,807	252,669
Steel castings	12,752	137	1,097	82	25	1	2,441	884	17,419
Other products	33,047	271	6,603	1,923	3,537	20,382	29,874	6,199	101,836
Total consumption	189,302	33,912	48,049	4,917	9,766	20,445	32,643	32,890	371,924
Stocks:									
Jan. 1, 1955	20,820	1,580	5,509	887	901	1,370	4,296	17,760	53,123
Dec. 31, 1955	28,718	2,087	5,966	830	978	1,762	8,742	3,384	52,467
Receipts from domestic producers	197,200	34,419	48,506	4,860	9,843	20,837	37,089	18,514	371,268

TABLE 4.—Consumption of silvery pig iron in 1955, in short tons

Consumed in producing—	Nominal grade, based on percentages of silicon contained in products					
	10 percent		15 percent		Total	
	Alloy	Silicon contained [1]	Alloy	Silicon contained [1]	Alloy	Silicon contained [1]
Ingots	12,112	1,221	72,397	11,526	84,509	12,747
Steel castings	19,679	1,984	6,776	1,079	26,455	3,063
Iron castings [2]	157,007	15,826	127,832	20,351	284,839	36,177
Total	188,798	19,031	207,005	32,956	395,803	51,987

[1] Estimated.
[2] Includes miscellaneous users.

Of the silicon contained in the silvery pig iron, approximately 72 percent was used in products other than ingots and steel castings. Although the quantity of silvery pig iron shipped to consumers in 1955 (488,292) would list this alloy tonnagewise second in importance to ferromanganese, the silicon content of the silvery iron used in ingot production was only 22.81 percent (62,013 tons) of the steel industry's total silicon consumption.

Carbon and Alloy Steels.—Steel-ingot production in 1955 was 117 million tons, of which 90.9 percent (106 million tons) was carbon steel to which no alloying elements were added other than the conventional additives manganese and silicon. The remaining 10.7 million tons of ingots which was not carbon steel is classed as alloy steel.

Alloy steels comprised 9.10 percent of the 1955 ingot production, distributed among 7 major types and grades. The quantities of the various types according to the AISI was: 7,251,289 tons of constructional steels; 1,263,829 tons of silicon sheets of transformer grade; 858,414 tons of so-called high-strength, low-alloy steels not generally heat-treated; 660,067 tons grouped into the 18–8 nickel-chromium stainless steels (AISI 300 series); 558,146 tons of the nickel-free, heat-resistant chrome steels (AISI 400 and 500 series); 68,346 tons of steel for castings, and 128,000 tons of alloy tool and die steel.

One or more of the 14 ferroalloying elements used exclusively in alloy steel were consumed in producing these various types and grades of steel. The cost of these 14 ferroalloying elements was small compared with the dollar value of the steel produced, but their industrial and strategic importance was considerable.

Chromium Alloys.—Domestic consumers reported consumption of 300,560 short tons of chromium alloys and chromium metal containing an estimated 180,336 tons of chromium. Of the total, 170,959 tons of chromium contained in the alloys and metal was used in steel, and in addition Metallurgical-grade chromite containing an estimated 7,662 tons of chromium was added directly to steel, making a total of 178,621 tons, excluding scrap, of chromium used in steel. The AISI statistical report for 1955 quoted chromium consumption, excluding scrap, in steel as 174,292 short tons.

Excluding the additives manganese and silicon, chromium was the most widely used in alloy steels. It was the major alloying constituent of steels resistant to atmospheric and chemical corrosion and in many grades of heat-resisting steels. Chromium in smaller quantities was used in many types of alloy tool steels, and in high-strength and low-alloy steels.

Nickel in Alloy Steel.—Twenty-three types of nickel-bearing stainless steels containing up to 24 percent nickel were produced in 1955 and utilized 26,500 tons of the element. In engineering alloy steels 18,200 tons of nickel was used in 1955.

Molybdenum in Alloy Steel.—Molybdenum in the form of molybdic oxide, ferromolybdenum, calcium molybdate, and, molybdenum sulfide was added to steel in amounts ranging from about 0.10 percent in some low-alloy grades to as much as 9 percent in some high-speed types.

According to AISI, 10,650 tons of molybdenum was consumed in producing alloy steel during 1955, a 50-percent increase over 1954.

Ferromolybdenum, molybdic oxide, and molybdenum silicide was added to cast irons in amounts of about 0.25 to 1.25 percent to improve such properties as tensile strength, resistance to chipping, and hardenability.

Ferrovanadium.—Minor quantities of vanadium in steel promote depth hardenability. Usually less than 5 pounds of vanadium per ingot ton has been used. If more is present, response to heat treatment is adversely affected.

Vanadium, in the form of ferrovanadium, was used in producing tool steels, structural steels, and as a constituent of chrome-vanadium ingots (AISI 6100 series).

Consumption of vanadium, as reported to the Bureau in 1955, indicates that: 514 tons was consumed in all types of high-speed tool steel and 1,000 tons as alloy steels and cast iron, including constructional and AISI 6100 series steels.

Ferrotitanium.—Titanium is an effective deoxidizer and degasifier for both carbon and alloy steels. It has been introduced into many of the dozen grades of heat-treatable steels to the extent of 0.12 percent. At this concentration the depth hardenability of steel is increased 60 percent, thus in effect permitting a 38-percent reduction in the use of the other alloying elements present without decreasing the steel's hardenability factor. If over 2.4 pounds per ton of titanium is present, however, response to heat treatment is decreased.

In 1955 the titanium content of the ferroalloy consumed was reported by the AISI as 1,438 tons. It has been stated that about 53 percent of the titanium is lost by oxidation when ferrotitanium is added to steel. To retain 0.12 percent titanium in the finished ingot, about 0.23 percent titanium must be added.

Ferrozirconium.—Zirconium improves the hardenability of heat-treatable engineering steel and, like manganese, reduces difficulties encountered in the hotworking of steel caused by its sulfur content. It may be considered a possible substitute for manganese in sulfur control. Zirconium is an efficient deoxidizer and imparts fine-grain structure to steel. It eliminates gaseous contaminants, particularly nitrogen, and is effective in producing sound ingots. In spite of these characteristics, zirconium was not specified in the analysis of any of the standard grades of alloy steel for which production was reported.

Consumption in 1955 was estimated at 5,400 tons of alloy (756 tons of zirconium).

Columbium and Tantalum.—The main industrial use of columbium was as ferrocolumbium—an alloy containing 57 percent of the element. It was used in manufacturing stainless steels to prevent intergranular corrosion at elevated temperatures. In 18–8 chromium-nickel steels that are joined by welding and cannot be heat-treated after welding, ferrocolumbium is especially beneficial. Columbium has a softening effect and was added to 16–20 chromium steels to improve ductility after rolling.

Tantalum exhibits similar characteristics as columbium, since it also decreases hardenability. Neither of the two elements was used in heat-treatable constructional steels.

Because of smaller atomic weight, columbium, pound for pound, combines with about twice as much carbon as tantalum, and its effectiveness as a carbon stabilizer is probably twice that of tantalum.

New uses for these two metals were in new heat-resisting alloy for gas turbines and jet engines. Some grades of alloys for this purpose carry as much as 3 percent columbium and tantalum. The quantity of the two metals used for this purpose has not been reported.

Boron in Alloy Steel.—The fact that a fraction of an ounce of boron per ton of ingots increases the depth hardenability of all grades of alloy steel 75 percent received wide recognition during and after World War II. Continuing research has substantiated the effectiveness of boron as an alloying element for steel. The tonnage of alloy steel that was boron-treated was reported by the AISI for the first time in 1951, when 4.10 percent of the heat-treatable alloy ingots contained boron. In 1952 this use of boron increased to 9.52 percent but dropped to 5.7 percent in 1953, 4.0 percent in 1954, and 3.5 percent in 1955. The cost of boron used in steel in 1955 was 9.38 cents per ounce. Since the recommended quantity of boron added to steel usually is less than 0.003 percent, the cost factor is not an obstacle to its wider use.

Tungsten in Alloy Steel.—In 1955 the estimated maximum tungsten content of the 21,616 tons of Class A High-Speed tool steel shipped amounted to 895 tons of the element or 4.14 percent of the total. The 3,345 tons of Class B High-Speed steel shipped averaged an estimated 19.64 percent and contained 657 tons of tungsten. Shipments of Class A and B steels contained an estimated 1,552 tons of the element.

Besides the 24,961 tons of High-Speed tool steel, 52,949 tons of "Other alloy-tool" was marketed, containing an unreported quantity of tungsten.

Cobalt in Alloys.—One of the major uses of cobalt was in manufacturing several grades of high-temperature alloys, which contain, in addition to cobalt, chromium, tungsten, and molybdenum. Consumption of cobalt in high-temperature alloys was 1,610 short tons in 1955 and accounted for 33 percent of total cobalt used. Magnetic alloys, which contain 5 to 52 percent cobalt combined with additional alloying elements, employed 1,409 tons of cobalt in 1955 or 29 percent of the total. Only 180 tons of cobalt was used in high-speed and low-cobalt alloy steels in 1955, indicating minor use of the metal in the steel industry.

Special Deoxidizers.—In 1955, 26,574 tons of relative pure aluminum was used in producing all types of steel. In producing low-carbon effervescing ingots, small quantities of aluminum were added to ingot molds to control the rimming action of the metal during solidification. Aluminum is a powerful deoxidizer and frequently has been used in killed steel to remove final traces of oxygen from the ingot.

Complex alloys of aluminum, silicon, manganese, and other elements were marketed under various trade names, such as Alsifer and Simanal. One pound of aluminum in steel promotes depth hardenability equivalent to 1.25 pounds of nickel. In alloy steels, however, aluminum was used principally to effect rigorous deoxidation and to control grain size rather than for its alloying effect on heat treatment.

Alloys of calcium with silicon or with silicon and titanium were used for drastic deoxidation of molten steel and for removing nitrogen. Calcium combines vigorously with sulfur and is of value in controlling this universal contaminant of steel. Calcium was marketed as a calcium silicide containing 32 percent calcium and 64 percent silicon and carrying less than 4 percent iron. A small, unreported tonnage of a lower grade ferroalloy carrying 6 percent calcium, 10 percent titanium, and 50 percent silicon has appeared on the market. Insufficient information was available to permit estimating the annual tonnage of calcium consumed by the steel industry.

FOREIGN TRADE[3]

The quantity and value of the ferroalloys imported for consumption in the United States during 1954 and 1955, as reported by the Bureau of the Census, United States Department of Commerce, are given in table 5.

In 1955, 122,002 tons (gross weight) of ferroalloys valued at $24,958,777 was imported. This was equivalent to approximately 5 percent of the quantity and 5 percent of the reported value of ferroalloy shipments by domestic producers. Of the total imports, ferromanganese represented 53.8 percent, ferrochromium 24.8 percent, and ferrosilicon 19.9 percent. Other imports of ferroalloying materials were approximately 1 percent of the total.

The total exports of ferroalloys, other than ferrophosphorus, as shown in table 7, totaled only 9,270 tons; this composes less than 0.4 percent of the total domestic production.

[3] Imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, 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, 1954–55, by varieties

[U. S. Department of Commerce]

Variety of alloy	1954			1955		
	Gross weight (short tons)	Content (short tons)	Value	Gross weight (short tons)	Content (short tons)	Value
Calcium silicide	89	(1)	$22,055	345	(1)	$92,366
Chromium metal	143	(1)	224,707	268	(1)	434,396
Chromium silicon	278	(1)	54,324	340	(1)	99,160
Ferrocerium and other cerium alloys	3	(1)	21,571	3	(1)	25,148
Ferrochrome or ferrochromium:						
Containing 3 percent or more carbon	14,756	8,124	2,752,347	20,163	12,076	4,189,470
Containing less than 3 percent carbon	2,017	1,439	749,510	10,137	7,321	3,822,132
Ferrochromium tungsten, chromium tungsten, chromium cobalt tungsten, tungsten nickel, and other compounds of tungsten, n. s. p. f. (tungsten content)	(1)	32	97,749	(1)	22	152,260
Ferromanganese:						
Containing not over 1 percent carbon	138	129	56,000	128	113	57,041
Containing over 1 and less than 4 percent carbon	9,096	7,594	2,510,454	17,191	14,113	4,478,465
Containing not less than 4 percent carbon	47,538	37,021	8,336,376	48,353	38,424	7,486,861
Ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum (molybdenum content)	(1)	(2)	[3] 1,512			
Ferrosilicon	[4] 17,791	[4] 3,980	[4] 1,323,271	24,359	5,963	[3] 1,992,565
Ferrotitanium	5	(1)	4,268	32	(1)	26,918
Ferrotungsten	309	250	837,418	418	338	1,275,508
Manganese silicon (manganese content)	(1)	1,581	280,206	(1)	2,950	478,461
Silicon-aluminum and aluminum-silicon	238	(1)	96,532	263	(1)	106,196
Silicon metal (silicon content)	[4] 20	[4] 19	[4] 4,896	(5)	(6)	320
Tungsten and combinations, in lump, grains, or powder (tungsten content)	(1)	77	[3] 342,584	(1)	45	[3] 241,116
Tungstic acid and other alloys of tungsten, n. s. p. f. (tungsten content)	(1)	1	3,136	(1)	(7)	394

[1] Not recorded.
[2] 50 pounds.
[3] Owing to changes in tabulating procedures by the U. S. Department of Commerce data known to be not comparable with earlier years.
[4] Revised figure.
[5] 2 pounds.
[6] 1 pound.
[7] 220 pounds.

TABLE 6.—Ferromanganese and ferrosilicon imported for consumption in the United States, 1954–55, by countries

[U. S. Department of Commerce]

Country	Ferromanganese (manganese content)				Ferrosilicon (silicon content)			
	1954		1955		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:								
Canada	1,315	$339,226	926	$311,889	3,760	$1,244,151	5,914	$1,980,596
Mexico			122	21,533				
Total	1,315	339,226	1,048	333,422	3,760	1,244,151	5,914	1,980,596
South America: Chile	264	40,500	3,910	613,356				
Europe:								
France	14,508	3,246,162	16,267	3,525,982				
Germany, West	11,794	2,808,175	113	57,041			5	4,009
Norway	14,078	3,815,696	19,771	5,155,635			44	7,960
Yugoslavia	406	67,604	1,722	308,014				
Total	40,786	9,937,637	37,873	9,046,672			49	11,969
Asia: Japan	2,379	585,467	9,819	2,028,917				
Grand total	44,744	10,902,830	52,650	12,022,367	3,760	1,244,151	5,963	1,992,565

TABLE 7.—Ferroalloys and ferroalloy metals exported from the United States, 1946–50 (average) and 1951–55, by varieties

[U. S. Department of Commerce]

Variety of alloy	1946–50 (average)		1951		1952		1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Spiegeleisen	1,646	$61,607	85	$4,130	34	$3,888						
Ferrochrome	2,978	1,047,616	240	96,635	1,274	518,721	607	$285,900	2,105	$995,797	4,693	$2,266,579
Ferromanganese	10,004	1,536,729	633	206,614	1,453	474,686	1,112	389,064	1,732	614,544	1,789	642,806
Ferromolybdenum	502	707,960	742	1,224,257	545	925,324	323	548,502	124	237,698	175	353,073
Ferrophosphorus	27,318	669,372	55,044	2,218,790	44,351	2,592,245	22,959	1,147,707	24,342	792,671	53,055	1,345,514
Ferrosilicon	2,307	307,701	2,775	387,664	7,240	1,439,465	1,698	287,539	2,080	365,338	1,689	308,033
Ferrotitanium and ferrocarbon-titanium	378	62,169	175	107,718	325	88,664	185	48,722	172	39,885	245	65,091
Ferrotungsten	247	702,683	142	1,007,424	148	1,150,465	18	122,949	5	3,963	2	9,698
Ferrovanadium	81	270,324	61	190,346	147	529,360	[1] 78	[1] 296,157	[1] 70	[1] 237,733	[1] 220	[1] 991,955
Other ferroalloys	202	89,151	274	131,641	193	73,680	703	256,029	168	102,748	457	251,887
Total	45,663	5,455,312	60,171	5,575,219	55,710	7,796,498	27,683	3,382,569	30,798	3,389,977	62,325	6,234,636

[1] Owing to changes in classification data not strictly comparable with earlier years.

Fluorspar and Cryolite

By Robert B. McDougal[1] and Louise C. Roberts[2]

CONSUMPTION of fluorspar in 1955 was 570,300 short tons, a recovery from the sharp decline in 1954, when 480,400 tons was consumed. Production, as measured by mine or mill shipments of finished fluorspar, increased to 279,500 short tons. Quoted prices for Acid-Grade fluorspar remained steady; however, during the year prices for Ceramic-Grade and Metallurgical-Grade fluorspar fluctuated and at the end of the year were slightly below those at the beginning of the year. Imports of fluorspar for consumption reached 363,400 short tons, an alltime record, exceeding the previously established high in 1953. The United States Tariff Commission undertook an investigation to determine the effect of Acid-Grade imports upon the domestic fluorspar industry. The Commissioners rendered a split decision on their findings, and President Eisenhower accepted the position of those three Commissioners who held that "escape-clause" relief was not warranted. Barter contracts for Mexican fluorspar in exchange for surplus wheat were negotiated by the Commodity Credit Corporation, United States Department of Agriculture, during the year.

TABLE 1.—Salient statistics of fluorspar in the United States, 1946–50 (average) and 1951–55, in short tons

Year	Shipments of domestic fluorspar	Foreign trade		Consumption	Industry stocks at end of year		
		Imports for consumption	Exports		Domestic mines [1]	Consumers' plants	Total
1946–50 (average)	295,477	96,091	1,023	371,388	29,096	130,997	[2] 160,093
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
1953	318,036	361,219	767	586,798	31,896	227,511	[2] 259,407
1954	245,628	293,320	643	480,374	26,370	143,813	[2] 170,183
1955	279,540	363,420	874	570,261	23,439	140,577	[2] 164,016

[1] Finished fluorspar only.
[2] In addition, importers held 11,000 tons in 1949, 7,500 tons in 1950, 2,845 tons in 1951, 31,400 tons in 1952, 15,492 tons in 1953, 26,100 tons in 1954, and 54,021 tons in 1955.

DOMESTIC PRODUCTION

Production of finished fluorspar of domestic origin totaled 239,500 short tons in 1955, including 189,600 tons of flotation concentrate. In 1954 the output of finished fluorspar was 247,700 tons, of which 202,900 tons was flotation concentrate.

[1] Commodity specialist.
[2] Statistical clerk.

Mine production of crude fluorspar in 1955 was 656,500 short tons, with new mine production 253,800 tons, expressed in terms of finished fluorspar, compared with 241,200 tons in 1954. Of the 1955 crude production, 10 mines (producing over 20,000 tons each) supplied 454,800 tons of crude (176,700 tons of finished fluorspar equivalent, or 69 percent); 8 mines (producing 10,000 to 20,000 tons each) supplied 126,800 tons (41,400 tons of finished fluorspar, or 16 percent); 16 mines (producing 1,000 to 10,000 tons each) supplied 57,700 tons (32,200 tons of finished fluorspar, or 13 percent); and 5 mines (producing 500 to 1,000 tons each) supplied 4,400 tons (1,800 tons of finished fluorspar, or 1 percent). Thus 39 mines produced 643,700 tons of crude, or a total of 252,100 tons, expressed in terms of finished fluorspar, which was 99 percent of the total "new" mine production. The remainder was produced from crude material mined at an undetermined number of small mines and prospects or recovered from tailings of previous milling operations.

In 1955, 16 mills recovered 239,500 tons of finished fluorspar from 667,500 tons of crude material compared with 1954, when 19 mills recovered 247,700 tons of finished fluorspar from 622,600 tons of crude.

Consumer-operated mines produced 140,800 tons of crude with an equivalent of 66,700 tons of finished fluorspar in 1955. The total output from consumer-operated mills, including production from stockpiled and purchased crude and tailings, was 104,400 short tons. In 1954 captive mines produced an equivalent of 87,400 tons of finished fluorspar, and captive-mill output totaled 110,300 tons of finished fluorspar. The entire captive production of 2 major aluminum producers and 2 chemical manufacturers was Acid-grade fluorspar.

The Illinois-Kentucky area continued to be the principal source of domestic fluorspar, although the supply from some of the Western States increased.

Production in Illinois—the largest fluorspar-producing State—increased in 1955, reversing a 2-year declining trend, with a total finished-fluorspar output of 161,400 tons, including 112,900 of flotation concentrate, compared with 109,500 tons of finished fluorspar, including 98,100 tons of flotation concentrate, in 1954. The major producers operated steadily throughout the year, although some were on a reduced schedule during the early months as a result of depressed market conditions in metallurgical-grade fluorspar. In September the Minerva Oil Co. purchased the Victory Fluorspar Mining Co. from A. H. Stacey & Sons.[3] A modernizing program was planned for the property.

Production in Kentucky continued to decline and was only 8,089 short tons of finished fluorspar, compared with 34,700 tons in 1954. Although some was produced in Caldwell County, most of the output was reported from Crittenden and Livingston Counties. Pennsylvania Salt Manufacturing Co. was reported to be sinking a 400-feet shaft on the Dyer's Hill property in Livingston County.[4] Pennsylvania Salt Manufacturing Co. announced in March 1955 incorporation of a new, wholly owned subsidiary, Calvert City Chemical Co., to

[3] Engineering and Mining Journal, vol. 156, No. 9, September 1955, p. 154.
[4] Engineering and Mining Journal, vol. 156, No. 10, October 1955, p. 144.

TABLE 2.—Shipments of domestic fluorspar, 1954–55, by State of origin

State	1954			1955		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Illinois	107,830	$5,989,219	$55.54	166,337	$7,838,471	$47.12
Kentucky	35,831	1,510,344	42.15	8,899	308,140	34.63
Utah	4,403	82,353	18.70	7,328	151,140	20.63
Other States:						
Montana	15,102			25,223		
New Mexico	8,876	1,553,611	40.49			
Nevada						
Arizona	14,389			71,753	4,292,647	44.27
California						
Colorado	59,197	3,197,252	54.01			
Total	245,628	12,332,779	50.21	279,540	12,590,398	45.04

TABLE 3.—Shipments [1] of domestic fluorspar by State of origin, 1946–50 (average) and 1951–55, with shipments of maximum year and cumulative shipments from earliest record to end of 1955, in short tons [2]

State	Maximum shipments		Shipments by years							Total shipments [1] from earliest record to end of 1955	
	Year	Short tons	1946–50 (average)	1951	1952	1953	1954	1955 Short tons	1955 Percent of total	Short tons	Percent of total
Colorado [3]	1944	65,209	26,640	20,661	29,185	53,276	59,197				
California	1934	181									
New Mexico	1944	42,973	20,592	24,402	16,443	11,890	8,876	71,753	25.7	1,370,384	14.7
Arizona	1953	1,951	1,012	1,623	434	1,951					
Nevada	1953	(4)	7,463	9,408	14,798	18,487	14,389				
Idaho	1951	(4)									
Illinois [3]	1951	204,328	153,949	204,328	188,293	163,303	107,830	166,337	59.5	4,974,269	53.2
Kentucky [3]	1941	142,862	76,373	68,635	48,308	47,244	35,831	8,899	3.2	2,803,394	30.0
Montana	1955	25,223	156		16,160	5,932	15,102	25,223	9.0	63,198	.7
New Hampshire	1917	1,274								8,302	.1
Tennessee	1953	[5] 426		140	[5] 348	[5] 426				2,111	(6)
Texas	1944	4,769	1,106							14,779	.1
Utah	1950	18,936	8,178	17,827	17,304	15,527	4,403	7,328	2.6	114,648	1.2
Washington	1945	132	8							382	(6)
Wyoming	1944	19								19	(6)
Total	1944	413,781	295,477	347,024	331,273	318,036	245,628	279,540	100.0	9,351,486	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 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.
4 Figures withheld to avoid disclosure of individual company confidential data.
5 Synthetic calcium fluoride recovered by TVA.
6 Less than 0.05 percent.

provide a long-range supply of Acid-grade fluorspar for its Calvert City, Ky., fluorine chemicals plant.[5]

Output in some Western States increased. The Cummings-Roberts operation at Crystal Mountain, Ravalli County, Mont., produced 29,000 tons of Metallurgical-grade fluorspar in 1955, compared with 16,900 tons in 1954. Production of Metallurgical-grade fluorspar in Utah in 1955 increased to 7,200 tons compared with 4,400 tons in 1954.

5 Skillings' Mining Review, vol. 43, No. 49, Mar. 12, 1955, p. 2.

Total production of finished fluorspar in Nevada increased in 1955 over output in 1954. Production in Colorado and New Mexico declined in 1955 compared with 1954. General Chemical Division of Allied Chemical & Dye Corp., the last major fluorspar operator in New Mexico, closed its processing plant at Deming.[6] Inability to compete with foreign producers was given as the reason for the shutdown, although it was said that if conditions improve within several years, the plant may be reactivated. Metallurgical-grade fluorspar was produced in California during 1955.

Total domestic gravel and lump-fluorspar shipments in 1955 comprised 85,500 short tons, compared with 43,900 tons in 1954 (which includes 2,800 tons of flotation concentrate blended with fluxing gravel). Shipments of flotation concentrate (including pelletized)

TABLE 4.—Shipments of domestic fluorspar, 1954–55, by uses

Use	1954				1955			
	Quantity		Value		Quantity		Value	
	Percent of total	Short tons	Total	Average	Percent of total	Short tons	Total	Average
Steel	19.9	48,978	$1,390,653	$28.39	29.5	82,389	$2,132,105	$25.88
Iron foundry	.3	769	28,845	37.51	1.2	3,320	99,400	29.94
Glass	9.7	23,683	993,917	41.97	7.8	21,711	874,296	40.27
Enamel	1.7	4,145	216,975	52.35	1.5	4,327	174,767	40.39
Hydrofluoric acid	65.6	[1] 161,145	[1] 9,394,805	[1] 58.30	56.3	[1] 157,327	[1] 8,882,766	[1] 56.46
Miscellaneous	2.6	6,429	283,746	44.14	3.7	10,414	425,009	40.81
Exported	.2	479	23,838	49.77	(2)	52	2,055	39.52
Total	100.0	245,628	12,332,779	50.21	100.0	279,540	12,590,398	45.04

[1] Includes shipments to General Services Administration.
[2] Less than 0.05 percent.

TABLE 5.—Shipments of domestic fluorspar, by grades and industries, 1954–55, in short tons

Grade and industry	1954	1955
Fluxing gravel and foundry lump:		
Ferrous	[1] 41,888	84,756
Nonferrous	345	152
Miscellaneous	1,607	561
Exported	39	30
Total	[1] 43,879	85,499
Ground and flotation concentrates:		
Ferrous [2]	[1] 8,342	953
Nonferrous	656	346
Glass and enamel	27,828	25,816
Hydrofluoric acid	[3] 161,145	[3] 157,327
Miscellaneous	3,338	9,577
Ground and flotation concentrates—Continued		
Exported	440	22
Total	[1] 201,749	194,041
All grades:		
Ferrous	[1] 50,230	85,709
Nonferrous	1,001	498
Glass and enamel	27,828	25,816
Hydrofluoric acid	[3] 161,145	[3] 157,327
Miscellaneous	4,945	10,138
Exported	479	52
Grand total	[1] 245,628	279,540

[1] Fluxing gravel includes (and flotation concentrates exclude) the following quantities of flotation concentrates blended with fluxing gravel: 1954, 2,804 tons.
[2] Includes pelletized flotation concentrates.
[3] Includes shipments to General Services Administration.

[6] Rock Products, vol. 58, No. 10, October 1955, p. 58.

totaled 194,000 tons in 1955, compared with 201,700 tons in 1954. A large proportion of the fluxing gravel and foundry-lump fluorspar was consumed in steel plants and iron foundries. Small tonnages were shipped to ferro-alloy plants, smelters of secondary metals, and producers of fluxing compounds and for export. Of the flotation concentrate shipped, about 81 percent was used for hydrofluoric acid manufacture or delivered to the National Strategic Stockpile, and about 13 percent was shipped to glass and enamel industries. The remainder was shipped to manufacturers of steel and ferroalloys, aluminum- and magnesium-reduction plants, welding-rod manufacturers, and smelters of secondary metals.

CONSUMPTION AND USES

Fluorspar consumption increased to 570,300 short tons in 1955 compared with 480,400 tons in 1954. The steel industry, historically the largest consumer, was again the largest single consumer in 1955, after falling behind consumption of fluorspar for hydrofluoric acid production in 1954. In 1955, as in 1954, the consumption of fluorspar at steel plants for the production of 1 long ton of basic open-hearth steel averaged 4.9 pounds.

Table 6 shows consumption and stocks of fluorspar at consumer plants. Consumption and stocks of fluorspar and the production of basic open-hearth steel for 1946 through 1955 are shown in table 7. Fluorspar was reported consumed in 36 States; the 3 largest, Illinois, Ohio, and Pennsylvania, accounted for about 42 percent of the total, as shown in table 8.

TABLE 6.—Fluorspar (domestic and foreign) consumed and in stock in the United States, by industries, 1954–55, in short tons

Industry	1954		1955	
	Consumption	Stocks at consumers' plants, Dec. 31	Consumption	Stocks at consumers' plants, Dec. 31
Basic open-hearth steel	174,198		217,353	
Electric-furnace steel	21,409	103,589	33,436	107,067
Bessemer steel	460		450	
Iron foundry	8,778	2,871	15,563	4,049
Ferroalloys	[1] 3,240	[1] 1,048	4,293	859
Hydrofluoric acid [2]	225,096	26,094	248,218	20,580
Primary aluminum [3]	3,609	1,838	2,071	1,281
Primary magnesium	540	218	872	239
Glass	29,746	4,596	32,482	4,057
Enamel	5,737	1,114	6,003	888
Cement	[1] 216	[1] 594	178	63
Miscellaneous	[1] 7,345	[1] 1,851	9,342	1,494
Total	480,374	143,813	570,261	140,577

[1] Partly estimated.
[2] 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.
[3] Figures on consumption represent fluorspar used as a flux; see footnote 2.

TABLE 7.—Production of basic open-hearth steel and consumption and stocks of fluorspar (domestic and foreign) at basic open-hearth steel plants, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Production of basic open-hearth steel ingots and castings____long tons__	66,575,000	83,118,000	75,297,000	85,690,000	70,625,000	89,221,000
Consumption of fluorspar in basic open-hearth steel production____short tons__	187,744	242,180	237,483	252,442	174,198	217,353
Consumption of fluorspar per long ton of basic open-hearth steel made____pounds__	5.6	5.8	6.3	5.9	4.9	4.9
Stocks of fluorspar at basic open-hearth steel plants at end of year____short tons__	92,400	133,100	195,700	163,600	95,200	102,200

TABLE 8.—Fluorspar (domestic and foreign) consumed in the United States, by States, 1954–55, in short tons

State	1954 [1]	1955	State	1954 [1]	1955
Alabama, Georgia, Mississippi, North Carolina, and South Carolina	13,098	12,952	Massachusetts	545	530
Arkansas, Kansas, Louisiana, and Oklahoma	51,053	58,152	Michigan	12,584	24,651
California	22,261	25,727	Missouri	4,843	3,668
Colorado and Utah	16,497	20,759	New York	15,100	20,378
Connecticut	449	949	Ohio	57,462	69,031
Delaware and New Jersey	58,711	67,701	Oregon and Washington	1,517	2,097
Illinois	83,286	86,703	Pennsylvania	60,668	83,679
Indiana	27,692	33,322	Tennessee	736	974
Iowa, Minnesota, Nebraska, South Dakota, and Wisconsin	4,648	5,236	Texas	15,539	19,138
Kentucky	19,809	23,021	Virginia	99	56
Maryland	5,479	5,646	West Virginia	4,777	5,891
			Undistributed	3,521	
			Total	480,374	570,261

[1] Consumption estimated from sample canvass of consumers who accounted for more than 95 percent of total usage in 1953.

STOCKS

Fluorspar stocks at mines or shipping points reported by producers at the close of 1955 declined substantially, owing largely to a reduction of crude stocks at Colorado operations.

TABLE 9.—Stocks of fluorspar at mines or shipping points in the United States, by States, at end of year, 1953–55, in short tons

	1953		1954		1955	
	Crude [1]	Finished	Crude [1]	Finished	Crude [1]	Finished
Arizona			287			
California			200		1,300	
Colorado	88,213	1,693	119,509	1,077	66,843	1,067
Illinois	57,725	15,920	32,941	18,128	48,271	13,236
Kentucky	10,009	7,515	7,759	6,465	7,272	
Montana		5,115	5,988		1,000	8,716
Nevada, New Mexico	20,301	1,069	17,459	700	14,091	420
Tennessee		134				
Utah		450			300	
Total	176,248	31,896	184,143	26,370	139,077	23,439

[1] This crude (run-of-mine) fluorspar must be beneficiated before it can be marketed.

Consumer stocks at the end of 1955 declined only slightly from 143,800 tons to 140,600. Stocks at steel plants were 107,100 tons at year end compared with 103,600 tons in 1954. At the December 1955 rate of consumption, fluorspar stocks at steel plants about equaled a 5-month supply. Changes in stocks at the other consuming plants had no great significance.

PRICES

Prices of domestic Metallurgical-Grade fluorspar declined in March 1955 but advanced by the end of the year to a little less than that in January. However, prices of imported fluorspar increased substantially. Metallurgical-Grade fluorspar containing 72½ percent effective CaF_2[7] was quoted at $36 per short ton, f. o. b. shipping point, Illinois-Kentucky, until March, when a reduction to $30 per ton was reported, rose to $33 in July, and remained steady for the remainder of the year. Metallurgical-Grade fluorspar containing 70 percent effective CaF_2 was quoted at $33 per short ton, f. o. b. shipping point, Illinois-Kentucky, until March, when the price fell to $29 per ton. During July the price for this grade advanced to $32 per ton and remained steady for the remainder of the year. Metallurgical-Grade fluorspar containing 60 percent CaF_2 was quoted at $29 per short ton, f. o. b. shipping point, Illinois-Kentucky, until March, when the price dropped to $27 per ton. At the end of July the price for this grade increased to $28 per ton and remained there throughout the rest of the year.

The price on foreign Metallurgical-grade fluorspar entering the United States, c. i. f. ports, duty paid, was quoted at $28 per short ton until early April, when it was increased to $31. This price remained in effect until mid-May, when the price for 70 percent effective CaF_2 was quoted at $33 per short ton, and in October it was $34 per ton. Prices on Mexican Metallurgical-grade fluorspar containing 72½ percent effective CaF_2 were quoted at $23 per short ton, all rail, duty paid, f. o. b. shipping point, until March, when the price f. o. b. border increased to $24.50 per ton. In July and September the price was increased to $24.75 and $25.75 per ton, respectively. A price of $25.50 per ton for 70-percent effective CaF_2 was quoted on barges at Brownsville, Tex., until March when the price was increased to $26.75 per ton, f. o. b. border. The price was increased to $27, $27.50 and $27.75 per ton respectively in July, September, and October.

Ceramic-grade fluorspar containing a minimum of 94 percent CaF_2 calcite and silica variable, and 0.14 percent Fe_2O_3, was quoted at $44, per short ton, in bulk, f. o. b. Rosiclare, Ill., until March, when the price was increased to $45 per ton. In December the price fell to $41 per ton for 93–94 percent CaF_2. Quoted prices throughout the year for Ceramic-grade fluorspar in 100-pound bags was $4 per ton above the bulk-shipment price.

Acid-grade concentrate, f. o. b. Rosiclare, Ill., was quoted at $47.50 per short ton throughout the year, following the drop in October 1954 from $52.50 per ton. Foreign Acid-grade flourspar, c. i. f. United States ports, duty paid, was quoted at $52.50 per short ton during the year.

[7] The effective CaF_2 content is determined by subtracting from the percentage of CaF_2 2½ times the SiO_2 present.

FOREIGN TRADE[8]

Imports.—Imports in 1955 increased to a new record of 363,400 short tons and for the fourth consecutive year exceeded the domestic output. Mexico continued to be the leading foreign source, supplying about 54 percent of the total quantity imported in 1955. Of the total imports, the United States Government imported 12,412 short tons duty free, compared with duty-free imports of 50,774 tons in 1954.

Following a resolution by the Senate Finance Committee, the United States Tariff Commission instituted an investigation to determine if Acid-grade fluorspar was being imported into the United States in such quantitites as to cause or threaten serious injury to the domestic fluorspar industry.[9] Hearings were scheduled to begin September 27, 1955.

The Commissioners in their report rendered a split 3-to-3 decision on the findings of their investigation. Three Commissioners con-

TABLE 10.—Fluorspar imported for consumption in the United States in 1955, 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
North America:						
Canada:						
Michigan			53	$1,721	53	$1,721
Philadelphia	38,958	$1,495,181			38,958	1,495,181
Total	38,958	1,495,181	53	1,721	39,011	1,496,902
Mexico:						
Arizona			208	1,486	208	1,486
El Paso	6,281	159,335	25,073	427,493	31,354	586,828
Laredo	61,773	1,754,800	91,491	1,048,302	153,264	2,803,102
Michigan			56	2,383	56	2,383
Philadelphia	6,690	246,522	5,869	79,921	12,559	326,443
San Diego	49	1,227			49	1,227
Total	74,793	2,161,884	122,697	1,559,585	197,490	3,721,469
Total North America	113,751	3,657,065	122,750	1,561,306	236,501	5,218,371
Europe:						
Germany, West: Philadelphia	25,673	881,691			25,673	881,691
Italy:						
Michigan	3,672	99,702	1,566	23,435	5,238	123,137
Philadelphia	30,800	917,010	8,440	217,077	39,240	1,134,087
Total	34,472	1,016,712	10,006	240,512	44,478	1,257,224
Spain:						
Buffalo			8,911	126,619	8,911	126,619
Maryland			889	11,903	889	11,903
Philadelphia	31,191	787,865	15,777	256,758	46,968	1,044,623
Total	31,191	787,865	25,577	395,280	56,768	1,183,145
Total Europe	91,336	2,686,268	35,583	635,792	126,919	3,322,060
Grand total: 1955	205,087	[1] 6,343,333	158,333	[1] 2,197,098	363,420	[1] 8,540,431
1954	205,775	[1] 7,575,203	87,545	[1] 1,386,392	293,320	[1] 8,961,595

[1] Owing to changes in tabulating procedures by U. S. Department of Commerce data known to be not comparable with years before 1954.

[8] Unless otherwise indicated, figures on imports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

[9] Mining World, Public Hearing Set on Fluorspar Imports: Vol. 17, No. 10, September 1955, p. 49.

TABLE 11.—Imported fluorspar delivered to consumers in the United States 1954–55, by uses

Use	1954			1955 [1]		
	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	[2] 81,378	[2] $2,132,623	$26.21	164,480	$4,459,335	$27.11
Hydrofluoric acid	74,223	3,817,980	51.44	193,796	8,330,123	42.98
Glass and enamel	6,582	359,670	54.64	18,777	735,546	39.17
Other	10,937	363,018	33.19	10,577	286,471	27.08
Total	173,120	6,673,291	38.55	387,630	13,811,475	35.63

[1] Partly estimated.
[2] Revised figure.

cluded that the domestic Acid-grade fluorspar industry was threatened with serious injury and will suffer from increased imports and recommended withdrawal for an indefinite period the tariff concessions granted in the General Agreement on Tariff and Trade. The other three Commissioners found that the domestic industry was not threatened with serious injury and that no withdrawals of tariff concessions was necessary.[10] The report was sent to the President, who on March 20, 1956, accepted the position of the three Commissioners who found that no basis exists for granting escape-clause relief.[11]

Numerous bills that were designed to restrict fluorspar imports were introduced in the Senate and House of Representatives during the first of the year. One such bill, H. R. 5333, stated in part that the total quantity of fluorspar imported into the United States that may be entered or withdrawn from warehouses, for consumption, during the last 6 months of 1955 or during any calendar year thereafter shall not exceed 25 percent of the total domestic consumption of fluorspar during the corresponding period of the previous calendar year.[12] These bills were either tabled or defeated before being reported from the committees.

Exports.—The Bureau of the Census, U. S. Department of Commerce, reported exports of 874 short tons valued at $64,981 to

TABLE 12.—Fluorspar reported by producers as exported from the United States, 1946–50 (average) and 1951–55

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average			Total	Average
1946–50 (average)	1,013	$38,912	$38.41	1953	695	$36,906	$53.10
1951	1,148	51,809	45.13	1954	479	23,838	49.77
1952	665	31,173	46.88	1955	52	2,055	39.52

[10] United States Tariff Commission, Acid-Grade Fluorspar; Report to the President on Escape-Clause Investigation No. 42, Under Provisions of Section 7 of the Trade Agreements Extension Act of 1951 as amended Jan. 18, 1956.
[11] U. S. Department of Commerce, Foreign Commerce Weekly: Vol. 55, No. 14, Apr. 2, 1956, p. 19.
[12] American Metal Market, Text of Bill to Limit Imports of Fluorspar: Vol. 62, No. 66, Apr. 5, 1955, p. 11.

Canada, Colombia, Venezuela, Netherlands, Belgium-Luxembourg, and France.

TECHNOLOGY

The Association of Special Phosphatic Fertilizers of Japan expressed so much interest in the W. H. MacIntire patents (U. S. 2,584,894 and 2,584,895, February 5, 1952, assigned to American Zinc, Lead & Smelting Co.), pertaining to treating fluoric effluents to obtain magnesium silicofluoride and for hydrofluoric acid and to produce ammonium fluoride that they were translated into Japanese for distribution among its members.[13] A British patent presented a method of removal of excess fluorides from water by filtration, thus regulating the fluorine content to avoid the deleterious effect of excess fluorides on teeth.[14] An American patent describes the production of hydrogen fluoride.[15] Another patent issued late in 1955 describes the recovery of fluorine chemicals from phosphate rock.[16]

One domestic firm announced development of a toothpaste containing stannous fluoride, that was said to bring the advantages of small quantities of fluoride to the teeth of older children and adults.[17] The use of fluoralcohols as high-temperature lubricants, utilizing properties such as lower flamabilities and better oxidation stabilities, was reported.[18] Dibasic acid esters of fluorinated alcohols were said to be more resistant to hydrolysis than petroleum oils or alkyl diesters. Interest increased in other fluorinated-carbon compounds. Teflon-impregnated bearings said to have resistance to the corrosive action of warm water were discussed.[19]

Report was made of a revolutionary new type of oil-well pipe-cutting tool, employing halogen fluorides fired at high pressures by electrical impulses.[20] The tool was developed by McCullough Tool Co., designers, and Pennsalt, chemists. The chemical was said to be placed in a heavy-walled cylinder provided with a firing, head, with orifices through which ejection of the fluorides takes place. The assembly can be positioned accurately and held against strong thrusts by means of specially designed latches, and it may be lowered to any depth in the oil well. It was claimed that this new use may be classed as the first nonmilitary application of the halogen fluorides. Another article described the increasing active field of halogenation—the chemistry of fluorine-containing compounds.[21]

Determination of silica in fluosilicates was reported as being possible without the removal of fluorine, by the addition of aluminum (III) to hydrochloric acid used in the process before evaporation to dryness.[22]

---

13 Industrial and Engineering Chemistry, Less Fluorine—More HF: Vol. 47, No. 2, February 1955, p. 7A.

14 Journal of Applied Chemistry, Removal of Fluorides from Water: Vol. 6, No. 3, March 1956, p. 239 (South African Council for Scientific and Industrial Research, British Patent 734,356, Oct. 31, 1952; S. Afr., Nov. 22, 1951).

15 Mitchell, W. F., and Grant-McKay, J. A., Production of Hydrogen Fluoride (assigned to Pennsylvania Salt Manufacturing Co.) U. S. Patent 2,702,233, Feb. 15, 1955.

16 Miller, R., Process of Treating Phosphate Rock for the Recovery of Fluorine Chemicals and Production of Fertilizers (assigned to the Chemical Foundation, Inc.): U. S. Patent 2,728,634, Dec. 27, 1955.

17 Chemical and Engineering News, Procter & Gamble Toothpaste Contains Stannous Fluoride: Vol. 33, No. 10, Mar. 7, 1955, p. 1022.

18 Chemical and Engineering News, Fluoralcohols as Lubricants: Vol. 33, No. 16, Apr. 18, 1955, pp. 1646–47.

19 Nudelman, H. B., and Sump, Cord H., Teflon-Impregnated Bearings for Service in Water: Metal Progress, vol. 68, No. 2, Aug. 1, 1955, pp. 112–113.

20 Chemical and Engineering News, Fluorides Go Underground: Vol. 33, No. 33, Aug. 15, 1955, p. 3395.

21 Industrial and Engineering Chemistry, Halogenation: Vol. 47, No. 9, September 1955 (part II), pp. 1876–1881.

22 Shell, H. R., Determination of Silica in Fluosilicates without Removal of Fluorine: Anal. Chem., vol. 27, December 1955, pp. 2006–2007.

An increase in organic and inorganic fluorine-chemical production was expected, with completion of two new fluorine-chemical plants. Davison Chemical Co. completed facilities at Lansing, Mich., for hydrofluoric acid production for water fluoridation. Pennsylvania Salt Manufacturing Co. was expected to begin operation in 1956 of a large organic fluorine-chemicals plant at Calvert City, Ky.[23] Initial products will serve the aerosol-propellant and refrigerant fields. Later products from this plant and related facilities at Calvert City will, according to report, find uses in new and improved plastics, lubricants, metal fluxes, anesthetics, ceramics, and agricultural chemicals and new applications in the field of atomic energy.

WORLD REVIEW

NORTH AMERICA

Canada.—Production of fluorspar in Canada in 1955 reached a new record of 131,700 short tons valued at C$3,063,876, compared with 119,000 tons valued at C$2,987,026 in 1954, reported by the Department of Mines and Technical Surveys, Ottawa.[24]

Exports in 1955, which were shipped to the United States, reached a new high of 38,958 short tons compared with 34,694 tons in 1954. Imports increased to 21,774 tons in 1955, compared with 16,240 tons imported in 1954. After a 2-year decline they were back almost to the 1952 level. Mexico continued to be the leading foreign source, with the United Kingdom, the Union of South Africa, the United States and Spain supplying smaller quantities. Canadian consumption of fluorspar totaled 80,670 short tons in 1954, of which 63,751 tons was used to produce heavy chemicals and white-metal alloys, and 16,002 tons was consumed at steel plants, 757 tons at glass plants, and 160 tons in the enameling and glazing industries. In comparison, the 1953 consumption reached 83,116 short tons, including 59,562 tons for heavy chemicals and white-metal alloys, 22,730 tons consumed at steel plants, 672 tons for glass manufacture, and 152 tons for the enameling and glazing industries.

Almost all of the fluorspar output in Canada was mined in Newfoundland by Newfoundland Fluorspar, Ltd., and St. Lawrence Corp. of Newfoundland, Ltd.[25] Newfoundland Fluorspar, a subsidiary of the Aluminum Co. of Canada, Ltd., operated the Director mine and sink-float plant near St. Lawrence during the year. In 1955 output by the firm totaled 78,091 short tons of heavy-medium concentrate, Submetallurgical grade, of which 71,049 tons was shipped to Arvida, Quebec, for further concentration. Four properties operated by the St. Lawrence Corp. included the Iron Springs mine, which supplied approximately 40 percent of the company total output of 62,684 tons of heavy-medium concentrate, Submetallurgical grade, of which 58,443 tons was shipped to its affiliate plant at Wilmington, Del., for beneficiation.

A small tonnage was shipped from the Kilpatrick mine of the Huntingdom Fluorspar Mines, Ltd., Ontario, from its stockpile.

[23] Chemical Engineering, Two New Plants for Fluorine Chemicals: Vol. 63, No. 1, January 1956, p. 124.

[24] Canada Department of Mines and Technical Surveys, Fluorspar in Canada in 1955 (preliminary): Ottawa, 4 pp.

[25] Work cited in footnote 24, p. 3.

TABLE 13.—World production of fluorspar, by countries,[1] 1946–50 (average) and 1951–55, in short tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	60,107	74,211	82,187	88,569	118,969	131,728
Mexico (exports)	57,910	73,590	198,680	173,163	146,198	145,105
United States (shipments)	295,477	347,024	331,273	318,036	245,628	279,540
Total	413,494	494,825	612,140	579,768	510,795	556,373
South America:						
Argentina (shipments)	3,082	7,937	7,882	[3] 8,000	[3] 8,000	12,125
Bolivia (exports)	128	42	88	21	213	569
Brazil	602	[3] 660				
Total	3,812	[3] 8,600	7,970	[3] 8,000	[3] 8,200	12,694
Europe:						
Belgium	[3] 4,200	(4)	(4)	(4)	(4)	(4)
France	37,910	59,961	78,836	69,702	64,595	71,650
Germany:						
East [3]	36,400	80,000	90,000	90,000	90,000	90,000
West	49,593	154,753	161,566	177,719	190,916	176,370
Italy	26,300	45,216	63,546	83,544	85,041	110,694
Norway	1,881	995	750	777	488	317
Spain	34,813	62,472	68,899	56,426	81,032	69,446
Sweden (sales)	3,327	5,607	4,926	4,773	4,140	1,459
United Kingdom	63,850	83,725	84,922	88,624	92,607	96,235
Total [3]	258,000	500,000	560,000	575,000	615,000	620,000
Asia:						
Japan	849	4,405	4,356	7,206	6,771	4,730
Korea, Republic of	2,122	4,677	6,121	12,139	9,780	11,111
Turkey	136		277	110		
U. S. S. R.[3] [5]	80,000	90,000	90,000	90,000	110,000	110,000
Total [1] [3]	101,000	105,000	110,000	140,000	170,000	180,000
Africa:						
French Morocco	[6] 182	2,169	3,642	3,188	1,188	11
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	187	122		373	120	480
South-West Africa	17	859	4,870	5,641	3,063	675
Tunisia	201		2,723	2,249		
Union of South Africa	5,555	13,537	11,343	16,029	21,996	32,839
Total	6,142	16,687	22,578	27,480	26,367	34,005
Oceania: Australia	903	548	96	373	21	316
World total (estimate) [1]	780,000	1,130,000	1,300,000	1,330,000	1,330,000	1,400,000

[1] In addition to countries listed, fluorspar is produced in China and North Korea. Estimates by author of chapter are included in the total.
[2] This table incorporates a number of revisions of data published in previous Fluorspar chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Data not available; estimate by author of chapter included in total.
[5] U. S. S. R. in Europe included with U. S. S. R. in Asia, as the deposits are predominantly in Asiatic Russia.
[6] Average for 1948–50.

Canadian prices of Ceramic-grade fluorspar, quoted in December by the Aluminum Co. of Canada, f. o. b. Arvida, Quebec, were as follows:

Ceramic grade, coarse, in 100-lb. bags: minimum carload or truckload, $61.50; L. C. L. to one ton, $70.70; less than one ton, $76.85. In bulk: minimum carload or truckload, $57.75.

Ceramic grade, fine, in 100-lb. bags: minimum carload or truckload, $63.50; L. C. L. to one ton, $73.00; less than one ton, $79.35. In bulk: minimum carload or truckload, $59.75.

Specifications: 95 per cent CaF_2 minimum with maximum 2.5 per cent $CaCO_3$, 2 per cent SiO_2 and 0.1 per cent Fe_2O_3.[26]

[26] Northern Miner (Toronto), vol. 41, No. 40, Dec. 29, 1955, p. 19.

Mexico.—Mexico continued to be the leading foreign supplier of fluorspar, to the United States, imports totaling 197,500 short tons. Output in Mexico, classed as exports, was estimated to be about 145,000 tons, compared with 146,000 tons in 1954. It was reported from reliable sources in the fluorspar industry that, over a long period of time, production equals exports. Output for a given period may be more or less than exports during the same period.[27] The Mexican fluorspar industry depends almost entirely upon exports to the United States. Though relatively small in the country's overall economy, the local fluorspar industry has increased its production, as reflected by the exports of Acid-grade fluorspar, which in 1955 was over 10 times as great as in 1948.

Under terms of a $1 million barter agreement signed with Mexico in June 1955, the United States will exchange 100,000 tons of surplus wheat for Mexican fluorspar.[28]

Two American companies (Reynolds Metals Co. and United States Steel Corp.) were investigating fluorspar in the Paila district, State of Coahuila.[29] Exploration and development of the Reynolds property were expected to begin soon. It was anticipated that shipments would commence following the rainy season.

SOUTH AMERICA

Argentina.—The opening of a flotation plant in the outskirts of Buenos Aires for treating fluorite, nickel, and uranium for the metallurgical industries was reported.[30]

EUROPE

Reserves of crude fluorspar containing over 35 percent CaF_2 in Western Europe were estimated at 13.2 million short tons, while reserves in the Soviet Union and its sphere may exceed 5.5 million short tons. Major Western European reserves were said to be in Italy, West Germany, Spain, and the United Kingdom. The general geology and location of these and other European deposits were described in an article.[31]

France.—Exports of fluorspar from France in 1954 totaled 4,313 short tons valued at 39,228,000 francs (350 francs equal U. S. $1), compared with 3,412 tons in 1953. Of the 1954 exports 1,779 tons was sent to Belgium-Luxembourg, 1,138 tons to Sweden, 859 tons to Brazil, 220 tons to the United States, and 317 tons to other countries.[32]

Italy.—Fluorspar production totaled 110,694 short tons, an increase of about 30 percent over production in 1954.

Norway.—Preliminary reports indicated that 288 tons of fluorspar was produced in 1955 compared with 443 tons in 1954. There are numerous deposits, but most of the output was low grade. The principal use was as a fluxing agent in the Norwegian steel industry. None was exported.[33]

---

[27] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 3, February 1956, pp. 26–27.
[28] Oil, Paint and Drug Reporter, Fluorspar-Wheat Exchange With Mexico Is Underway: Vol. 168, No. July 4, 1955, p. 3.
[29] Mining World, vol. 17, No. 10, September 1955, p. 91.
[30] Engineering and Mining Journal, vol. 156, No. 5, May 1955, p. 172.
[31] Rose, H. R., European Fluorspar Supplies: Trans. AIME, Min. Eng., vol. 7, No. 4, April 1955, 383–390.
[32] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 1, January 1956, p. 25.
[33] U. S. Embassy, Oslo, Norway, State Department Dispatch 248: Oct. 10, 1956, p. 15.

United Kingdom.—Detailed United Kingdom fluorspar-production data, which do not add to the production total in table 13, were reported as follows: 20,954 tons of Acid grade, 60,536 tons of Metallurgical, and 14,747 tons of ungraded fluorspar.[34] This compares with 1954 production, when 19,556 tons was Acid grade, 58,844 tons was Metallurgical grade, and 14,207 tons was ungraded.[35]

Considerable work was done by the Weardale Lead Co., Ltd.[36] to reopen its Wolfcleugh and Barbary mines in Durham. These mines began production in late 1954. A small flotation plant was added to increase recovery of lead and fluorspar and to improve the market outlook for the company products.

ASIA

Korea.—According to a State Department Dispatch[37] fluorspar exports for the first 9 months of 1955 totaled 10,176 tons valued at $284,867.

A 5-year plan for mineral production beginning in 1956 included fluorspar production of 12,000 tons in 1956, 15,000 tons in 1957, 18,000 tons in 1958, 20,000 tons in 1959, and 25,000 tons in 1960.

Pakistan.—According to a reliable source, the Pakistan Geological Survey had discovered fluorspar deposits in the Kohimara Range, 25 miles from Kalipur (Baluchistan); at Kalai, 18 miles from Kojekazai near Fort Sandeman; and at Sherwan in Hazarat district.[38] The deposits at Sherwan were said to be the most extensive although of low grade. Some of the fluorspar deposits were considered commercially workable.

No production from Pakistan during 1955 was reported.[39]

CRYOLITE

The only known commercial-size deposit of cryolite is at Ivigtut, Greenland. In the United States synthetic cryolite was produced by the Aluminum Co. of America at East St. Louis, Ill., and the Reynolds Metals Co. at Bauxite, Ark. The Kaiser Aluminum & Chemical Corp. also recovered cryolite from scrap linings of aluminum-reduction cells.

A process for recovering cryolite from fusion electrolysis cells was described in a patent.[40]

Imports of cryolite for 1946 through 1955 are shown in table 14. Differentiation was not made between natural and synthetic cryolite in the import statistics; however, it is believed that most of the shipments from countries other than Greenland were of synthetic cryolite.

Exports of natural and artificial cryolite in 1955 totaled 173 short tons valued at $54,029. Exports were largely to Canada and Mexico, with smaller shipments to Indonesia, Switzerland, and Union of South Africa.

---

[34] U. S. Embassy, London, England, State Department Dispatch 29: July 5, 1956, p. 1.
[35] U. S. Embassy, London, England, State Department Dispatch 3307: May 5, 1955, pp. 10–11.
[36] Mining World, vol. 17, No. 6, May 1955, p. 82.
[37] U. S. Embassy, Seoul, Korea, State Department Dispatch 355: May 2, 1956, pp. 2, 10.
[38] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 1, January 1955, p. 44.
[39] U. S. Embassy, Karachi, Pakistan, State Department Dispatch 203: Sept. 25, 1956, p. 1.
[40] Albert, Otto, and Mader, Herbert (assigned to Vereinigte Aluminum-Werke Aktiengesellschaft, Oeffentliche Verwaltung der Betriebe Braunau am Inn und Unterlaussa, Braunau, Austria), Process for the Recovery of Cryolite from the Carbon Bottoms of Fusion Electrolysis Cells: U. S. Patent 2,714,053, July 16, 1955.

TABLE 14.—Cryolite imported for consumption in the United States, 1946–50 (average), 1951–53 (totals), and 1954–55, by countries, in short tons

[U. S. Department of Commerce]

	Short tons	Value
1946–50 (average)	14,685	$976,098
1951	38,851	2,190,123
1952	38,373	3,124,801
1953	29,457	3,528,148
1954:		
North America: Greenland [1]	13,652	580,688
Europe:		
Denmark	542	33,174
France	219	52,475
Germany, West	5,125	1,201,026
Italy	1,603	348,524
Total	7,489	1,635,199
Grand total	21,141	2,215,887
1955:		
North America: Greenland [1]	9,772	432,063
Europe:		
Denmark	441	29,108
France	3,316	817,392
Germany, West	5,103	1,201,230
Italy	3,348	709,968
Total	12,208	2,757,698
Grand total	21,980	3,189,761

[1] Crude natural cryolite.

Gem Stones

By John W. Hartwell [1] and Eleanor V. Blankenbaker [2]

GEM-STONE production in the United States during 1955 increased 17 percent in value over 1954 and reached an alltime high exceeding $800,000. This was due largely to the increased number of collectors, lapidaries, and "rockhounds." It was estimated that 150,000 to 300,000 individuals were engaged, full or part time, in this field. Some of the added interest was created by the increase in articles on gem stones published in nationally distributed magazines and newspapers. Many retired individuals supplemented their income by collecting, cutting and polishing, and selling gem stones in small shops throughout the United States. These small businesses increased the demand for gem materials, and prices rose as the quantity of good gem material decreased; however, as prices increased, new locations of gem material were found, and old areas were reworked.

DOMESTIC PRODUCTION

In 1955, approximately 65 percent of the total value of gem-stone production was credited to quartz, jade, and turquois, in decreasing order. Eight States—Oregon, Texas, California, Arizona, Nevada, Washington, Wyoming, and Colorado—produced 88 percent of the total value. Oregon was the leading producing State, with an estimated $150,000.

Agate.—As in previous years, agate was the principal gem material produced in the United States. The price varied with the quality of the material, and only estimates could be made on the value of production. The areas near Roosevelt, Klickitat County, Wash., and Miles City, Custer County, Mont., were the most productive, and the price of agate from these localities ranged from $0.50 to $3.50 per pound.

Oregon was the leading producer, with an estimated value of $25,000, more than double the 1954 figure. Owners of about 20 agate-bearing properties in central and eastern Oregon charged fees to collectors, based on the quantity of agate removed.

Agate from New Mexico was produced from a locality near Deming, Luna County, with reported sales exceeding $12,000.

Over 20 tons of agate was produced in Wyoming, mainly from Sweetwater and Fremont Counties.

Other States with a reported agate-production value of over $3,000 were Arizona, California, Colorado, South Dakota, and Texas.

The Yellowstone River Valley in Montana was a good source of moss agate, but more work was required to recover the material than in the past. The better grade of rough agate sold for $2 to $50 per pound and some rare stones up to $150. About 90 percent of the

[1] Commodity specialist.
[2] Literature-research clerk.

TABLE 1.—Value of production and imports of precious and semiprecious stones in the United States,[1] 1867–1955, in thousand dollars

Year	Production	Imports	Year	Production	Imports
1867	(2)	$1,319	1912	$320	$41,363
1868	(2)	1,063	1913	319	45,432
1869	(2)	1,998	1914	125	19,211
1870	(2)	1,779	1915	170	26,194
1871	(2)	2,351	1916	218	50,267
1872	(2)	3,034	1917	131	37,794
1873	(2)	3,134	1918	107	23,443
1874	(2)	2,372	1919	112	102,968
1875	(2)	3,479	1920	265	73,980
1876	(2)	2,617	1921	518	36,525
1877	(2)	2,235	1922	(2)	65,617
1878	(2)	3,071	1923	(2)	74,148
1879	(2)	3,965	1924	(2)	71,264
1880	(2)	6,870	1925	(2)	73,915
1881	(2)	8,607	1926	(2)	78,291
1882	(2)	8,923	1927	(2)	64,950
1883	$206	8,127	1928	(2)	67,964
1884	222	9,139	1929	(2)	75,317
1885	210	6,043	1930	(2)	38,642
1886	119	8,260	1931	(2)	21,126
1887	164	10,832	1932	(2)	12,771
1888	140	10,558	1933	20	13,752
1889	189	11,978	1934	3	17,908
1890	119	13,106	1935	5	27,612
1891	235	12,757	1936	12	38,146
1892	312	14,522	1937	32	50,494
1893	264	10,198	1938	127	28,305
1894	132	7,427	1939	235	40,488
1895	114	6,574	1940	340	37,769
1896	98	4,619	1941	240	33,777
1897	131	6,277	1942	150	28,449
1898	161	10,163	1943	67	72,110
1899	186	17,209	1944	41	77,530
1900	233	13,559	1945	40	114,435
1901	289	22,815	1946	325	189,018
1902	328	24,754	1947	570	110,538
1903	308	26,525	1948	500	115,990
1904	324	27,229	1949	500	84,186
1905	326	36,846	1950	500	118,500
1906	208	43,602	1951	500	128,954
1907	471	31,867	1952	500	124,699
1908	415	13,700	1953	487	130,194
1909	534	40,238	1954	607	[3] 143,589
1910	296	40,704	1955	814	175,262
1911	344	40,820			

[1] Includes Alaska.
[2] Not available.
[3] Revised figure.

TABLE 2.—Localities in the United States where gem materials were reported to have been found in 1955

State	County or district	Locality	Gem material
Alaska	Seward district	Seward	Pyrite, jasper, plasma, and epidote.
Do	Shungnak district	Kobuk	Jade.
Do	Chichagof district	Baranof	Agate.
Arizona	Apache	Globe	Peridot.
Do	do	St. Johns	Petrified wood.
Do	Coconino	Flagstaff	Do.
Do	Gila	Claypool	Turquois.
Do	do	Globe	Serpentine, turquois, hypersthene, and peridot.
Do	do	Miami	Turquois.
Do	Greenlee	Clifton	Agate.
Do	do	Duncan	Jasper, chalcedony, and agate.
Do	Maricopa	Black Gap	Copper silicate.
Do	do	Cavecreek	Jasper.
Do	do	Globe	Amethyst.
Do	do	Hassayampa	Chalcedony.
Do	do	New River	Agate.
Do	do	Phoenix	Jasper and agate.
Do	do	Rock Springs	Marble.

TABLE 2.—Localities in the United States where gem materials were reported to have been found in 1955—Continued

State	County or district	Locality	Gem material
Arizona	Maricopa	Tonopah	Chalcedony.
Do	Pima	Ajo	Chalcedony (desert rose).
Do	Pinal	Superior	Apache tears.
Do	Yavapai	Prescott	White jade, lavender agate, and chrysoprase.
Do	Yuma	Quartzsite	Quartz crystals and orbicular rhyolite.
Do	do	Salome	Jasper.
Do	do	Yuma	Rhyolite.
California	Amador	Fiddletown	Rhodonite.
Do	El Dorado	Georgetown	Idocrase, vesuvianite, and garnet
Do	Imperial	Winterhaven	Jasp-agate.
Do	do	Ogilby	Chalcedony.
Do	Inyo	Bigpine	Quartz crystals.
Do	do	Trona	Onyx.
Do	Kern	Boron	Morrisonite.
Do	do	Randsburg	Agate.
Do	do	Rosamond	Rhodonite.
Do	do	Tejon Ranch	Do.
Do	Lake	Lower Lake	Quartz crystals.
Do	Marin	Inverness	Petrified whalebone.
Do	Mendocino	Covelo	Jade and jasper.
Do	Monterey	Lucia	Nephrite.
Do	Mono		Geode.
Do	Napa	Etna Springs	Quartz crystals.
Do	Nevada	North Bloomfield	Opal.
Do	do	Nevada City	Do.
Do	Placer	Colfax	Jade (nephrite).
Do	Riverside	Anza	Rose quartz.
Do	do	Blythe	Fire agates.
Do	San Benito	New Idria	Benitoite, jadeite, and silicified serpentine.
Do	San Bernardino	Kramer Junction	Jasp-agate.
Do	do	Needles	Blue agate.
Do	do	Shoshone	Amethyst.
Do	do	Wrightwood	Rhodonite.
Do	San Diego	Mesa Grande	Tourmaline.
Do	do	Pala	Beryl, kunzite, and tourmaline (blue).
Do	do	Ramona	Essonite garnet.
Do	San Francisco	San Francisco	Jasper.
Do	San Luis Obisopo	Nipomo	Agate.
Do	Siskiyou	Happy Camp	Jade.
Do	Tulare	Dunlap	Topaz.
Colorado	Chaffee	Nathrop	Aquamarine and phenacite.
Do	do	Salida	Agate and beryl.
Do	Douglas	Sedalia	Topaz.
Do	do	Westcreek	Amazonstone.
Do	El Paso	Colorado Springs	Phenacite and amazonite.
Do	Fremont	Howard	Agate.
Do	do	Texas Creek	Rose quartz.
Do	Jefferson	Deckers	Amazonstone crystals and amazonstone.
Do	do	Hartsel	Tourmaline
Do	Kiowa	Kiowa	Agate.
Do	Mesa	Grand Junction	Dinosaur bone.
Do	Mineral	Creede	Amethyst and marcasite agate.
Do	Montrose	Paradox	Covellite.
Do	Rio Grande	Del Norte	Marcasite agate.
Do	Saguache	do	Agate.
Do	do	Villa Grove	Turquois.
Do	San Juan	Silverton	Rhodonite.
Do	San Miguel	Nucla	Dinosaur bone, jasper, and sloth bone.
Do	Teller	Colorado Springs	Amazonstone.
Do	do	Florissant	Amazonite.
Do	do	Lake George	Do.
Georgia	Rabun		Amythest.
Do	Towns		Ruby and sapphire.
Do	Troup	La Grange	Rose quartz.
Maine	Oxford	Stow	Aquamarine and beryl.
Michigan	Emmet	Petoskey	Petoskey stone.
Do	Houghton	Calumet	Agate.
Do	Keweenaw	Copper Harbor	Datolite and thomsonite.
Do	do	Phoenix	Cholorastrolite.
Do	Marquette	Ishpeming	Jasper.
Minnesota	Cook	Grand Marais	Thomsonite.
Do	Lake	Beaver Bay	Agate (Lake Superior).
Do	St. Louis	Duluth	Do.

TABLE 2.—Localities in the United States where gem materials were reported to have been found in 1955—Continued

State	County or district	Locality	Gem material
Montana	Custer	Miles City	Agate and moss agate.
Do	Dawson	do	Agate.
Do	Fergus		Sapphire.
Do	Prairie	Terry	Agate.
Do	Rosebud	Rosebud	Do.
Nebraska	Sioux	Orella	Chalcedony and agate.
Nevada	Elko	Elko	Chalcedony.
Do	Esmeralda	Tonopah	Turquois.
Do	Humboldt	Denio	Common and fire opal.
Do	do	Golconda	Rhodonite.
Do	Lander	Battle Mountain	Turquois.
Do	Mineral	Mina	Do.
Do	do	Luning	Petrified wood.
Do	Nye	Tonopah	Turquois.
Do	Washoe		Sulfur and piedmontite crystals and schroeckingerite.
New Mexico	Eddy	Carlsbad	Galven and agate.
Do	Hildalgo	Duncan, Arizona	Chalcedony and agate eyes.
Do	Luna	Deming	Agate.
Do	San Juan	Redrock	Ricolite.
Do	Sierra	Bingham	Blue fluorite.
Do	do	Torc	Desert scenic stone.
New York	Warren	North Creek	Garnet.
North Carolina	Alexander	Hiddenite	Quartz and rutile.
Do	Clay		Ruby and sapphire crystals.
Do	Macon	Franklin	Ruby.
Do	Yancey	Spruce Pine	Emerald.
Oregon	Jackson	Medford	Jasper, agate, petrified wood, rhodonite, and quartz.
Do	Jefferson	Madras	Moss agate.
Do	Lake	Burns	Obsidian.
Do	Linn	Crawfordsville	Purple agate.
Do	Wasco		Jasper, quartz, opal, and agate.
Puerto Rico	Cabo Rojo Municipality.	Rio Guanajibo	Chalcedony.
Do	Comerio Municipality.	Rio Pinas	Nephrite.
Do	Humacao Municipality.	Playa de Humacao	Jasper.
Do	San Juan Municipality.	Condado Beach	Jade.
Do	San Sebastian Municipality.	Rio Guatemala	Fossil coral.
South Dakota	Custer	Custer	Agate and rose quartz.
Do	do	Fairburn	Fairburn agate, jasp-agate, and rose quartz.
Do	do	Hermosa	Jasp-agate.
Do	Pennington	Creston	Agatized wood.
Do	do	Keystone	Garnet.
Texas	Brewster	Alpine	Agate.
Do	Gillespie	Eckert	Amethyst.
Do	Mason	Katemcy	Topaz, amazonstone, smoky quartz, and green fluorite.
Do	Travis	Mason	Topaz.
Utah	Beaver	Beaver	Blue valley agate and obsidian.
Do	do	Milford	Obsidian.
Do	Emery	Ferron	Petrified wood.
Do	do	Black Rock	Obsidian.
Do	Garfield	Hatch	Onyx.
Do	Grand	Cisco	Agate.
Do	do	Green River	Lace agate and jasper.
Do	do	Moab	Agate.
Do	do	Thompson	Jasp-agate and dinosaur bone.
Do	Iron	Cedar City	Agate.
Do	Juab	Dragway Mountain	Geodes.
Do	Kane	Orderville	Septarium nodules.
Do	Millard	Cave Fort	Jasper.
Do	do	Milford	Obsidian.
Do	San Juan	Joy	Agate and topaz.
Do	Sevier	Salina	Agate.
Do	Washington	Central	Do.
Do	Wayne	Torrey	Petrified wood.
Virginia	Amelia	Amelia	Amazonite.
Do	Madison	Syria	Unakite (Pikes Peak epidote).
Washington	Benton	Mabton	Opalized wood.
Do	Kittitas	Ellensburg	Agate and petrified wood.
Do	Klickitat	Roosevelt	Moss agate.
Wisconsin	Clark	Greenwood	Agate.

TABLE 2.—Localities in the United States where gem materials were reported to have been found in 1955—Continued

State	County or district	Locality	Gem material
Wyoming	Carbon	Baggs	Turitella agate.
Do	do	Saratoga	Agatized wood.
Do	Fremont	Lander	Jade, sweetwater agate, and petrified wood.
Do	do	Riverton	Agate and jade.
Do	do	Shoshoni	Jade.
Do	do	South Pass City	Algae.
Do	do	Three Forks	Jade.
Do	Natrona	Casper	Agate.
Do	Sweetwater	Eden	Petrified wood.
Do	do	Farson	Agatized wood, eden-valley wood, and petrified wood.
Do	do	Green River	Agate.
Do	do	Rock Springs	Petrified wood.
Do	do	Wamsutter	Agate and turitella.

agate found had no value. The value of moss-agate production from this area was estimated at $5,000 to $10,000.

Jade.—Alaska jade continued to be the most important gem material of the Territory. A large quantity of the raw material was shipped to Germany and Japan for cutting and polishing. The business of selling jade handicraft to tourists continued to flourish.

Wyoming production had some importance, but the float material was more difficult to find. The 1955 jade production in Wyoming was valued at $10,000 and came mainly from an area near Lander, Fremont County.

California production was reported to be approximately $5,000. Nephrite was probably the most important jade material in the State and ranged in color from pale to dark bluish green. A new jade locality was discovered near Cloverdale, Sonoma County, Calif.

Arizona produced a small quantity of white jade near Prescott.

Opal.—The Rainbow Ridge mine near Denio, Humboldt County, Nev., was reported to be developing a vein of precious opal within streaks of opalized wood. This mine has produced opals since 1909 and recovered one of the largest pieces of precious opal ever recorded, weighing 7 pounds.[3] Production from this area was about $4,000 in 1955.

Some opal was produced in Nevada County, Calif.

Petrified Wood.—It was reported that in Wyoming the largest production of petrified wood was from an area around Farson, Sweetwater County, where 2 tons was collected. The total value of Wyoming production was approximately $10,000.

About 10 tons of petrified wood was produced near Medford, Jackson County, Oreg.

Rhodonite.—Some interest was shown in rhodonite during 1955, and a large deposit of this material was reported in Amador County, Calif. Most of it was poor grade.

About 2 tons of rhodonite was produced in Humboldt County, Nev., and smaller quantities were recovered in other States. The total production in the United States was less than $10,000.

Topaz.—A new discovery of topaz crystals was reported in New

[3] Mining World, vol. 17, No. 9, August 1955, p. 100.

Hampshire in the vicinity of Conway, Carroll County. Only a few clear 5- to 10-carat pieces suitable for cutting were obtained from each crystal.

The production of topaz from Mason County, Tex., continued during 1955, and it was estimated that 5,500 grams with a value of over $6,000 was recovered. These stones were fine light-blue and made excellent gem stones. In the San Creek area, Tulore County, Tex., a production of over $1,000 was reported.

Turquois.—Large quantities of low-grade turquois from Arizona were reported sold as gem material at prices ranging from $1.50 to $3 per pound.

The Lone Mountain Turquoise mine, Nye County, Nev., produced about $20,000 of turquois in 1955. Another producer was the Blue Gem lease near Battle Mountain, Lander County. Some turquois was mined on claims north and west of Columbus Flat near Candelaria, Mineral County, Nev.

Miscellaneous Gems and Specimens.—A report was published on garnet deposits near Wrangell, Alaska.[4] These garnets were of the almandite variety and averaged ½ to ⅝ inch in diameter.

One hundred and fifty pounds of dinosaur bone was found near Thompson, Grand County, Utah, and 300 pounds was found near Grand Junction, Mesa County, Colo. Smaller quantities were reported elsewhere. Petrified whalebone valued at over $200 was recovered in Inverness, Marin County, Calif.

Additional varieties of specimens reported found in 1955 from various localities were: Amber, sulfur, piedmontite, schroeckingerite, copper silicate, quartz, pyrite, and others.

Gem stones reported as more precious types than the common varieties were highly esteemed when cut and polished and had a greater value in the gem-stone trade. They are listed in table 3, according to variety, State, and value of 1955 production.

TABLE 3.—Value of selected gem stones produced in 1955

Variety	State	Value	Variety	State	Value
Amethyst	Arizona	$18,500	Fire chalcedony	Arizona	$2,500
Do	Texas	(1)	Fire opal	Nevada	4,000
Amethyst agate	New Mexico	2,000	Peridot	Arizona	2,500
Aquamarine	Colorado	1,800	Pink chalcedony	do	200
Blue tourmaline	California	2,000	Purple agate	do	4,800
Desert rose	Arizona	500	Rose quartz	Georgia	400
Fairburn agate	South Dakota	500	Sapphire	Montana	800
Fire agate	Arizona	500			
Do	California	2,500			

1 Value not reported.

CONSUMPTION

A survey was taken by N. W. Ayer & Son, Inc., to establish trend information on sales, inventories, prices, and customer preferences on diamond jewelry. It is estimated that the United States consumes three-fourths of the world cut-diamond production, and in 1955 its value was approximately $151.5 million. The Central Selling Organ-

4 Houston, J. R., The Garnet Deposits Near Wrangell, Alaska: Rocks and Minerals, vol. 30, No. 11-12, November-December 1955, pp. 563-569.

ization reported sales of gem and industrial diamonds to be 10 and 45 percent, respectively, greater in 1955 than in 1954.[5]

The consumption of gem stones (excluding diamonds) in the United States during 1955 was greater, in line with increased imports of sapphires, rubies, emeralds, pearls, and semiprecious stones and the larger quantity of gem stones domestically produced. Amateur lapidaries consumed most of the domestic gem-stone production.

PRICES

The average retail prices for gem diamonds in 1955 follow: ¼-carat, $130; ½-carat, $310; 1-carat, $860; 2-carat, $2,140; 3-carat, $3,530.[6] The greater demand for precious and semiprecious gem stones increased the prices of imported material.

FOREIGN TRADE [7]

The value of gem-stone imports into the United States in 1955 increased 22 percent over 1954. Gem diamonds composed 86 percent of the total value of imports. Pearls (precious and semiprecious) and synthetic gem-stone imports increased 11 percent in 1955 over 1954.

The value of imports of gems and precious stones into the United States from 1867 to 1955, inclusive, is shown in table 1. Table 4 lists the 1954 and 1955 imports of precious and semiprecious stones, and table 5 shows the imports of gem diamonds for the same period.

In 1955 the United States exported 46 percent more gem stones (precious, semiprecious, synthetic, and imitation) than in 1954.

TABLE 4.—Precious and semiprecious stones (exclusive of industrial diamonds) imported for consumption in the United States, 1954–55

[U. S. Department of Commerce]

Item	1954		1955	
	Carats	Value	Carats	Value
Diamonds:				
Rough or uncut (suitable for cutting into gem stones), duty free	[1] 887,702	[1] $59,423,768	1,064,932	[2] $76,735,186
Cut but unset, suitable for jewelry, dutiable	594,772	62,758,349	707,859	[2] 74,833,550
Emeralds: Cut but not set, dutiable	24,460	385,063	45,235	1,564,676
Pearls and parts, not strung or set, dutiable:				
Natural		503,753		669,351
Cultured or cultivated		[2] 4,333,890		[2] 6,197,897
Other precious and semiprecious stones:				
Rough and uncut, duty-free		[2] 265,837		228,939
Cut but not set, dutiable		[2] 1,848,989		[2] 2,837,932
Imitation, except opaque, dutiable:				
Not cut or faceted		[2] 37,902		[2] 25,885
Cut or faceted:				
Synthetic		[2] 283,302		[2] 298,985
Other		[2] 13,651,937		[2] 11,806,001
Imitation, opaque, including imitation pearls, dutiable		[2] 35,014		[2] 19,185
Marcasites, dutiable: Real and imitation		61,073		44,439
Total		[1] [2] 143,588,877		[2] 175,262,026

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to years before 1954.

[5] Switzer, George, 31st Annual Report on the Diamond Industry, 1955: Jewelers' Circ.-Keystone, 1955, p. 2.
[6] Switzer, George, 31st Annual Report on the Diamond Industry, 1955: Jewelers' Circ.-Keystone, 1955, p. 3.
[7] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 5.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1954–55, by countries

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
1954						
North America:						
Bermuda	6,231	$118,899	$19.08			
Canada	4,984	514,120	103.15	275	$59,487	$216.32
Mexico	100	750	7.50			
Total	11,315	633,769	56.01	275	59,487	216.32
South America:						
Brazil	6,890	161,606	23.46	350	28,985	82.81
British Guiana	2,064	63,591	30.81			
Venezuela	81,442	2,421,299	29.73			
Total	90,396	2,646,496	29.28	350	28,985	82.81
Europe:						
Belgium-Luxembourg	67,969	7,232,086	106.40	335,173	35,110,962	104.75
France	14,563	346,162	23.77	4,405	594,543	134.97
Germany, West				38,724	2,645,535	68.32
Netherlands	11,673	802,417	68.74	25,866	2,973,356	114.95
Switzerland	1,455	82,314	56.57	208	124,199	597.11
United Kingdom	632,394	44,923,762	71.04	4,732	1,267,999	267.96
Total	728,054	53,386,741	73.33	409,108	42,716,594	104.41
Asia:						
Ceylon				12	1,717	143.08
India				1,156	216,743	187.49
Israel	4,066	42,836	10.54	137,073	11,620,417	84.78
Japan	186	2,779	14.94	398	34,751	87.31
Lebanon	1,325	146,867	110.84	53	22,271	420.21
Malaya	453	55,351	122.19			
Total	6,030	247,833	41.10	138,692	11,895,899	85.77
Africa:						
Belgian Congo	204	24,717	121.16			
French Equatorial Africa	16,812	731,630	43.52			
Liberia	2,843	35,729	12.57			
Union of South Africa	[1] 32,048	[1] 1,716,853	[1] 53.57	46,347	8,057,384	173.85
Total	[1] 51,907	[1] 2,508,929	[1] 48.35	46,347	8,057,384	173.85
Grand total	[1] 887,702	[1] 59,423,768	[1] 66.94	594,772	62,758,349	105.52
1955						
North America:						
Bermuda	2,205	228,467	103.61			
Canada	5,900	569,306	96.49	127	14,125	111.22
Netherlands Antilles				29	39,955	1,377.76
Total	8,105	797,773	98.43	156	54,080	346.67
South America:						
Brazil	4,127	199,085	48.24	113	13,427	118.82
British Guiana	2,566	73,104	28.49			
Venezuela	90,236	2,642,087	29.28	48	7,662	159.63
Total	96,929	2,914,276	30.07	161	21,089	130.99
Europe:						
Austria				7	3,674	524.86
Belgium-Luxembourg	102,676	10,692,952	104.14	427,422	45,354,711	106.11
France	9,203	730,133	79.34	4,470	869,862	194.60
Germany, West	1,141	11,215	9.83	48,948	3,452,716	70.54
Italy				136	127,461	937.21
Netherlands	2,573	261,443	101.61	22,243	2,633,320	118.39
Switzerland	29,965	1,911,100	63.78	250	58,799	235.20
United Kingdom	728,285	56,960,288	78.21	5,464	947,127	173.34
Total	873,843	70,567,131	80.75	508,940	53,447,670	105.02

See footnotes at end of table.

TABLE 5.—Diamonds (exclusive of industrial diamonds) imported for consumption in the United States, 1954–55, by countries—Continued

[U. S. Department of Commerce]

Country	Rough or uncut			Cut but unset		
	Carats	Value		Carats	Value	
		Total	Average		Total	Average
Asia:						
Hong Kong	294	$1,177	$4.00			
India				249	$29,042	$116.63
Indonesia	130	19,497	149.98			
Iraq				103	9,284	90.14
Israel	4,136	44,821	10.84	157,326	13,735,028	87.30
Japan				837	80,848	96.59
Lebanon	549	44,750	81.51			
Malaya	71	12,201	171.85			
Saudi Arabia				2	700	350.00
Total	5,180	122,446	23.64	158,517	13,854,902	87.40
Africa:						
French Equatorial Africa	8,110	383,815	47.33			
Liberia	14,536	422,726	29.08			
Nigeria	415	6,158	14.84			
Rhodesia and Nyasaland, Federation of				21	8,365	398.33
Union of South Africa	57,814	1,520,861	26.31	40,064	7,447,444	185.89
Total	80,875	2,333,560	28.85	40,085	7,455,809	186.00
Grand total	1,064,932	[2] 76,735,186	72.06	707,859	[2] 74,833,550	105.72

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to earlier years.

TECHNOLOGY

Several books were published during 1955 on identification of rocks and minerals.[8] The structure and optical behavior of jadeite [9] and methods of identifying petrified wood [10] were discussed. Articles were published on the origin of jadeite and rose quartz.[11]

Block caving was initiated at the Kimberly, Union of South Africa, diamond mine.[12]

Methods of cutting amethyst [13] and asterated quartz [14] were described. The process of "tumbling" gem stones, giving instructions on types of equipment and abrasives for grinding and polishing, was published.[15] Polishing and cutting of cleavable gem stones such as kunzite, zircon, spodumene, and barite were discussed in an article.[16]

[8] Pearl, R. M., How to Know Minerals and Rocks: McGraw-Hill Book Co., Inc., New York, N. Y., 1955, 192 pp.
Wahlstrom, E. E., Petrographic Mineralogy: John Wiley & Sons, Inc., New York, N. Y., 1955, 408 pp.
Jensen, D. E., My Hobby Is Collecting Rocks and Minerals: Hart Publishing Co., New York, N. Y., 1955, 122 pp.

[9] Raman, C. V., and Jayaraman, A., The Structure and Optical Behavior of Jadeite: Proc. Indian Acad. Sci., vol. 41a, 1955, pp. 117–120; Chem. Abs., vol. 50, No. 19, Oct. 10, 1955, column 13031-f.

[10] Mineralogist, Identifying Wood: Vol. 23, No. 2, February 1955, pp. 72–74.

[11] de Roever, W. P., Genesis of Jadeite by Low-Grade Metamorphism: Am. Jour. Sci., vol. 253, No. 5, May 1955, p. 9283.
Petrun, V. F., [The Origin of Rose Quartz in Hydrothermal Veins]: Zapiski Vsesoyus. Mineralog. Odshchestva, vol. 84, 1955, pp. 191–197. Chem. Abs., vol. 50, No. 22, Nov. 25, 1955, column 15650-i.

[12] Gallagher, W. S., New Approach to Diamond Mining at Kimberly: Optima (Johannesburg, South-West Africa), vol. 5, No. 2, June 1955, pp. 52–61.

[13] Dake, H. C., How to Cut Amethyst: Mineralogist, vol. 23, No. 2, February 1955, pp. 92–94.

[14] Bly, Merwyn, The Cutting of Asterated Quartz Cabochons: Mineralogist, vol. 9, No. 9, September 1955, pp. 327–330.

[15] Dake, H. C., The Tumbled Gems: Mineralogist, vol. 23, No. 3, March 1955, pp. 133–138.

[16] Zinkanikas, John, Treatment of Cleavable Gemstones: Rocks and Minerals, vol. 30, No. 5–6, May–June 1955, pp. 266–269.

The investigation on discoloring of ordinary violet amethysts that change to a colorless, yellow or brown variety at 400°–500° C. and a discolored green amethyst was reviewed.[17]

The Consolidated Diamond Mines of South-West Africa, Ltd., have developed a method to recover diamonds from gravel by treating them with a water-repellent coating.[18] A summary of the latest metallurgical methods for the recovery of diamonds in the Belgian Congo was given by the Academie royale des sciences coloniales, Paris, France.[19]

An article described the formation of various varieties of quartz and chalcedony and their modes of occurrence.[20]

A new lapis-lazuli-colored synthetic gem stone with a hardness of 8 and specific gravity of 3.58 was developed in Germany.[21] A process for purifying alumina used to produce synthetic gem material was developed in Japan.[22] Included was the removal of iron, titanium, and rarer elements by only two recrystallizations.

A patent was obtained for an apparatus by which synthetic jewels are manufactured.[23] Another patent was issued for a process whereby cobalt or nickel oxide is added to TiO_2 to produce a single crystal varying in color from yellow to deep red when fired in an oxidizing atmosphere.[24]

WORLD REVIEW

The 1955 world diamond production reached an alltime high of 21.5 million carats, exceeding by 5 percent the previous record high reported in 1954. Of this total over 4 million carats were gem quality. Countries reporting major increases in production in 1955 were Belgian Congo, French West Africa, Gold Coast, Sierra Leone, South-West Africa, and Venezuela. Table 6 shows the world production of diamonds, 1951–55, by countries.

Angola.—The production of diamonds in Angola during 1955 was 743,378 carats. The proportion of gem diamonds was unknown.[25]

Belgian Congo.—All the diamond companies in Belgian Congo pooled their resources to conduct geological surveys of the areas in their respective concessions during a period of 3 years beginning July 1955.[26]

The production of diamonds in Belgian Congo from 1913–55 is shown in table 7.

Brazil.—Discovery of an aquamarine weighing 134.5 pounds was reported in the State of Minas Gerais. Its value was placed at $400,000.[27]

[17] Rose, H., and Lietz, J., [A Green Discolored Amethyst]: Naturwissenschaften, vol. 41, 1954, p. 448; Chem. Abs., vol. 50, No. 17, Sept. 10, 1955, column 11511–d.
[18] Mine and Quarry Engineering, vol. 21, No. 11, November 1955, pp. 463–471.
[19] Bureau of Mines, Mineral Trade Notes, Special Supplement 47: Vol. 41, No. 4, October 1955, pp. 5–7.
[20] Walton, James, The Formation of Quartz and Chalcedony: Gemologist (London), vol. 24, No. 288, July 1955, pp. 119–123; vol. 24, No. 289, August 1955, pp. 139–142; vol. 24, No. 290, September 1955, pp. 164–169; vol. 24, No. 291, October 1955, pp. 191–194.
[21] Bambauer, H. V., and Schmitt, C. H., [A New Lapis-Lazuli-Colored Synthetic]: Fortschr. Mineral., vol. 33, 1955, p. 130; Chem. Abs., vol. 49, No. 21, Nov. 10, 1955, column 14587–d.
[22] Shiro, I., Alumina for Synthetic Gem Material: Jour. Chem. Soc. (Japan), Ind. Chem. Sec., vol. 58, 1955, pp. 181–183; Chem. Abs., vol. 49, No. 20, Oct. 25, 1955, column 14282–i.
[23] Dauncey, L. A. (assigned to General Electric Co., Ltd., London), Apparatus for Manufacturing Synthetic Jewels: U. S. Patent 2,692,456, Oct. 26, 1954.
[24] Merker, Leon (assigned to National Lead Co., New York, N. Y.), Colored Rutile Boules and Method for Making the Same: U. S. Patent 2,715,071, Aug. 9, 1955.
[25] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 4, April 1956, p. 25.
[26] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 4, October 1955, p. 35.
[27] Washington Post and Times Herald, Dec. 21, 1955.

TABLE 6.—World production of diamonds, 1951–55, by countries, in carats [1]

(Including industrial diamonds)

	1951	1952	1953	1954	1955
Africa:					
Angola	734,324	743,302	729,337	721,607	743,378
Belgian Congo	10,564,667	11,608,763	12,580,256	12,619,378	13,041,487
French Equatorial Africa	136,000	163,400	140,144	152,529	136,900
French West Africa	101,000	136,080	180,000	216,000	318,450
Gold Coast	1,752,878	2,189,557	2,180,728	2,135,141	2,276,631
Sierra Leone	475,759	451,426	472,934	[illegible] 398,608	[2] [3] 930,038
South-West Africa	478,075	541,027	617,411	683,536	797,207
Tanganyika	108,625	143,023	172,304	326,009	325,525
Union of South Africa:					
Lode	1,967,272	2,093,138	2,397,755	[4] 2,544,305	[4] 2,276,894
Alluvial	[5] 289,063	[5] 282,681	[5] 300,000	[5] 314,000	[5] [2] 310,000
South America:					
Brazil	[2] 200,000	[2] 200,000	[2] 200,000	[2] 200,000	[2] 200,000
British Guiana	43,260	38,305	35,306	30,073	33,298
Venezuela	63,226	98,291	84,790	96,983	141,147
Other countries	[2] 3,000	[2] 5,000	[2] 5,000	[2] 5,000	[2] 5,000
Grand total	16,917,000	18,694,000	[6] 20,096,000	20,440,000	21,540,000

[1] Source: Jewelers' Circular-Keystone, 31st Annual Report on the Diamond Industry: 1955, p. 7.
[2] Estimate.
[3] Includes an estimated production by African natives of about 500,000 carats.
[4] Pipe mines under De Beers control for 1954 included 75,225 carats and 58,787 carats in 1955 from De Beers alluvial diggings at Kleinzee.
[5] Includes an estimated 100,000 carats from the State mines of Namaqualand.
[6] Revised figure.

Burma.—Gem-stone production in Burma declined sharply in 1955 from 1954. Ruby production dropped from 21,628 carats to 17,053, sapphire production from 46,872 to 6,150, and spinel production from 31,163 to 5,400. All production for 1955 may not have been reported.[28]

Canada.—The most famous jade locality in Canada is in the Fraser River Valley of British Columbia. Some of the jade is light green and has excellent translucency.[29]

Ceylon.—The production of gem stones during 1955 was estimated by the Ceylon Department of Mineralogy to be from $315,000 to $420,000.[30] Ceylon's exports to the United States in 1955 were 17 percent more than in 1954. The principal stones were sapphire, ruby, cat's-eye, aquamarine, topaz, garnet, zircon, amethyst, and moonstone.

China.—It was reported that diamond-bearing deposits were discovered in northern Hunan Province in central China.[31]

TABLE 7.—Belgian Congo diamond production, 1913–55, in thousand carats

Year	Production	Year	Production	Year	Production	Year	Production
1913	16	1924	548	1935	3,812	1946	6,033
1914	24	1925	884	1936	4,634	1947	5,474
1915	49	1926	1,141	1937	4,925	1948	5,825
1916	54	1927	1,042	1938	7,206	1949	9,650
1917	100	1928	1,649	1939	8,360	1950	10,147
1918	164	1929	1,908	1940	9,603	1951	10,565
1919	215	1930	2,519	1941	5,866	1952	11,609
1920	225	1931	3,528	1942	6,018	1953	12,580
1921	174	1932	3,990	1943	4,882	1954	12,619
1922	250	1933	2,257	1944	7,533	1955	13,041
1923	415	1934	3,331	1945	10,386		
						Total	195,250

[28] United States Embassy, Rangoon, Burma, State Department Dispatch 68: July 31, 1956, 24 pp.
[29] Bennett, John, A Gem Hunter in Canada: Mineralogist, vol. 23, No. 2, February 1955, pp. 60–62.
[30] United States Embassy, Colombo, Ceylon, State Department Dispatch 685: Mar. 1, 1956, 53 pp.
[31] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 3, September 1955, p. 42.

457676—58——32

Colombia.—In 1955 the Ministry of Mines and Petroleum continued to review the laws and regulations governing the mining of emeralds. Certain temporary regulations were put into effect early in the year, so that mining would not be interrupted.[32]

Japan.—In 1954, 130,000 first-grade pearls were produced off the southern tip of Awagi Island. Plans in 1955 called for increased plantings until production of 1 million pearls per year is reached.[33]

Liberia.—New diamond deposits continued to be reported. Contrary to popular belief Liberian gem diamonds are of good quality. The business of cutting and polishing diamonds was started in Liberia in 1955, and equipment was installed for processing small stones for the export market.

The law governing the sale, purchase, and mining of diamonds, enacted by the 1954–55 session of the National Legislature was reported to be excellent. It did not impose too many restrictions and encouraged the large growth that the industry had during 1955.[34]

Rhodesia and Nyasaland, Federation of.—On August 19, 1955, an agreement was reached between De Beers Corp. and the Northern Rhodesian Legislative Council under which diamond-mining rights in the Territory will be relinquished to the Government in 1986.[35]

Sierra Leone.—It was reported that illicit diamond mining and trading increased during 1954 and 1955.[36]

Thailand.—The most important precious stones produced in Thailand in 1955 were black sapphires and Siamese rubies.[37]

Union of South Africa and South-West Africa.—Quotas on gem diamonds, released by the Central Selling Organization in 1955, for 1955–60, inclusive, were as follows: Government of Union of South Africa, 10 percent; Administration of South-West Africa, 26 percent; De Beers Consolidated Mines, Ltd., 25 percent; Diamond Corp., Ltd., 35 percent; and Premier (Transvaal) Diamond Mining Co., Ltd., 4 percent.[38]

Gem-stone production in South-West Africa in 1955 is shown in table 8.

TABLE 8.—Gem-stone production in South-West Africa, 1955 [1]

Gems	Production	Sales
Diamonds carats	797,198	789,475
Tourmaline grams	31,651	7,780
Amethyst pounds	22,680	
Chalcedony do	2,286	
Tiger's eye tons	(2)	2

1 United States Consulate, Johannesburg, South-West Africa, State Department Dispatch 244: May 1, 1956, 3 pp.
2 Not available.

Venezuela.—It was estimated that the 1955 production of pearls from Venezuela was nearly US$1.5 million.[39]

32 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 54.
33 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 3, March 1955, p. 37.
34 United States Embassy, Monrovia, Liberia, State Department Dispatch 330: May 3, 1956, 6 pp.
35 Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 5, November 1955, p. 43.
36 Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 3, March 1956, pp. 24–25.
37 Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 2, February 1956, p. 34.
38 Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 2, February 1956, p. 24.
39 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 48.

Gold

By J. P. Ryan [1] and Kathleen M. McBreen [2]

UNITED STATES mine production of gold in 1955 increased 2 percent compared with 1954; but except for World War II years 1943–46, it was the second lowest in over 60 years. Most of the increase was attributed to greater output of base-metal ores yielding byproduct gold, especially in Utah and Arizona. Overall output of gold from straight gold-mining operations was virtually unchanged as production gains in some areas were offset by losses in others.

The United States Treasury buying price for gold during 1955 continued at $35 per fine ounce. Treasury stocks declined $22 million during the year; monetary reserves in countries outside the United States (and the Soviet Union) increased about $800 million.

The price of gold on the free markets of the world fluctuated within rather narrow limits in 1955; in most markets the average price equivalent in United States funds was only slightly higher than the United States Treasury price.

The United States Assay Office at Seattle was closed permanently on January 15 owing to a budget cut in the Bureau of the Mint. This office had been established in 1898 to purchase gold in bullion, dust, nugget, and other forms from the mines of the Pacific Northwest and Alaska.

Legislation was introduced in the United States Congress in January 1955 to authorize unrestricted private transactions in gold and to prohibit the sale of gold by the Treasury or Federal Reserve banks for commercial use or for the purpose of depressing the market price. The Congress took no action on the proposed legislation.

During 1955 the U. S. S. R. continued to sell large quantities of gold in western European markets to reestablish its currency balances. It was estimated that Russian gold sales for the year were on the order of $100 million.

The United States Court of Claims heard oral arguments in January in connection with the damage suits brought by a group of gold-mining companies against the Government for losses suffered as a result of War Production Board Limitation Order L–208, which closed the Nation's gold mines during World War II. The Court took under advisement the question of the Government's liability for damages. In all, 217 claims for damages have been filed with the Court.

---
[1] Commodity specialist.
[2] Statistical assistant.

TABLE 1.—Salient statistics of gold in the United States,[1] 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Mine production, fine ounces	2,016,792	1,980,512	1,893,261	1,958,293	1,837,310	1,880,142
Ore (dry and siliceous) produced (short tons):						
Gold ore	3,228,182	2,606,202	2,339,160	2,198,688	2,248,604	2,233,953
Gold-silver ore	434,347	368,184	237,211	81,658	46,345	120,303
Silver ore	405,846	492,143	502,208	555,050	680,442	570,303
Percentage derived from—						
Dry and siliceous ores	41	39	40	40	43	41
Base-metal ores	29	36	38	39	34	37
Placers	30	25	22	21	23	22
Net consumption in industry and the arts (fine ounces)	2,595,778	1,985,057	2,752,872	2,142,860	1,269,800	1,300,000
Imports	$1,105,572,855	$81,258,502	$740,254,160	$47,024,515	$37,852,514	$104,591,654
Exports	$270,890,210	$630,381,566	$55,921,206	$44,808,300	$21,293,551	$6,953,225
Monetary stocks (end of year)[2]	----------	$22,695,000,000	$23,186,000,000	$22,030,000,000	[3] $21,713,000,000	$21,690,000,000
Price, average, per fine ounce[4]	$35.00	$35.00	$35.00	$35.00	$35.00	$35.00
World production, fine ounces (estimated)	30,000,000	33,500,000	34,300,000	33,700,000	35,100,000	36,400,000

[1] Includes Alaska.
[2] Owned by Treasury Department; privately held coinage not included.
[3] Revised figure.
[4] Price under authority of Gold Reserve Act of Jan. 31, 1934.

TABLE 2.—Gold produced in the United States,[1] 1946–50 (average) and 1951–55, according to mine and mint returns, in fine ounces of recoverable metal

	1946–50 (average)	1951	1952
Mine	2,016,792	1,980,512	1,893,261
Mint	1,972,762	1,894,726	1,927,000
	1953	**1954**	**1955**
Mine	1,958,293	1,837,310	1,880,142
Mint	1,970,000	1,859,000	1,876,830

[1] Includes Alaska.

TABLE 3.—Gold refined in the United States, 1955, by States

[U. S. Bureau of the Mint]

State or Territory	Fine ounces	State or Territory	Fine ounces
Alaska	252,670	Pennsylvania	1,630
Arizona	127,800	South Dakota	527,100
California	248,000	Tennessee	190
Colorado	87,000	Utah	442,210
Idaho	9,500	Vermont	180
Montana	26,000	Washington	74,000
Nevada	76,600	Wyoming	130
New Mexico	2,000		
North Carolina	320	Total	1,876,830
Oregon	1,500		

MINE PRODUCTION

Although domestic mine production of recoverable gold was 2 percent greater in 1955 than in the preceding year, it was 8 percent lower than the average for the postwar years 1947–53 and only 39 percent of the alltime high established in 1940. The production gain in 1955 reflected increased mining of base-metal ores yielding byproduct gold. Production from straight-gold mines in Alaska, California, and South Dakota, where virtually all the gold output was recovered from placers or "dry" gold ores, remained nearly the same as in 1954. Of the total domestic output in 1955, 22 percent was recovered by placer mining, 41 percent from precious metal ore, and 37 percent as a byproduct from base-metal ores.

Basic units of measurement and methods of calculating mine production used in this report are explained in detail in preceding Minerals Yearbook chapters on Gold and Silver and Gold.

South Dakota continued to be the leading State in gold production in 1955, followed in order by Utah, California, and Alaska. California displaced Alaska in 1955 as the third-ranking State. These 4 States supplied 78 percent of the total domestic production. South Dakota output came almost entirely from gold ore produced at the Homestake mine; Utah production was recovered chiefly as a byproduct of the treatment of copper ore from the West Mountain (Bingham) district; California output was obtained principally from straight-gold mines, both lode and placer; and Alaska gold came from placers and was recovered mostly by bucketline dredges. Of the total

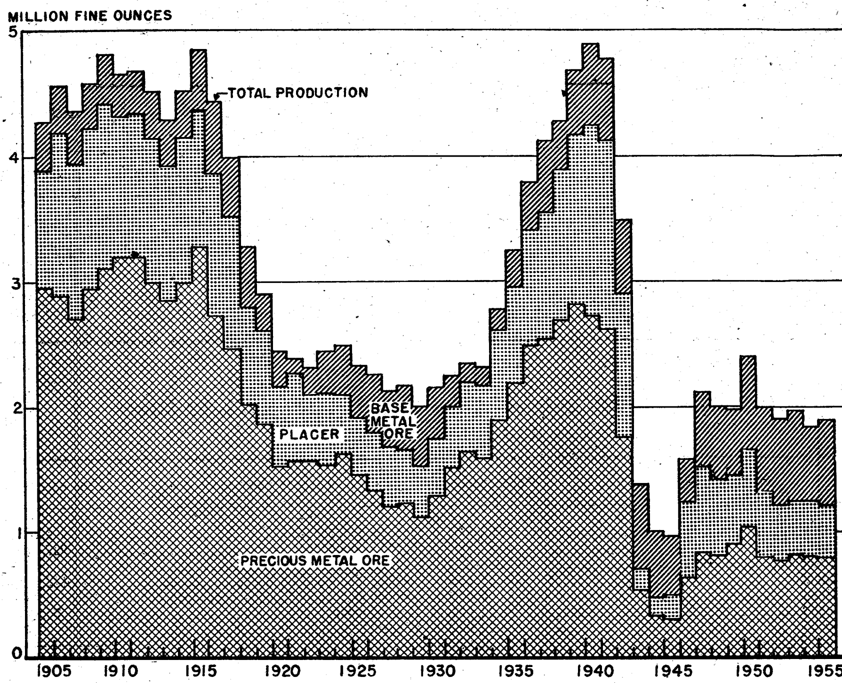

FIGURE 1.—Gold production of the United States, 1905–55.

TABLE 4.—Mine production of gold in the United States [1] in 1955, by months

	Fine ounces		Fine ounces
January	139,474	August	160,637
February	134,787	September	192,384
March	147,946	October	186,915
April	145,558	November	175,324
May	155,353	December	147,857
June	161,060		
July	132,847	Total	1,880,142

[1] Includes Alaska.

domestic gold production in 1955, 22 percent was recovered by placer mining, 38 percent by amalgamation and cyanidation, and 40 percent in smelting ores and concentrates.

Except for the wartime period 1943–45, when the West Mountain (Bingham), Utah, copper district ranked first in gold production, Lawrence County (Lead), S. Dak., has been the leading gold-producing area in the United States for many years, a position it continued to hold through 1955. The West Mountain district has ranked second since 1946, and the Yuba River, Calif., gold-dredging district ranked third in 1954 and 1955, having displaced the Grass Valley-Nevada City, Calif., gold-ore district, which dropped from third place to seventh. The 2 leading districts continued to produce about half of the total domestic output in 1955.

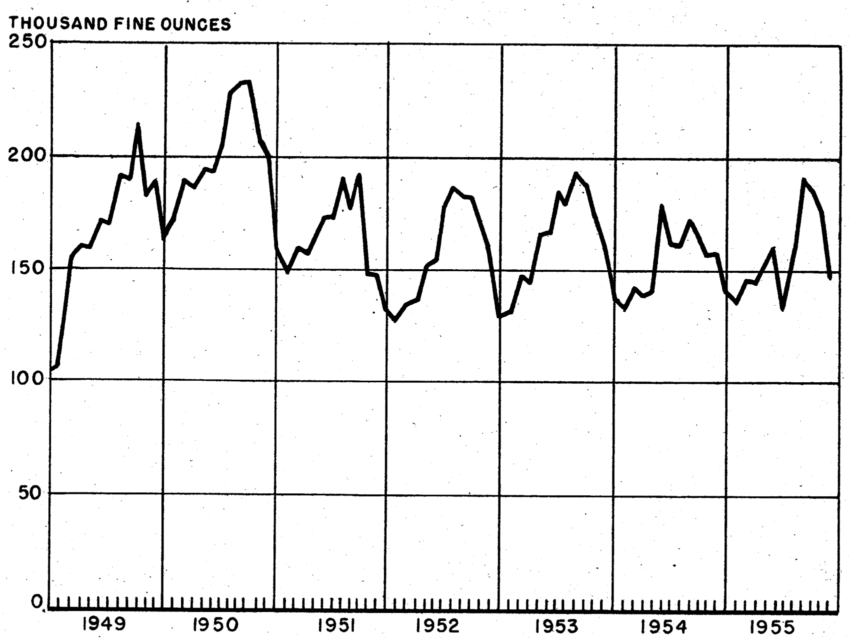

FIGURE 2.—Mine production of gold in the United States, 1949–55, by months, in terms of recoverable gold.

TABLE 5.—Mine production of recoverable gold in the United States, 1946–50 (average) and 1951–55, by districts that produced 10,000 fine ounces or more during any year (1951–55), in fine ounces [1]

District or region	State	1946–50 (average)	1951	1952	1953	1954	1955
Lawrence County	South Dakota	425, 984	458, 040	482, 511	534, 984	541, 445	529, 865
West Mountain (Bingham)	Utah	314, 469	407, 196	417, 607	450, 882	369, 760	405, 194
Yuba River	California	(2)	(2)	(2)	(2)	(2)	(2)
Chelan County	Washington	39, 855	46, 458	[3] 54, 135	[3] 61, 468	[3] 66, 477	[3] 74, 135
Republic (Eureka)	do	23, 606	(2)	(3)	(3)	(3)	(3)
American River (Folsom)	California	97, 946	86, 867	73, 366	65, 275	61, 885	55, 794
Grass Valley-Nevada City	do	(2)	(2)	(2)	(2)	(2)	(2)
Cripple Creek	Colorado	35, 721	27, 699	48, 527	51, 559	48, 935	47, 171
Warren (Bisbee)	Arizona	14, 085	25, 338	26, 697	29, 840	40, 208	42, 351
Ajo	do	35, 659	33, 805	36, 37[illegible]	36, 599	32, 708	40, 030
Robinson	Nevada	40, 952	60, 055	59, 521	61, 093	34, 139	39, 430
Park City Region	Utah	19, 333	18, 476	13, 827	27, 919	27, 900	32, 208
Summit Valley	Montana	16, 931	15, 674	16, 918	19, 871	17, 325	22, 262
Klamath River	California	5, 189	154	37	3, 727	13, 838	21, 857
Big Bug	Arizona	12, 554	19, 724	17, 317	17, 788	17, 802	19, 942
Upper San Miguel	Colorado	37, 755	34, 030	34, 822	39, 876	21, 514	18, 987
Bullion	Nevada	16, 681	(2)	17, 824	(2)	(2)	(2)
Downieville	California	(2)	6, 739	(2)	(2)	(2)	(2)
Pioneer	Arizona	10, 777	12, 207	11, 665	14, 480	13, 382	11, 299
Redcliff (Battle Mountain)	Colorado	2, 157	2, 793	1, 700	3, 750	10, 121	8, 416
Battle Mountain	Nevada	(2)	(2)	(2)	(2)	(2)	(2)
Alleghany	California	(2)	10, 776	9, 683	13, 112	8, 483	5, 769
California (Leadville)	Colorado	(2)	(2)	18, 405	9, 321	5, 438	5, 149
Mother Lode	California	(2)	(2)	7, 127	3, 524	842	1, 415
Round Mountain	Nevada	(2)	(2)	(2)	60	23	55
Oroville (Palermo)	California	(2)	(2)	2, 946	47	67	54
Fairplay	Colorado	(2)	(2)	2, 019	----------	----------	22
Yellow Pine	Idaho	34, 211	19, 605	17, 638	----------	----------	--------

[1] Exclusive of Alaska.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Chelan and Ferry Counties combined in 1952–55 to avoid disclosure of individual company output.

TABLE 6.—Twenty-five leading gold-producing mines in the United States in 1955, 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	Yuba Unit	Yuba River	California	Yuba Consolidated Gold Fields	Do.
5	Natomas	American River (Folsom)	do	The Natomas Co	Do.
6	Empire Star Group	Grass Valley-Nevada City	do	Empire Star Mines Ltd	Gold ore.
7	Copper Queen-Lavender Pit	Warren	Arizona	Phelps Dodge Corp	Copper ore.
8	New Cornelia	Ajo	do	do	Gold, copper ores, copper tailings.
9	Knob Hill	Republic (Eureka)	Washington	Knob Hill Mines, Inc	Gold ore.
10	Mayflower, Galena, and Star Units.	Blue Ledge	Utah	New Park Mining Co	Lead-zinc ore.
11	Gold King	Wenatchee River	Washington	Lovitt Mining Co	Gold ore.
12	Nome Unit	Nome	Alaska	U. S. Smelting, Refining & Mining Co	Dredge.
13	Ajax	Cripple Creek	Colorado	Golden Cycle Corp	Gold ore.
14	Siskon	Klamath River	California	Siskon Corp	Do.
15	Iron King	Big Bug	Arizona	Shattuck Denn Mining Co	Lead-zinc ore.
16	Goldacres	Bullion	Nevada	The London Extension Mining Co	Gold ore.
17	Treasury Tunnel-Black Bear	Upper San Miguel	Colorado	Idarado Mining Co	Copper-lead-zinc ore.
18	Tuluksak River and Tributaries	Aniak	Alaska	New York-Alaska Gold Dredging Corp	Dredge.
19	Holden Group	Chelan Lake	Washington	Howe Sound Co	Copper-zinc ore.
20	Portland, etc	Bald Mountain	South Dakota	Bald Mountain Mining Co	Gold ore.
21	Cresson	Cripple Creek	Colorado	Cresson Consolidated Gold Mining & Milling Co.	Do.
22	Brush Creek	Downieville	California	Best Mines Co., Inc	Do.
23	Morris Pit	Robinson	Nevada	Kennecott Copper Corp	Copper ore.
24	Butte Hill Lead-Zinc Mines	Summit Valley	Montana	Anaconda Co	Lead-zinc ore.
25	Magma	Pioneer	Arizona	Magma Copper Co	Copper ore.

TABLE 7.—Mine production of recoverable gold in the United States, 1945–55, with production of maximum year, and cumulative production from earliest record to end of 1955, by States, in fine ounces

	Maximum production [1]		Production by years											Total production from earliest record to end of 1955
	Year	Quantity	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	
Western States and Alaska:														
Alaska	1906	1,066,030	68,117	226,781	279,988	248,395	229,416	289,272	239,486	240,557	253,783	248,511	249,294	28,362,281
Arizona	1937	332,694	77,223	79,024	95,860	109,487	108,993	118,313	116,093	112,355	112,824	114,809	127,616	11,884,509
California	1852	3,932,631	147,938	356,824	431,415	421,473	417,231	412,118	339,732	258,176	234,591	237,886	251,737	104,885,578
Colorado	1900	1,391,364	100,935	142,613	168,279	154,802	102,618	130,390	116,503	124,594	119,218	96,146	88,577	40,159,070
Idaho	1871	212,850	17,780	42,975	64,982	58,454	77,829	79,652	45,064	32,997	17,630	13,245	10,572	8,241,174
Montana	1865	870,750	44,597	70,507	90,124	73,091	52,724	51,764	30,502	24,161	24,768	23,660	28,123	17,451,038
Nevada	1910	913,265	92,265	90,680	89,063	111,532	130,399	178,447	121,036	117,203	101,799	79,067	72,913	26,518,460
New Mexico	1915	70,681	5,604	4,009	3,146	3,414	3,249	3,414	3,959	2,949	2,614	3,539	1,917	2,211,036
Oregon	1940	113,402	4,467	17,598	18,979	14,611	16,226	11,058	7,927	5,509	8,488	6,520	1,708	5,782,578
South Dakota	1939	618,536	55,948	312,247	407,194	377,850	464,650	567,996	458,101	482,534	534,987	541,445	529,865	25,410,923
Texas	1929	1,279		9	45	57	40	49	32	39				8,552
Utah	1953	483,430	279,979	178,533	421,662	368,422	314,058	457,551	432,216	435,507	483,430	403,401	441,206	14,400,431
Washington	1950	92,117	57,860	51,168	34,965	70,075	71,994	92,117	67,405	54,776	62,560	66,740	74,360	2,773,662
Wyoming	1869	7,498	2	105	1,486	115	389		9	1	1	407	52	80,501
Total			952,715	1,573,073	2,107,188	2,011,778	1,989,816	2,392,141	1,978,065	1,891,358	1,956,693	1,835,376	1,877,940	288,169,793
West Central States: Missouri	1900	33												33
States east of the Mississippi:														
Alabama	1936	4,726	5	1										49,495
Georgia	1882	12,094		21	76	19	18		3		2			870,663
Indiana	(2)	(2)												(3)
Maryland	1937	1,040												6,123
Michigan	1890	4,354						20	1					33,297
North Carolina	1887	10,884					13					214	190	1,165,005
Pennsylvania	1942	2,499	1,588	1,150	1,518	2,200	1,645	1,764	2,179	1,500	1,134	1,317	1,610	[4] 40,151
South Carolina	1941	15,508												318,801
Tennessee	1930	696	148	95	303	156	171	160	108	241	293	218	221	22,836
Vermont	1954	185	104	165	100	104	120	146	156	162	171	185	181	[5] 1,744
Virginia	1938	2,943	12											167,558
Total			1,857	1,432	1,997	2,479	1,967	2,090	2,447	1,903	1,600	1,934	2,202	2,675,673
Grand total			954,572	1,574,505	2,109,185	2,014,257	1,991,783	2,394,231	1,980,512	1,893,261	1,958,293	1,837,310	1,880,142	290,845,499

[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] 1908–55 only.
[5] 1905–55 only.

Of the 25 leading gold producers operating in the United States in 1955, 10 were lode-gold mines, 5 were placers worked by bucketline dredges, 5 were copper mines, 3 were lead-zinc mines, 1 was a copper-zinc mine, and 1 was a copper-lead-zinc mine. The 25 mines supplied about 87 percent of the domestic output, valued at $65.8 million.

Ore classification, methods of recovery, and metal yields embracing all ores that yielded gold in the United States in 1955 are given in the following tables (8 to 13). The terminology used in classifying ores is described in detail in the 1954 Gold chapter.

TABLE 8.—Ore, old tailings, etc., yielding gold produced in the United States, and average recoverable content, in fine ounces, of gold per ton in 1955 [1]

State	Gold ore		Gold-silver ore		Silver ore	
	Short tons	Average ounces of gold per ton	Short tons	Average ounces of gold per ton	Short tons	Average ounces of gold per ton
Western States and Alaska:						
Alaska	3,883	0.590				
Arizona	3,317	.232	67,516	0.011	25,511	0.001
California	154,494	.670	1,155	.367	2,559	
Colorado	106,084	.458	180	.906	8,000	.030
Idaho	6,740	.228	298	.701	372,414	.002
Montana	1,308	.914	8,032	.065	1,153	.020
Nevada	166,655	.134	7,128	.147	23,010	.005
New Mexico	135	1.163	2,673	.147	2,407	
Oregon	3,791	.394				
South Dakota	1,665,341	.318				
Texas						
Utah	639	.122	33,321	.036	135,249	.025
Washington	121,185	.462				
Wyoming	206	.252				
Total	2,233,778	.344	120,303	.039	570,303	.008
States east of the Mississippi	175	1.086				
Total	2,233,953	.344	120,303	.039	570,303	.008

State	Copper ore		Lead ore		Lead-copper ore	
	Short tons	Average ounces of gold per ton	Short tons	Average ounces of gold per ton	Short tons	Average ounces of gold per ton
Western States and Alaska:						
Alaska			1	1.000		
Arizona	52,253,289	0.002	4,706	.023		
California	9,365	.035	5,731	.012		
Colorado	67,513	.109	21,579	.042	77	
Idaho	180,960	.011	50,475	.010	202	0.376
Montana	5,760,564	.002	8,280	.070		
Nevada	10,520,428	.004	9,912	.223		
New Mexico	7,297,379		26,086	.001		
Oregon	44	.250				
South Dakota						
Texas	35		6			
Utah	27,751,432	.014	14,877	.035		
Washington	10,800	.013	10	.100		
Wyoming						
Total	103,851,809	.005	141,663	.034	279	.272
States east of the Mississippi	7,102,949		287			
Total	110,954,758	.005	141,950	.034	279	.272

See footnotes at end of table.

TABLE 8.—Ore, old tailings, etc., yielding gold produced in the United States, and average recoverable content, in fine ounces, of gold per ton in 1955 [1]—Con.

State	Zinc ore		Zinc-lead, zinc-copper, and zinc-lead-copper ores		Total ore	
	Short tons	Average ounces of gold per ton	Short tons	Average ounces of gold per ton	Short tons	Average ounces of gold per ton
Western States and Alaska:						
Alaska	----------	----------	----------	----------	3,884	0.590
Arizona	807	0.004	388,069	0.052	52,743,215	.002
California	38	----------	131,177	.006	304,519	.345
Colorado	228,576	.005	476,407	.060	908,416	.096
Idaho	[2] 106,950	----------	1,242,777	.001	1,960,816	.003
Montana	47,381	.002	1,433,199	.009	7,259,917	.003
Nevada	4,589	.001	28,615	.015	10,760,337	.006
New Mexico	54,788	----------	78,525	.002	7,461,993	----------
Oregon	----------	----------	----------	----------	3,835	.392
South Dakota	----------	----------	----------	----------	1,665,341	.318
Texas	----------	----------	----------	----------	41	----------
Utah	[2] 66,524	----------	604,950	.065	28,606,992	.015
Washington	570	----------	1,579,548	.012	1,712,113	.043
Wyoming	----------	----------	----------	----------	206	.252
Total	510,223	.002	5,963,267	.020	113,391,625	.013
States east of the Mississippi	2,297,616	----------	3,010,580	----------	[3] 12,411,607	([3])
Total	2,807,839	----------	8,973,847	.014	125,803,232	.012

[1] Missouri excluded.
[2] Zinc slag.
[3] Excludes magnetite-pyrite ore and gold and silver therefrom. Includes material classified as fluorspar ore mined in Illinois.

Placer-gold production in 1955, most of which was recovered by bucketline dredges in Alaska and California, dropped 2 percent to 409,800 ounces and supplied 22 percent of the total domestic output.

TABLE 9.—Mine production of gold in the United States,[1] 1946–50 (average) and 1951–55, by percentage 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	
1946–50 (average)	30.0	41.2	21.3	0.5	0.3	6.7	2,016,792
1951	24.8	38.9	27.5	.5	.2	8.1	1,980,512
1952	22.5	39.5	29.4	.4	.2	8.0	1,893,261
1953	20.9	40.4	30.9	.3	.1	7.4	1,958,293
1954	22.8	42.8	28.6	.3	.1	5.4	1,837,310
1955	21.8	41.3	30.1	.2	.1	6.5	1,880,142

[1] Includes Alaska.

TABLE 10.—Mine production of gold in the United States in 1955, by States and sources, in fine ounces of recoverable metals

State	Placers	Dry ore	Copper ore	Lead ore	Lead-copper ore	Zinc ore	Zinc-lead, zinc-copper, and zinc-lead-copper ores	Total
Alaska	247,002	2,291		1				249,294
Arizona	83	1,518	105,817	110		3	20,085	127,616
California	146,613	103,966	325	66			767	251,737
Colorado	1,796	48,956	7,350	908		1,069	28,498	88,577
Idaho	3,946	2,496	2,030	482	76		1,542	10,572
Montana	3,352	1,743	10,083	577		92	12,276	28,123
Nevada	6,768	23,489	40,011	2,206		5	434	72,913
New Mexico	81	552	1,097	17		11	159	1,917
North Carolina		190						190
Oregon	203	1,494	11					1,708
Pennsylvania			[1] 1,610					1,610
South Dakota		529,865						529,865
Tennessee							221	221
Utah		4,620	396,571	516		21	39,478	441,206
Vermont			181					181
Washington	3	55,947	145	1			18,264	74,360
Wyoming		52						52
Total	409,847	777,179	565,231	4,884	76	1,201	121,724	1,880,142

[1] From magnetite-pyrite ore.

TABLE 11.—Gold produced in the United States from ore and old tailings, in 1955, 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 (fine ounces)	Concentrates smelted and recoverable metal			
				Concentrates (short tons)	Fine ounces	Short tons	Fine ounces
Western States and Alaska:							
Alaska	3,884	3,871	2,014	14	127	13	151
Arizona	[2] 49,251,362	[2] 48,537,958	2,720	1,619,458	92,218	713,404	32,595
California	304,519	293,309	94,708	30,010	9,376	11,210	1,040
Colorado	908,416	830,137	55,661	112,774	22,626	78,279	8,494
Idaho	1,960,816	1,841,194	1,012	193,895	4,581	119,622	1,033
Montana	7,259,917	7,128,084	91	631,050	21,608	131,833	3,072
Nevada	10,760,337	10,627,412	20,121	271,237	38,870	132,925	7,154
New Mexico	7,461,993	7,354,983	36	232,625	1,204	107,010	596
Oregon	3,835	3,812	265	162	1,109	23	131
South Dakota	1,665,341	1,665,341	529,865				
Texas	41					41	
Utah	28,606,992	28,346,943		927,349	436,000	260,049	5,206
Washington	1,712,113	1,651,302	7,204	85,022	42,689	60,811	24,464
Wyoming	206	200	27			6	25
Total	109,899,772	108,284,546	713,724	4,103,596	670,408	1,615,226	83,961
States east of the Mississippi	[3] 12,411,607	12,321,616	11	523,103	2,191	89,991	
Grand total	122,311,379	120,606,162	713,735	4,626,699	672,599	1,705,217	83,961

[1] Missouri excluded.
[2] Excludes 3,491,853 tons of ore leached from which no gold or silver was recovered.
[3] Excludes magnetite-pyrite ore from Pennsylvania. Includes material classified as fluorspar ore mined in Illinois.

TABLE 12.—Gold produced at amalgamation and cyanidation mills in the United States and percentage of gold recoverable from all sources, 1946–50 (average) and 1951–55 [1]

Year	Bullion and precipitates recoverable (fine ounces)		Gold from sources (percent)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting [2]	Placers
1946–50 (average)	406,639	274,207	20.2	13.6	36.3	29.9
1951	445,466	224,968	22.5	11.3	41.4	24.8
1952	422,087	256,787	22.3	13.6	41.6	22.5
1953	467,561	265,552	23.9	13.5	41.7	20.9
1954	429,558	286,989	23.4	15.6	38.1	22.9
1955	445,135	268,600	23.7	14.3	40.2	21.8

[1] Includes Alaska.
[2] Both crude ores and concentrates.

TABLE 13.—Gold produced at amalgamation and cyanidation mills in the United States in 1955, by States

State	Amalgamation	Cyanidation	Gold from all sources in State (percent)	
	Bullion recoverable (fine ounces)	Bullion and precipitates recoverable (fine ounces)	Amalgamation	Cyanidation
Western States and Alaska:				
Alaska	2,014		0.81	
Arizona	67	2,653	.05	2.08
California	52,982	41,726	21.05	16.58
Colorado	8,571	47,090	9.68	53.16
Idaho	1,012		9.57	
Montana	91		.32	
Nevada	768	19,353	1.05	26.54
New Mexico	36		1.88	
Oregon	265		15.52	
South Dakota	379,249	150,616	71.57	28.43
Washington	42	7,162	.06	9.63
Wyoming	27		51.92	
Total	445,124	268,600	23.70	14.30
States east of the Mississippi	11		.50	
Grand total	445,135	268,600	23.68	14.29

TABLE 14.—Gold production at placer mines in the United States, by class of mine and method of recovery, 1946–50 (average) and 1951–55 [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:						
Bucketline dredges:						
1946–50 (average)	54	74	113,554,109	475,931	16,657,578	$0.147
1951	36	56	93,214,943	404,305	14,150,675	.152
1952	37	56	69,940,758	358,492	12,547,220	.179
1953	21	41	65,313,835	343,132	12,009,620	.184
1954	22	44	62,082,120	356,018	12,460,630	.201
1955	25	20	53,351,709	348,131	12,184,585	.228
Dragline dredges:						
1946–50 (average)	47	44	6,452,629	33,813	1,183,462	.183
1951	25	23	2,342,647	8,820	308,700	.132
1952	16	16	1,936,587	8,517	298,095	.154
1953	14	13	659,600	2,453	85,855	.130
1954	15	15	554,460	4,184	146,440	.264
1955	19	7	479,885	2,939	102,865	.214
Becker-Hopkins dredges:						
1946–50 (average)			1,000	6	224	.224
1951–55						
Suction dredges:						
1946–50 (average)	10	10	148,851	834	29,176	.196
1951	13	9	180,500	717	25,095	.139
1952	9	9	74,100	305	10,675	.144
1953	7	8	87,700	341	11,935	.136
1954	3	3	3,800	53	1,855	.488
1955	5	5	2,400	46	1,610	.671
Nonfloating washing plants:						
1946–50 (average)	150	149	5,450,343	64,583	2,260,398	.415
1951	117	115	7,049,566	69,592	2,435,720	.346
1952	103	102	4,795,100	54,866	1,920,310	.400
1953	128	128	4,019,325	58,295	2,040,325	.508
1954	128	128	2,973,510	52,491	1,837,185	.618
1955	118	109	2,259,263	53,332	1,866,620	.826
Gravel hydraulically handled:						
1946–50 (average)	126		1,738,165	19,885	695,975	.400
1951	51		257,800	3,460	121,100	.470
1952	33		130,401	1,326	46,410	.356
1953	48		440,290	1,923	67,305	.153
1954	48		258,100	2,079	72,765	.282
1955	44		200,001	1,528	53,480	.267
Small-scale hand methods:						
Wet:						
1946–50 (average)	271		454,379	7,116	249,053	.548
1951	148		99,804	3,106	108,710	1.089
1952	119		101,152	2,598	90,930	.899
1953	139		152,565	2,534	88,690	.581
1954	112		171,780	3,248	113,680	.662
1955	78		236,226	3,580	125,300	.530
Dry:						
1946–50 (average)	13		3,834	165	5,775	1.506
1951	4		550	27	945	1.718
1952						
1953	3		9,875	103	3,605	.365
1954	3		905	78	2,730	3.017
1955	2		420	75	2,625	6.250
Underground placers (drift):						
1946–50 (average)	31		11,253	487	17,038	1.514
1951	19		4,275	498	17,430	4.077
1952	14		4,370	159	5,565	1.273
1953	13		3,778	172	6,020	1.593
1954	23		9,130	304	10,640	1.165
1955	18		5,358	216	7,560	1.411
Unclassified placers:						
1946–50 (average)						
1951–53						
1954				[2] 1,476	[2] 51,660	(2)
1955						
Grand total placers:						
1946–50 (average)	[3] 704		127,814,563	602,820	21,098,679	.165
1951	413		103,150,085	490,525	17,168,375	.166
1952	331		76,982,468	426,263	14,919,205	.194
1953	373		70,686,968	408,953	14,313,355	.202
1954	354		66,053,805	419,931	14,697,585	.223
1955	309		56,535,262	409,847	14,344,645	.254

[1] Includes Alaska.
[2] Included in total of gold recoverable and value but not computed into average value per cubic yard.
[3] A mine using more than 1 method of recovery is counted but once in arriving at total for all methods.

CONSUMPTION AND USES IN INDUSTRY AND THE ARTS

By far the largest part of the gold produced through the years has been held for monetary use in the form of bullion in Government stocks; a small portion is absorbed in private hoards.

Gold consumption in industry and the arts of the United States, as estimated by the Bureau of the Mint, was about 1.3 million ounces in 1955, equal to approximately 69 percent of domestic mine production. The estimate of consumption represents the net quantity of gold and silver issued for domestic, industrial, professional, and artistic use by Government mints and assay offices, private refiners, and dealers, minus the amount of gold returned to these concerns as old jewelry, plate, scrap, and other forms.

Most nonmonetary gold was absorbed in the arts, where it was used chiefly for jewelry, watchcases, utensils, and tableware. Gold alloys were used in various scientific instruments and laboratory ware because of its resistance to corrosion and chemical action; other established uses of gold included electroplating and filling of other metals, gold leaf for decorative purposes, dental fillings, and appliances.

Available data indicate that most of the "natural gold" sold on the open market in the United States in 1955, which was less than 2,000 ounces, was used in making jewelry.

TABLE 15.—Net industrial[1] consumption of gold in the United States, 1946–50 (average) and 1951–55, in fine ounces

[U. S. Bureau of the Mint]

Year	Issued for industrial use	Returned from industrial use	Net industrial consumption
1946–50 (average)	3,837,191	1,241,413	2,595,778
1951	3,000,346	1,015,289	1,985,057
1952	3,633,985	881,113	2,752,872
1953	3,210,829	1,067,969	2,142,860
1954	2,236,179	966,379	1,269,800
1955	1,964,500	664,500	1,300,000

[1] Including the arts.

PRICE AND MONETARY STOCKS

The price of gold at the United States Mint has remained unchanged at $35 per fine troy ounce since January 1934. The bulk of the domestic output of gold is sold to Government mints or assay offices at the official price minus charges of $0.0875 per ounce for handling and refining.

Gold stocks of the United States Treasury declined $23 million—from $21,713 million on December 31, 1954, to $21,690 million on December 31, 1955, according to the Federal Reserve Bulletin. World monetary stocks of gold, excluding the U. S. S. R. and satellite countries but including the reserves of the International Monetary Fund and other international financial organizations, was estimated at $37,150 million at the end of 1955—an increase of $600 million during the year, according to the Annual Report of the International Monetary Fund.

Proposals intended to increase the United States Treasury's price for gold were not as prominent in 1955 as in preceding years; however, a strong appeal for an increase in the monetary price of gold was made by the South African delegate at the Tenth Annual Meeting of the Board of Governors of the International Monetary Fund at Istanbul in September. The official attitude of the United States was again expressed at the same meeting by the Under Secretary of the Treasury W. Randolph Burgess, as follows:

> * * * We continue to believe that a change in the par value of the dollar, or in the official dollar price which we pay for gold would be in sharp conflict with our objective, which is to maintain a sound currency as a basis for economic health, not only in the United States but also wherever the dollar is important. * * *

Since 1951, as a result of the International Monetary Fund's action permitting member gold-producing countries to regulate the disposal of newly mined gold on the free market, increasing supplies of gold have become available for open-market sale. The London Gold Market, which in 1955 marked its first full year of operation since 1938, is estimated to have handled at least 85 percent of the new gold supply coming on the international free market. For the first year since World War II, the price of gold on the free market dropped below the official parity price of $35 per ounce for a considerable period, in spite of increased demands for private hoarding. Gold quotations on the London market fluctuated in the very narrow range of $34.95 to $35.06 during the year, averaging only slightly higher than the United States Treasury price. It was estimated that at least 9 million ounces of gold was bought for private hoarding, mostly in France, the Middle East, and the Far East. Near the end of 1955 Belgium and Luxembourg abolished all restrictions on gold transactions.

FOREIGN TRADE [3]

Reflecting the settlement of favorable foreign trade balances, gold imports of the United States in 1955 continued to exceed gold exports for the fourth successive year. The excess of imports over exports rose $81 million during the year to $97.6 million. The gains from imports plus domestic production greatly exceeded consumption in the arts and industry, and thus monetary stocks increased.

TABLE 16.—Value of gold imported into and exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

	Imports	Exports	Excess of imports over exports [1]
1946–50 (average)	$1,105,572,855	$270,890,210	$834,682,645
1951	81,258,502	630,381,566	−549,123,064
1952	740,254,160	55,921,206	684,332,954
1953	47,024,515	44,808,300	2,216,215
1954	37,852,514	21,293,551	16,558,963
1955	104,591,654	6,953,225	97,638,429

[1] Excess of exports over imports indicated by minus sign.

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

TABLE 17.—Gold imported into the United States in 1955, by countries of origin

[U. S. Department of Commerce]

Country of origin	Ore and base bullion		Bullion, refined		Foreign coin (value)
	Troy ounces	Value	Troy ounces	Value	
North America:					
Canada	556,664	$19,447,055	1,710,886	$59,850,739	
Cuba	2,024	69,475			
El Salvador	3,469	121,376			
French West Indies			248	8,664	
Guatemala	1	28			
Honduras	1,650	57,682			
Mexico	81,743	2,848,166			
Nicaragua	151,780	5,306,349			
Panama	248	8,708	78	2,729	
Total	797,579	27,858,839	1,711,212	59,862,132	
South America:					
Bolivia	1,178	41,056			
Brazil	1,550	54,269			
British Guiana	3,788	132,941			
Chile	29,699	1,039,797			
Colombia	25,630	897,056			
Ecuador	14,212	494,331			
Peru	40,810	1,422,471	21,959	716,377	
Venezuela	867	30,303			
Total	117,734	4,112,224	21,959	716,377	
Europe:					
Austria					$104,912
Germany, West	7	230			427
Malta, Gozo and Cyprus	1,442	50,331			
Netherlands					70
Portugal	17,997	629,896			
Switzerland	10	334			66,068
Turkey	275	9,625			
United Kingdom	7,531	263,695	804	28,091	
Total	27,262	954,111	804	28,091	171,477
Asia:					
Japan					410
Philippines	108,493	3,708,726	124,152	6,452,111	
Total	108,493	3,708,726	124,152	6,452,111	410
Africa:					
Federation of Rhodesia and Nyasaland	3,974	139,050			
Union of South Africa	49	1,715			
Total	4,023	140,765			
Oceania: Australia	16,179	565,300	609	21,091	
Grand total	1,071,270	37,339,965	1,858,736	67,079,802	171,887

457676—58——33

TABLE 18.—Gold exported from the United States in 1955, by countries of destination

[U. S. Department of Commerce]

Country of destination	Ore and base bullion		Bullion, refined	
	Troy ounces	Value	Troy ounces	Value
North America:				
Canada			6, 285	$220, 942
El Salvador			8, 055	281, 939
Mexico			113	3, 951
Total			14, 453	506, 832
South America:				
Brazil			385	13, 500
Chile			12, 024	420, 834
Venezuela			27, 293	962, 168
Total			39, 702	1, 396, 502
Europe:				
Germany, West			917	32, 600
Iceland			171	6, 130
Ireland	86	$3, 000		
Portugal			19, 619	686, 781
Turkey			220	7, 693
United Kingdom	11, 120	389, 180	4, 007	140, 255
Total	11, 206	392, 180	24, 934	873, 459
Asia:				
Ceylon			51	1, 804
Philippines			71, 868	3, 782, 448
Total			71, 919	3, 784, 252
Grand total	11, 206	392, 180	151, 008	6, 561, 045

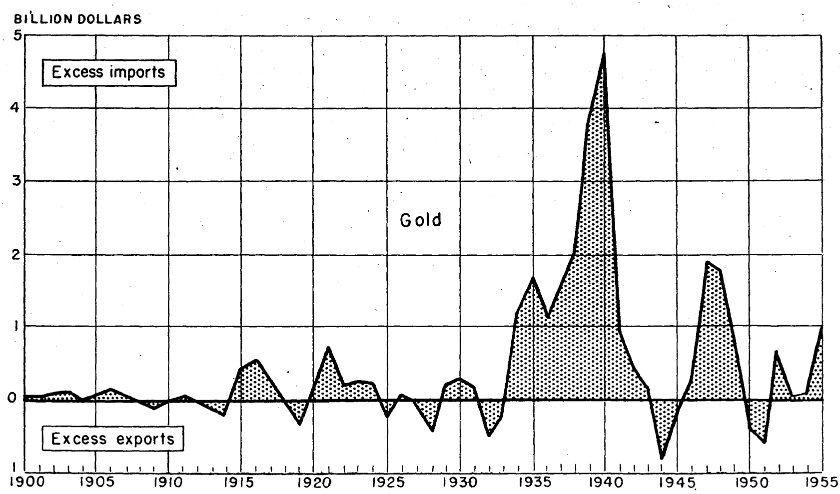

FIGURE 3.—Net imports or exports of gold, 1900–55.

TECHNOLOGY

Increased operating costs, combined with a fixed price, have emphasized the need for improved operating efficiency at gold mines.

In Canada noteworthy improvement in metallurgical efficiency and maintenance costs was effected at the McIntyre-Porcupine mill in Ontario by replacement of unit flotation cells between ball mills and classifiers with jigs. The jigs effectively removed from the grinding circuit those 65-mesh gold particles that neither the unit cells nor ensuing flotation had succeeded in recovering. Extensive tests of operating performance of ball mills at the gold mill of Wright-Hargreaves, also in Ontario, may lead to greater efficiency in grinding operations.[4]

Improvement in gold recovery at the reduction plant of Welgedacht Exploration Co. in South Africa by using cyclones as classifiers was significant. Successful tests in South Africa on the use of the Rand Lease plane table and the Titan continuous rotary amalgamator in treating certain ores carrying "free" gold may lead to improved gold recoveries and lower costs through reduction in labor requirements.

Articles pertaining to the technology of gold published during 1955 include the following:

1. BEALS, RIXFORD A. Aerofall Mill Finds Increasing Application. Min. Eng., vol. 7, No. 9, September, pp. 842–845.

2. BOYLE, R. W. The Geochemistry and Origin of the Gold Bearing Quartz Veins and Lenses of the Yellowknife Greenstone Belt. Econ. Geol., vol. 50, No. 1, January-February, pp. 51–66.

3. BRITTEN, H. Recent Progress in the Design and Operation of Gold Reduction Plants. South African Min. and Eng. Jour., vol. 66, No. 3256, pp. 779, 781, 783, 785, 787.

4. HOLLOWAY, J. E. The Role of Gold in the Monetary Mechanism. Min. Cong. Jour., vol. 41, No. 12, December, pp. 34–37, 49.

5. LOVITT, E. H. Longholding at Gold King Mine. Min. Cong. Jour., vol. 41, No. 5, May, pp. 52–53.

6. MINING JOURNAL (LONDON). Current Mining Practice at Merriespruit (Orange Free State) Gold Mining. Vol. 244, No. 6229, Jan. 7, pp. 10–11. Current Mining Practice at Stilfontein Gold Mining. Vol. 244, No. 6230, Jan. 14, pp. 38–39. Current Mining Practice at Free State Mines of the Anglo American Corp. Group. Vol. 244, No. 6231, Jan. 21, pp. 66–67. Current Mining Practice at Free State Mines of the Anglo American Corp. Group. Vol. 244, No. 6232, Jan. 28, pp. 96–97. Rock Bursts in Ultradeep Areas of the Central Witwatersrand. Vol. 245, No. 6256, July 15, pp. 73–74.

7. MINING WORLD. How New Table Recovers Fine Gold. Vol. 17, No. 1, January, pp. 47–49.

8. WASPE, L. A. Reduction Plant Practice of the Union Corporation Group. Canadian Min. Jour., vol. 76, No. 11, November, pp. 65–71. Current Reduction Plant Practice in the Johannesburg Cons. Investment Co. Group. Canadian Min. Jour., vol. 76, No. 12, December, pp. 61–65.

9. WELLS, A. SIMPSON. Cyanide Process—How It Was Brought to the Rand. South African Min. and Eng. Jour., vol. 66, No. 3252, June 11, p. 619.

WORLD REVIEW

World production of gold rose for the second successive year to the highest level since 1941; the gain in 1955 was about 4 percent over the preceding year, attributable almost entirely to increased output in the Union of South Africa. Production in Canada also was higher in

[4] Djingheuzian, L. E., Technical Advances During 1955; part II, Milling and Process Metallurgy: Canadian Min. Jour., vol. 77, No. 2, February 1956, pp. 119–120.

1955, whereas lower outputs were reported for Australia, Gold Coast, and The Federation of Rhodesia and Nyasaland. The world production rate in postwar years has remained well below prewar averages.

Australia.—Reversing the rising trend of the preceding 4 years, Australia's gold output in 1955 declined 6 percent to 1.0 million ounces. The drop in output was due chiefly to closure of the Big Bell and Wiluna mines in Western Australia.

The gold subsidy plan adopted in 1954 to aid marginal mines continued throughout the year. One new mine (Northern Hercules) came into production during the year. Improvements in operating efficiency at some mines have helped to offset rising costs.

Canada.—Production of gold in Canada in 1955 rose for the second successive year to a postwar high of 4.6 million ounces, a 4-percent gain over the preceding year. Most of the increase came from Ontario and Quebec, the leading gold-producing Provinces. Three mines closed, and two new mines came into production during the year. The value of the Canadian dollar declined during the year, which brought the Mint price for gold up to $34.52 in Canadian funds per ounce, the highest for several years. Cost-aid payments under the Emergency Gold Mining Assistance Act continued to be made to high-cost mines, but modifications in the basis of payment resulted in a reduction in total payments from about $16.5 million in 1954 to about $11.0 million in 1955. The average payment was estimated at $3.25 per ounce. Gold ranked fourth among minerals in value of output in 1955, being exceeded by petroleum, copper, and nickel.

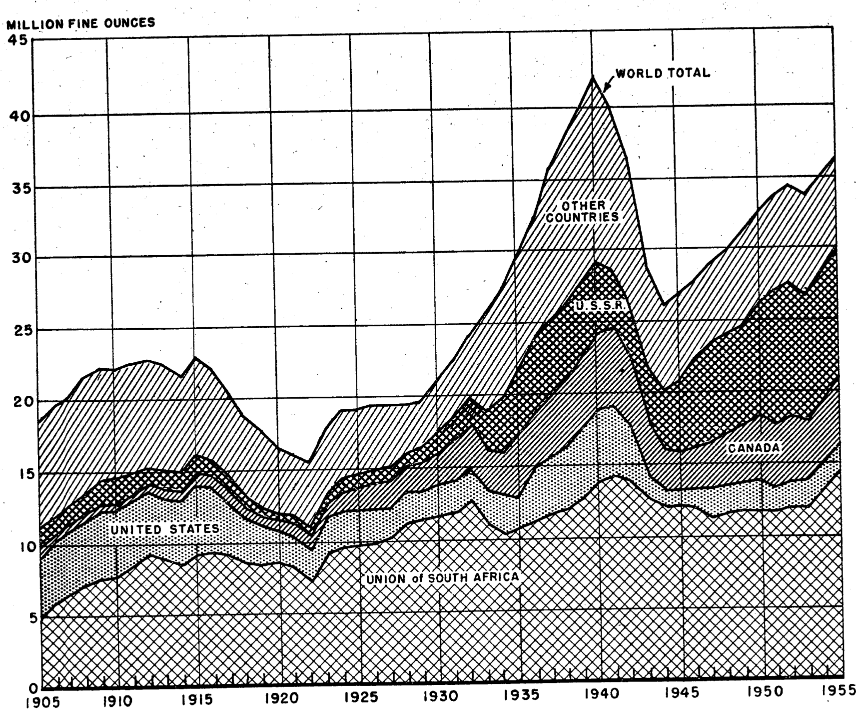

FIGURE 4.—World production of gold, 1905–55.

TABLE 19.—World production of gold, 1946–50 (average) and 1951–55, by countries,[1] in fine ounces [2]

[Compiled by Augusta W. Jann]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
United States (including Alaska)[3]	1,972,762	1,894,726	1,927,000	1,970,000	1,859,000	1,876,830
Canada	3,604,203	• 4.392,751	4,471,725	4,055,723	4,366,440	4,556,400
Central America and West Indies:						
Costa Rica [4]	947	1	----------	----------	----------	----------
Cuba [4]	2,882	835	881	1,181	677	2,024
Dominican Republic [4]	432	411	332	----------	----------	----------
Guatemala [4]	98	7	4	3	1	1
Haiti	8	----------	----------	----------	----------	----------
Honduras	20,176	31,216	31,967	47,523	20,429	817
Nicaragua (exports)	216,642	251,160	254,675	261,899	232,212	237,376
Panama	[5] 2,355	2,897	----------	----------	----------	----------
Salvador (exports)	21,895	27,097	27,682	23,359	5,326	3,818
Mexico	413,305	394,007	459,370	483,483	386,870	382,883
Total	6,255,700	6,995,100	7,173,600	6,843,200	6,871,000	7,060,000
South America:						
Argentina [6]	8,010	8,000	8,000	8,000	8,000	6,700
Bolivia	16,949	3,200	10,770	22,923	28,614	31,508
Brazil [6]	175,580	200,000	180,000	180,000	180,000	180,000
British Guiana	18,168	13,485	22,237	19,247	26,938	23,766
Chile	188,662	174,868	177,054	130,693	124,970	122,877
Colombia	378,870	430,723	422,231	437,297	377,466	380,824
Ecuador	81,779	12,601	24,294	29,239	18,479	14,972
French Guiana	15,059	12,056	8,231	2,576	1,512	8,713
Peru	125,354	144,765	130,944	140,228	147,424	180,025
Surinam	4,260	6,494	6,134	6,482	6,771	7,204
Venezuela	43,192	2,861	4,797	27,304	56,074	61,140
Total [6]	1,055,900	1,009,000	995,000	1,004,000	976,000	1,018,000
Europe:						
Austria	[6] 1,600	(7)	(7)	(7)	(7)	(7)
Bulgaria	[6] 2,600	(7)	(7)	(7)	(7)	(7)
Czechoslovakia	[6] 2,000	(7)	(7)	(7)	(7)	(7)
Finland	10,543	18,069	19,741	19,483	16,976	18,840
France	51,515	68,127	68,706	58,000	(7)	(7)
Germany:						
East	[6] 400	(7)	(7)	(7)	(7)	(7)
West	[6] 900	1,498	2,009	6,398	4,665	3,839
Hungary	[6] 2,000	(7)	(7)	(7)	(7)	(7)
Italy	11,851	12,089	14,854	12,153	5,208	5,562
Portugal	12,018	18,358	17,940	14,854	18,583	16,075
Rumania	93,518	(7)	(7)	(7)	(7)	(7)
Spain	12,271	12,777	8,944	8,263	9,677	(7)
Sweden	79,599	70,474	65,877	88,254	110,277	121,433
U. S. S. R.[6] [8]	7,000,000	9,500,000	9,500,000	[9] 9,000,000	9,000,000	9,000,000
Yugoslavia	29,212	21,380	36,266	36,620	(7)	(7)
Total [6]	7,300,000	9,800,000	9,900,000	9,400,000	9,400,000	9,400,000
Asia:						
Burma	129	173	43	647	107	124
China	[6] 72,750	100,000	[6] 100,000	[6] 100,000	(7)	(7)
India	169,007	226,364	253,264	223,020	240,708	210,880
Indonesia	[6] 28,200	(7)	(7)	(7)	(7)	(7)
Japan	77,566	177,521	200,935	228,255	237,272	238,816
Korea:						
North	[6] 262,800	(7)	(7)	(7)	(7)	(7)
Republic of	[6] 5,510	7,620	18,647	15,882	52,406	47,037
Malaya	9,604	17,018	19,806	18,283	20,955	22,838
Philippines	179,429	393,602	469,408	480,625	416,052	419,112
Sarawak	794	931	843	442	531	463
Saudi Arabia	61,407	73,104	69,394	81,566	34,298	----------
Taiwan (Formosa)	15,952	30,511	33,147	24,821	21,541	28,100
Thailand	[6] 3,600	(7)	(7)	(7)	(7)	(7)
Total [6] [8]	887,000	1,290,000	1,430,000	1,440,000	1,440,000	1,390,000

See footnotes at end of table.

TABLE 19.—World production of gold, 1946–50 (average) and 1951–55, by countries,[1] in fine ounces[2]—Continued

Country[1]	1946–50 (average)	1951	1952	1953	1954	1955
Africa:						
Angola	375	61	40	20	36	57
Bechuanaland	3,829	493	1,245	1,109	1,216	560
Belgian Congo[10]	321,160	352,308	368,737	371,020	365,490	365,200
Egypt	5,301	16,469	17,059	14,234	17,387	6,524
Eritrea	2,522	675	699	1,363	1,484	[6] 1,500
Ethiopia	41,826	32,937	27,291	26,696	33,894	[6] 30,000
French Cameroon	10,050	5,422	2,604	1,022	686	518
French Equatorial Africa	63,542	52,849	51,655	54,180	45,307	46,548
French Morocco	615	2,069	4,051	2,533	3,566	4,270
French West Africa	53,475	5,700	1,500	1,608	418	225
Gold Coast	636,537	698,676	691,460	730,963	787,075	687,151
Kenya	23,659	19,765	10,210	9,603	6,607	9,528
Liberia	14,594	[5 11] 9,806	[5 11] 949	863	1,135	672
Madagascar	2,219	1,951	1,784	1,640	1,363	981
Mozambique	3,878	861	831	1,034	2,027	1,248
Nigeria	2,947	1,566	1,348	689	730	681
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia[12]	2,283	857	2,523	3,107	2,648	2,214
Southern Rhodesia	524,223	486,907	496,731	501,057	535,852	524,701
Sierra Leone	2,160	3,261	2,638	1,451	2,254	474
South-West Africa	124	---	---	---	---	7
Sudan	3,718	1,495	1,545	2,175	1,554	[6] 2,000
Swaziland	3,659	322	1	---	---	---
Tanganyika	57,504	65,583	64,693	69,886	71,447	68,892
Uganda (exports)	1,172	223	201	511	568	460
Union of South Africa	11,616,211	11,516,450	11,818,681	11,940,616	13,237,119	14,602,267
Total	13,398,000	13,275,000	13,570,000	13,740,000	15,120,000	16,350,000
Oceania:						
Australia:						
Commonwealth	881,136	895,551	980,435	1,075,181	1,117,077	1,048,744
New Guinea	63,913	94,085	122,431	120,568	86,195	73,980
Papua	390	248	149	141	318	873
Fiji	95,454	93,635	78,282	76,970	72,200	70,100
New Zealand	97,367	75,115	59,151	38,656	41,713	26,443
Total	1,138,260	1,158,634	1,240,448	1,311,516	1,317,503	1,220,140
World total (estimate)	30,000,000	33,500,000	34,300,000	33,700,000	35,100,000	36,400,000

[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).
[2] This table incorporates a number of revisions of data published in previous gold chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[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] Production is believed to have decreased because of a probable diversion of forced labor into other activities.
[10] Includes Ruanda-Urundi.
[11] Year ended September 30 of year stated.
[12] Included is yield from Nkana mine refinery slimes: 1946–50 (average), 2,081 ounces; 1951, 756; 1952, 2,503; 1953, 2,820; 1954, 2,470; and 1955, 2,203.

Gold output in 1954 and 1955 was distributed as follows: [5]

Province or Territory	Fine ounces 1954	Fine ounces 1955	Province or Territory	Fine ounces 1954	Fine ounces 1955
Ontario	2,361,385	2,526,199	Saskatchewan	101,785	83,800
Quebec	1,098,570	1,155,536	Yukon	82,208	74,380
Northwest Territories	308,563	321,044	Others [1]	10,477	4,636
British Columbia	268,508	256,470			
Manitoba	134,944	131,455	Total	4,366,440	4,553,520

[1] Alberta, Nova Scotia, and Newfoundland.

Of the total output in 1955, 87 percent came from straight-gold mines, both lode and placer, and 13 percent was recovered as a byproduct of base-metal mining.

The report of a Canadian Committee of Inquiry into the Economics of the Gold-Mining Industry stated that it foresaw no early solution to the problems of the gold-mining industry in the absence of a rise in the price of gold, discovery of new ore bodies, or significant technologic innovations. Nevertheless, the committee concluded, the industry should not be written off; the market for gold remains constant, production is still high, many workers are employed, and important communities depend upon it. The committee recommended continuance of Federal aid under the Emergency Gold Mining Assistance Act until some improvement occurs in the cost-price structure of the industry.

Colombia.—Output of gold from Colombia, the leading South American gold producer, was slightly higher in 1955 than in 1954. Most of the total output (381,000 ounces) was derived from placers.

Philippines.—Gold output of the Philippines rose slightly from 416,000 ounces in 1954 to 419,000 in 1955.

The subsidy program for domestic gold producers originally instituted in 1954 was modified by the Gold Subsidy Board in September 1955. Under the new arrangement domestic gold miners are required to sell at least 50 percent of their output to the Central Bank at net prices of ₱105 ($52.50) per ounce for marginal mines and ₱103 ($51.50) per ounce for nonmarginal mines; producers are permitted to sell the remaining 50 percent, either to the Central Bank at the same price, or in the local free market. The modified plan remained in effect to the end of the year and was reported to have helped strengthen the price of gold on the local free market.

The Masara mine, the first new gold mine to open since World War II, started production in October with a 250-ton mill. There were 13 gold producers during 1955, including 2 copper mines, that recovered byproduct gold and 2 small placer operations.

India.—Production of gold in India during 1955 was 211,000 ounces, representing a 12-percent decrease from the preceding year. The drop in production was attributed partly to labor disputes and partly to the effects of rockbursts in the latter part of 1954. The price of gold on the local market rose sharply in January and continued throughout the year at an average of 251 rupees ($52.71) per ounce.

[5] Department of Mines and Technical Surveys, Gold in Canada, 1955 (Prelim.): Ottawa, Canada, No. 9, p. 2.

Almost all the production of gold in India came from mines at the Kolar gold fields in Mysore State, managed by John Taylor & Sons, Ltd. The Mysore State Government was considering a proposal to nationalize the gold mines, with a view to increasing the State's revenue.

Union of South Africa.—Expansion of the gold-mining industry in the Union of South Africa, the world's largest gold producer, continued in 1955. Substantial increases both in tons milled and average grade resulted in establishing a new record in gold production of 14.6 million ounces, a 10-percent gain over 1954. The increased output came entirely from new mines in the Far West Rand, Klerksdorp, and Orange Free State areas, which more than offset lower output from older mines on the Rand. Some of these older mines were able to continue profitable gold production only because of the additional income derived from byproduct uranium. Improvement in the short supply of African labor and power supplies were factors that contributed to the increased milling rate.

In the Transvaal 45 mines were producing gold in 1955; in the Orange Free State 9 gold mines were in production during the year, and 3 others under development were nearing the production stage.

TABLE 20.—Salient statistics of gold mining in the Union of South Africa, 1946–50 (average), and 1951–55

[Transvaal Chamber of Mines]

	1946–50 (average)	1951	1952	1953	1954	1955
Ore milled (tons)	56,464,450	58,645,800	60,500,000	58,772,000	62,534,500	65,950,700
Gold recovered (fine ounces)	11,612,430	11,516,450	11,818,681	11,440,830	12,682,328	14,093,668
Gold recovered (dwt. per ton)	3.944	3.756	3.767	3.893	4.068	4.274
Working revenue	[1] £107,655,539	£137,494,860	£141,271,310	£142,198,156	£158,630,787	£177,414,094
Working revenue per ton	38s.0d.	46s.11d.	47s.1d.	48s.5d.	50s.11d.	53s.10d.
Working cost	£76,247,648	£93,494,860	£102,525,003	£107,306,956	£120,435,001	£133,161,104
Working cost per ton of ore	27s.0d.	31s.10d.	34s.2d.	36s.6d.	38s.8d.	40s.5d.
Working cost per ounce of metal	137s.0d.	169s.6d.	181s.6d.	187s.7d.	189s.11d.	189s.0d.
Working profit	£31,406,883	£44,157,054	£38,746,307	£34,891,200	£38,195,786	£44,252,990
Working profit per ton	11s.0d.	15s.1d.	12s.11d.	11s.11d.	12s.3d.	13s.5d.
Premium gold sales			£3,699,124	£1,934,421	£12,999	£233,942
Estimated uranium profits			£125,000	£1,828,067	£8,105,744	£17,558,208
Dividends	£16,152,883	£22,787,806	£19,804,928	£18,994,307	[2] £19,127,166	£22,361,887

[1] 1 £ valued at $4.03 (approx. average) from Jan. 1, 1946, to September 19, 1949; after that date, 1 £ valued at $2.80.
[2] Revised figure.

Graphite

By Donald R. Irving [1] and Eleanor V. Blankenbaker [2]

WORLD production of 290,000 short tons of natural graphite in 1955 was exceeded only by the alltime high of 299,000 tons in 1943 and the 294,000 tons reported in 1942. Most of the increase was attributable to the expanded output of amorphous graphite in the Republic of Korea.

Domestic production, imports, and consumption increased 10, 19, and 37 percent, respectively, reflecting the higher level of activity recorded for most industries during the year. All grades of graphite were in ample supply to meet the higher demand.

DOMESTIC PRODUCTION

Southwestern Graphite Co., Burnet, Tex., was the only producer of crystalline flake graphite in North America during 1955. Graphite Mines, Inc., Cranston, R. I., continued to produce amorphous graphite but reported a decrease in output for the year. There were no other domestic natural graphite producers.

TABLE 1.—Salient statistics of the graphite industry in the United States, 1954–55

	1954		1955	
	Short tons	Value	Short tons	Value
Domestic graphite produced	(1)	(1)	(1)	(1)
Domestic graphite sold	(1)	(1)	(1)	(1)
Natural graphite consumed [2]	33,038	$4,386,760	45,245	$6,289,416
Imports:				
Crystalline flake	8,464	1,198,665	7,706	1,018,600
Lump, chip, or dust	653	100,191	195	28,703
Amorphous (natural)	31,510	970,771	40,663	1,328,197
Artificial	212	11,629	236	11,130
Total imports	40,839	2,281,256	48,800	2,386,630
Exports:				
Crystalline flake, lump, or chip	49	18,806	141	47,720
Amorphous (natural)	608	66,802	1,141	129,876
Other natural graphite	141	19,990	112	21,787
Total exports	798	105,598	1,394	199,383

[1] Figure withheld to avoid disclosure of individual company operations.
[2] Minimum quantities as reported by consumers to the Bureau of Mines.

[1] Assistant chief, Branch of Ceramic and Fertilizer Materials.
[2] Literature-research clerk.

Manufactured (artificial) graphite powder and products were produced by National Carbon Co., a Division of Union Carbide & Carbon Corp., in plants at Niagara Falls, N. Y., Clarksburg, W. Va., and Columbia, Tenn.; Great Lakes Carbon Corp., in plants at Niagara Falls, N. Y., and Morganton, N. C.; International Graphite & Electrode Division, Speer Carbon Co., in plants at St. Marys, Pa., and Niagara Falls, N. Y.; and Stackpole Carbon Co., in a plant at St. Marys, Pa. The Dow Chemical Co. produced graphite electrodes for its own use at Midland, Mich.

TABLE 2.—Production and shipments of natural graphite in the United States, 1946–50 (average) and 1951–55

Year	Production (short tons)	Shipments		Year	Production (short tons)	Shipments	
		Short tons	Value			Short tons	Value
1946–50 (average)	6,223	6,148	$365,557	1953	6,281	4,850	$488,008
1951	7,135	6,808	771,434	1954–55	(1)	(1)	(1)
1952	5,606	5,081	594,618				

1 Figures withheld to avoid disclosure of individual company operations.

CONSUMPTION AND USES

The coverage of the consumption canvass in 1955 was comparable to that in 1954, when it was expanded to include data from many consumers who previously had not been requested to report. Consumption in 1955 increased 37 percent over 1954. Major increases were reported as follows: Foundry facings, 54 percent; lubricants, 51 percent; steelmaking, 38 percent; and crucibles, 37 percent.

TABLE 3.—Consumption of natural graphite in the United States, 1947–50 (average) and 1951–55

Year	Consumption		Year	Consumption	
	Short tons	Value		Short tons	Value
1947–50 (average)	18,823	$2,592,326	1953	34,884	$4,778,981
1951	38,318	5,083,527	1954	33,038	4,386,760
1952	26,911	4,048,787	1955	45,245	6,289,416

Graphite may be classified broadly as crystalline flake, Ceylon amorphous lump, and other amorphous. Although there is an area of interchangeability among these three types of graphite, the use patterns are distinctive enough to justify separate tabulations of the uses reported for each type. The 1955 data are presented in table 4.

TABLE 4.—Consumption of natural graphite in the United States in 1955, by uses

Use	Crystalline flake		Ceylon amorphous		Other amorphous [1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Batteries	99	$34,892			2,143	$143,246	2,242	$178,138
Bearings	22	17,887	72	$40,356	30	11,911	124	70,154
Brake lining	302	137,775	243	69,422	203	42,044	748	249,241
Carbon brushes	144	51,418	297	160,633	189	26,411	630	238,462
Crucibles, retorts, stoppers, sleeves, and nozzles	3,608	736,064	(2)	(2)	121	13,306	3,729	749,370
Foundry facings	695	120,848	722	141,734	16,383	1,302,499	17,800	1,565,081
Lubricants	1,585	438,663	2,003	548,072	2,838	337,822	6,426	1,324,557
Packings	270	142,412	91	42,380	139	21,282	500	206,074
Paints and polishes	88	11,483	(2)	(2)	666	28,274	754	39,757
Pencils	118	50,431	963	356,243	1,016	128,979	2,097	535,653
Rubber	34	13,492			121	15,781	155	29,273
Steelmaking	349	64,237	(2)	(2)	9,254	918,380	9,603	982,617
Other [3]	188	63,671	69	20,752	180	36,616	437	121,039
Total	7,502	1,883,273	4,460	1,379,592	33,283	3,026,551	45,245	6,289,416

[1] Includes small quantity of mixtures of natural and manufactured graphite.
[2] Included with "Other."
[3] Includes adhesives, carbon resistors, chemical equipment and processes, copper refining, electronic tubes, fillers, insulation, plastics, powdered-metal parts, roofing granules, specialties, welding electrodes, and other uses not specified, in addition to uses indicated by footnote 2.

PRICES

Price quotations for all grades of graphite, as reported in the trade journals, were unchanged during 1955. Quotations in E&MJ Metal and Mineral Markets were as follows per pound, carlots, f. o. b. shipping point (United States): 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; 98 percent carbon, special for brushes, etc., 26½ cents. Amorphous, natural, for foundry facings, etc., up to 85 percent carbon, 9 cents: Madagascar, c. i. f. New York, "standard grades, 85–88 percent carbon," $235 per short ton; special mesh, $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.

Quotations in Oil, Paint and Drug Reporter were as follows: Per pound, bags or fiber drums, ex warehouse, amorphous, powdered, 6 to 9½ cents; crystalline, 88–90 percent, powdered, 19 to 21½ cents; 90–92 percent, powdered, 21 to 24½ cents; 95–97 percent, powdered, 29 to 31½ cents; No. 1 Flake, 90–95 percent, 29 to 31 cents; No. 2 Flake, 90–95 percent, 29 to 31 cents.

FOREIGN TRADE [3]

Graphite imports for consumption in the United States increased 19 percent in quantity but only 5 percent in value from 1954. Increases ranging from 33 to 91 percent were reported for all countries of origin except Canada and Madagascar. The only natural graphite producer in Canada discontinued mining in 1954, and 1955 imports represented shipments from inventory. Imports from Madagascar decreased 17 percent in quantity and 24 percent in value.

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

TABLE 5.—Graphite (natural and artificial) imported for consumption in the United States, 1946–50 (average) and 1951–55

[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
1946–50 (average)	3,584	$388,163	229	$28,474	37,030	$1,224,282	75	$4,257	40,918	$1,645,176
1951	10,227	1,412,787	336	29,096	43,830	1,561,494	90	7,420	54,483	3,010,797
1952	8,878	1,473,516	67	10,733	33,504	1,357,035	337	18,502	42,786	2,859,786
1953	10,579	1,608,960	79	7,958	40,382	1,176,613	283	15,647	51,323	2,809,178
1954										
North America:										
Canada	141	32,065	11	1,129	1,878	160,263	192	10,098	2,222	203,555
Mexico					24,844	414,845			24,844	414,845
Total	141	32,065	11	1,129	26,722	575,108	192	10,098	27,066	618,400
Europe:										
Germany, West	226	34,071	38	10,848	491	48,617	17	693	772	94,229
Italy							3	838	3	838
Norway					877	66,602			877	66,602
Total	226	34,071	38	10,848	1,368	115,219	20	1,531	1,652	161,669
Asia:										
Ceylon			75	9,980	2,486	257,169			2,561	267,149
Hong Kong					881	19,782			881	19,782
India					2	358			2	358
Total			75	9,980	3,369	277,309			3,444	287,289
Africa:										
British East Africa	34	5,496			51	3,135			85	8,631
Madagascar	8,063	1,127,033	529	78,234					8,592	1,205,267
Total	8,097	1,132,529	529	78,234	51	3,135			8,677	1,213,898
Grand total 1954	8,464	1,198,665	653	100,191	31,510	970,771	212	[1] 11,629	40,839	[1] 2,281,256
1955										
North America:										
Canada					108	1,967	5	406	113	2,373
Mexico					32,801	597,411	173	3,061	32,974	600,472
Total					32,909	599,378	178	3,467	33,087	602,845
Europe:										
Austria					3	583			3	583
France	32	14,109							32	14,109
Germany, West	485	81,709	72	11,636	503	53,149	17	604	1,077	147,098
Norway					1,676	133,564			1,676	133,564
Switzerland							13	4,293	13	4,293
Total	517	95,818	72	11,636	2,182	187,296	30	4,897	2,801	299,647
Asia:										
Ceylon			123	17,067	4,093	504,970	28	2,766	4,244	524,803
Hong Kong					1,230	26,762			1,230	26,762
Japan					112	2,312			112	2,312
Total			123	17,067	5,435	534,044	28	2,766	5,586	553,877
Africa:										
British East Africa	34	4,593			92	5,648			126	10,241
Madagascar	7,155	918,189							7,155	918,189
Mozambique					45	1,831			45	1,831
Total	7,189	922,782			137	7,479			7,326	930,261
Grand total 1955	7,706	1,018,600	195	28,703	40,663	1,328,197	236	11,130	48,800	2,386,630

[1] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.

TABLE 6.—Graphite exported from the United States, 1954–55, by countries of destination

[U. S. Department of Commerce]

Country	Amorphous		Crystalline flake, lump, or chip		Natural, n. e. c.	
	Short tons	Value	Short tons	Value	Short tons	Value
1954						
North America:						
Canada	443	$41,568	10	$6,063	70	$4,234
Cuba	8	1,075	8	2,860		
Dominican Republic					1	1,050
Mexico	9	1,787	2	1,506		
Total	460	44,430	20	10,429	71	5,284
South America:						
Brazil					2	975
Colombia	3	617				
Ecuador			6	1,320		
Peru			1	1,126		
Venezuela			2	647	2	2,790
Total	3	617	9	3,093	4	3,765
Europe:						
Austria	3	548				
Denmark					10	2,030
France	11	1,415			8	1,272
Germany, West	16	2,230			22	3,033
Italy	10	1,200	1	627		
Netherlands			(1)	536		
Sweden	2	638				
United Kingdom	86	12,512				
Total	128	18,543	1	1,163	40	6,335
Asia:						
India			1	641		
Philippines	15	2,463	18	3,480	26	4,606
Total	15	2,463	19	4,121	26	4,606
Africa: Belgian Congo	2	749				
Grand total 1954	608	66,802	49	18,806	141	19,990
1955						
North America:						
Canada	700	59,643	28	13,774	9	2,311
Cuba			24	6,701		
Mexico			7	4,684		
Netherlands Antilles			3	1,500		
Total	700	59,643	62	26,659	9	2,311
South America:						
Chile			18	7,956		
Colombia	5	740	3	1,107		
Ecuador			10	1,900		
Venezuela	5	893	2	546	5	915
Total	10	1,633	33	11,509	5	915
Europe:						
Austria	6	936			3	549
France	17	3,011				
Germany, West	25	3,519			11	1,568
Greece	11	1,461				
Netherlands			1	1,220		
Switzerland					6	926
United Kingdom	366	58,413			33	5,331
Total	425	67,340	1	1,220	53	8,374
Asia:						
India					27	4,633
Israel			1	550		
Philippines	6	1,260	14	4,222	18	5,554
Total	6	1,260	15	4,772	45	10,187
Oceania: Australia			30	3,560		
Grand total 1955	1,141	129,876	141	47,720	112	21,787

[1] Less than 1 ton.

The United States tariff rates on graphite, effective January 1, 1948, remained in force during 1955. They were: 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.

Total exports of natural graphite, 1951–53, were: 1951, 1,504 tons, $195,948; 1952, 1,786 tons, $211,125; 1953, 1,760 tons, $200,110. Data for 1954 and 1955, by countries of destination and tariff classifications, are shown in table 6.

TECHNOLOGY

The general properties of manufactured (artificial) graphite were described in a handbook issued by the Atomic Energy Commission to assist workers in the reactor field and to acquaint science and industry generally with techniques, processes, and equipment.[4] The report stated:

> Elemental carbon may be employed with considerable success in heterogeneous nuclear reactors as a moderator and as a reflector because of its low atomic weight, low neutron-absorption cross section, and high neutron-scattering cross section. Manufactured carbon products are predominantly of two types, both of which may be of the same raw materials. When the material is heated only to 2,750° F., it is known as "industrial carbon." It is extremely hard and has a low thermal conductivity and high electrical resistivity. When the material is heated to 4,500° F. or higher, it is known as "artificial graphite," "electro-graphite," or simply "graphite"; this product is easily machined and has a high thermal conductivity and a low electrical resistivity. Large quantities of both types of carbon are used commercially. However, owing to the ease of machining and the somewhat greater purity of artificial graphite, the data in this chapter pertain primarily to this form.
>
> The high strength of graphite at elevated temperatures, its exceedingly high melting point, and its excellent resistance to rupture by thermally induced stresses make the material of potentially great value in high-temperature reactors and possibly in auxiliary associated equipment. In homogeneous reactors, graphite is proposed to serve as the continuous phase of solid fuel elements and to contribute a moderating value in addition to a structural value. Graphite is susceptible to radiation damage at low temperatures and to corrosion by certain fluids at high temperatures.

The report includes data on commercial preparation, preparation for reactor use, grades, physical and chemical constants, crystallography, mechanical properties, forming and fabrication, and reaction with corrosive materials.

During 1955, the Atomic Energy Commission declassified a number of reports dealing with the properties of graphite.[5]

---

[4] Slyh, J. A., Graphite: The Reactor Handbook, vol. 3, sec. 1, General Properties of Materials, Atomic Energy Commission, March 1955, pp. 133–153.

[5] The following references were cited in U. S. Government Research Reports, Office of Technical Services, U. S. Dept. of Commerce (page number in parentheses after each reference):

Vol. 25, No. 2, Feb. 17, 1956:

Prosen, E. J., and Valent, D. R., The Energy Content of Irradiated Graphite Samples: Nat. Bur. of Stand. Rept. NBS-D-106, November 1951, 6 pp. (p. 81).

Spalaris, C. N., Adsorption Properties of Virgin and Irradiated Graphite: Hanford Atomic Products Operations, Richland, Wash., Contract No. W-31-109-Eng-52, November 1954, 85 pp. (p. 79).

Vol. 25, No. 5, May 20, 1956:

Bankoff, S. G., Cabell, C. P., and Rosner, G., Thermal Warping of Graphite Pile: Univ. of Chicago Metallurgical Lab., Chicago, Ill., September 1943, 9 pp. (p. 254).

Binner, C. R., Miller, Philip, and Comsey, K. W., Machining of Graphite for Brookhaven Reactor H. K. Ferguson Co., New York, N. Y., Contract AT-30-2-gen-16, June 1949, 75 pp. (p. 257).

Bowen, D., The Electrical Conductivity of Irradiated Graphite, Part I: North American Aviation, Inc., Los Angeles, Calif., Contract AT-11-1-gen-8, September 1949, 13 pp. (p. 260).

(Footnote continued on p. 519)

The properties of graphite were described in various technical papers published during the year.[6]

Methods of estimating the quantities of graphitic and amorphous carbon by X-ray diffraction and a suggested "sink-float" test were compared.[7]

Applications of manufactured (artificial) graphite in atomic power production [8] and the use of carbon and graphite products in the chemical, metallurgical and foundry industries [9] were discussed. The production of graphite crucibles, the composition of the mix used in different types of applications, the source of the graphite used, its particle size, and its structure were abstracted from a foreign publication [10] and safety and economic considerations for handling, storing, and use of graphite crucibles were discussed.[11]

---

[6] Austerman, S. B., and Hove, J. E., Irradiation of Graphite at Liquid Helium Temperatures: Phys. Rev., vol. 100, 2d ser., No. 4, Nov. 15, 1955, pp. 1214–1215.
Austin, A. E., and Harrison, R. J., Interpretation of the Stored Energy of Irradiated Graphite in Terms of Elastic Energy Associated with Microscopic Strains: Phys. Rev., vol. 100, 2d ser., No. 4, Nov. 15, 1955, pp. 1225–1226.
Baskin, Y., and Meyer, L., Lattice Constants of Graphite at Low Temperatures: Phys. Rev., vol. 100, 2d ser., No. 2, Oct. 15, 1955, p. 544.
Berlincourt, T. G., and Steele, M. C., Oscillatory Hall Effect, Magnetoresistance, and Magnetic Susceptibility of a Graphite Single Crystal: Phys. Rev., vol. 98, 2d ser., No. 4, May 15, 1955, pp. 956–961.
Colladay, G. S., Resonance Energy of Graphite: Jour. Chem. Phys., vol. 22, No. 12, December 1954, pp. 2085–2086.
DeSorbo, W., Low Temperature Heat Capacity of Ceylon Graphite: Jour. Am. Chem. Soc., vol. 77, No. 18, Sept. 20, 1955, pp. 4713–4715.
DeSorbo, W., Specific Heat of Graphite at Very Low Temperatures: Jour. Chem. Phys., vol. 23, No. 10, October 1955, pp. 1970–1971.
Edwards, R. K., and Downing, J. H., Mechanisms of Permeation: Jour. Phys. Chem., vol. 59, No. 10, October 1955, pp. 1079–1083.
Gomer, R., and Meyer, L., Energy Exchange Between Cold Gas Molecules and a Hot Graphite Surface: Jour. Chem. Phys., vol. 23, No. 7, July 1955, p. 1370.
Heindl, R. A., and Mohler, N. F., Oxidation Studies of Some Natural Graphites: Jour. Am. Ceram. Soc., vol. 38, No. 3, Mar. 1, 1955, pp. 89–94.
Hove, J. E., Electronic Density of States of Graphite: Phys. Rev., vol. 97, 2d ser., No. 6, Mar. 15, 1955, pp. 1717–1718.
Hove, J. E., Theory of the Magnetic Susceptibility of Graphite: Phys. Rev., vol. 100, 2d ser., No. 2, Oct. 15, 1955, pp. 645–649.
Johnston, D. F., The Structure of the π-band of Graphite: Proc. Roy. Soc. (London), vol. 227, ser. A, No. 1170, Jan. 20, 1955, pp. 349–358.
Johnston, D. F., A Theory of the Hall Effect in Graphite: Proc. Roy. Soc. (London), vol. 227, ser. A, No. 1170, Jan. 20, 1955, pp. 359–367.

(Footnotes continued on p. 520.)

(Footnote continued from p. 518)

Eatherly, W. P., and Donoghue, J. J., A New Circuit for Precision Measurement of the Hall and Magneto-Resistive Effects with Results of Observations on Reactor Irradiated Graphite: North American Aviation, Inc., Los Angeles, Calif., April 1950, 33 pp. (p. 261).
Gilmore, F. H., Malmstrom, C. R., and Jarrett, A. A., Technique of Resistivity Measurements on Cyclotron Bombarded Graphite: North American Aviation, Inc., Los Angeles, Calif., Contract AT-11-1-gen-8, April 1949, 17 pp. (p. 260).
Gorton, A. F., and Malmstrom, C., Tensile Strength of Type EBP Graphite at Elevated Temperatures and Its Relation to Apparent Density at Room Temperature: North American Aviation, Inc., Los Angeles, Calif., March 1950, 8 pp. (p. 261).
Hennig, Gerhart, A Comparison of the Effect of Oxidation and the Effects of Neutron Irradiation on Graphite: Argonne National Lab., Lemont, Ill., Contract W-31-109-eng-38, February 1952, 20 pp. (p. 253).
Johnson, P. A., Filler Block Graphite Sample Report. Final Report on Production Test 105-329-P: Hanford Works, Richland, Wash., Contract W-31-109-eng-52, December 1955, 7 pp. (p. 258).
Riley, W. C., and Corners, A. M., Effect of Process Variables on Graphite Purity: Hanford Atomic Products Operation, Richland, Wash., Contract W-31-109-eng-52, July 1954, 14 pp. (p. 258).
Ross, W. L., Purification of Graphite: Carbide and Carbon Chemicals Corp., Oak Ridge, Tenn., Contract W-7405-eng-26, November 1948, 32 pp. (p. 247).
Ross, W. L., and Graham, C. B., Purification of Graphite: Carbide and Carbon Chemicals Corp. Y-12 Plant, Oak Ridge, Tenn., Contract W-7405-eng-26, March 1948, 15 pp. (p. 262).
Sermon, G. T., Purification of Graphite: United Carbon Products Co., Inc., Bay City, Mich., Contract AT-30-1-gen-127, June 1948, 25 pp. (p. 253).
Simon, A. W., Erosion of Graphite by Steel Shot: Chicago, Univ. Metallurgical Lab., December 1942, 4 pp. (p. 254).
Smith, A. W., and McClelland, J. D., Electronic Properties of a Graphitized Lamp-Black and Their Dependence on Neutron Irradiation: North American Aviation, Inc., Downey, Calif., Contract AT-11-1-gen-8, June 1953, 26 pp. (p. 261).
Vol. 25, No. 6, June 15, 1956:
Cochran, R. G., Flynn, J. D., Henry, K. M., and Estabrook, G., Reactor Radiations Through Slabs of Graphite: Oak Ridge National Lab., Oak Ridge, Tenn., Contract W-7405-eng-26, July 1954, 22 pp. (p. 354).

A graphite abrasion tester and procedure for evaluation of the abrasive properties of graphites used for lubricating purposes were approved as tentative standards during the year by the American Society for Testing Materials.[12]

The design and construction of graphite furnaces were described.[13]

The low first cost, nonsolubility in molten bronze, and high heat-transfer rate of manufactured graphite dies made possible continuous casting of large-diameter solid, tubular, and intricate cast-bronze shapes.[14] Variable resistors, used to control the flow of current to the transmitter and receiver of a telephone were manufactured from a mixture of graphite, silicon carbide, and clay.[15]

WORLD REVIEW

World production of natural graphite in 1955 increased 57 percent over 1954, reversing the downward trend that began in 1952. The 1955 total was exceeded only by the alltime high of 299,000 short tons reported in 1943 and the 294,000 short tons reported in 1942. Most of the increase resulted from the expanded output of amorphous graphite in the Republic of Korea. Substantial increases also were reported for Ceylon, Madagascar, and Mexico. Decreases were reported for Hong Kong, Italy, and Japan.

12 ASTM Standards, Part 5, Tentative Method of Test for Lubricating Qualities of Graphite: ASTM Designation: D1367-55T, 1955, pp. 778-781.
13 Almond, L. H., and Albrecht, W. L., How To Build a Graphite Furnace: Chem. Eng., vol. 62, No. 9, September 1955, pp. 179-182.
Chard, E. A., Construction of an Experimental Graphite Resistance Furnace: Iron and Coal Trade Rev., vol. 171, No. 4559, Aug. 26, 1955, pp. 495-497.
14 E & MJ Metal & Mineral Markets, vol. 26, No. 46, Nov. 17, 1955, p. 7.
15 Pacific Coast Ceramic News, vol. 4, No. 5, May 1955, p. 7.

(Footnotes continued from p. 519)

Keating, D. T., X-ray Measurements on Low-temperature Neutron-irradiated Graphite: Phys. Rev., vol. 98, 2d ser., No. 6, June 15, 1955, pp. 1859-1860.
Keesom, P. H., and Pearlman, N., Atomic Heat of Graphite Between 1° and 20° K: Phys. Rev., vol. 99, 2d ser., No. 4, Aug. 15, 1955, pp. 1119-1124.
Kinchin, G. H., Changes in the Electrical Properties of Graphite Due to Neutron Irradiation: Jour. Nuclear Energy, vol. 1, No. 2, December 1954, pp. 124-129.
Liljeblad, Ragnar, Equilibrium Pressure for Different Temperatures Between Graphite and Diamond: Arkiv. Kemi, vol. 8, 1955, pp. 423-432 (in English); Chem. Abs., vol. 50, No. 4, Feb. 25, 1956, p. 2266i.
Lomer, W. M., The Valence Bands in Two-dimensional Graphite: Proc. Roy. Soc. (London), vol. 227, ser. A, No. 1170, Jan. 20, 1955, pp. 330-349.
Petersen, E. E., Wright, C. C., and Walker, P. L., Jr., Reaction of Artificial Graphite With Carbon Dioxide: Ind. Eng. Chem., vol. 47, No. 8, August 1955, pp. 1624-1634.
Taft, E., and Apker, L., Photoelectric Emission from Polycrystalline Graphite: Phys. Rev., vol. 99 2d ser., No. 6, Sept. 15, 1955, pp. 1831-1832.
Thorn, R. J., and Winslow, G. H., Rate of Evaporation of Graphite: Jour. Chem. Phys., vol. 23, No. 7, July 1955, p. 1369.
7 Walker, P. L., Jr., Rakszawski, J. F., and Armington, A. F., Distinguishing Between Graphitic and Amorphous Carbon: ASTM Bull. 208, September 1955, pp. 52-54.
8 Hinton, C., Graphite-moderated Gas-cooled Pile; Its Place in Power Production: Chem. Eng. Prog., vol. 51, No. 10, October 1955, pp. 442-444.
Starr, C., Sodium Graphite Reactor Power Plants: Power, vol. 99, No. 7, July 1955, p. 152.
9 Gaylord, W. M., Carbon and Graphite: Ind. Eng. Chem., vol. 47, No. 9, part 2, September 1955, pp. 1953-1955, 2051.
Mader, W. A., Colloidal Graphite Mixtures Aid Nonferrous Casting Techniques: Iron Age, vol. 175, No. 9, Mar. 3, 1955, pp. 124-126. Colloidal Graphite in the Foundry: Modern Metals, vol. 11, No. 4, May 1955, pp. 40-41.
Swartz, C. E., Carbon—a Neglected Metallurgical Tool?: Metal Prog., vol. 67 No. 2, February 1955, pp. 77-81.
10 Lex, Walter, Technology of Graphite Crucibles: Berg-u. Huttenmann Monatsh Montan. Hochschule Leoben, vol. 97, No. 6, 1952, pp. 107-108, abs. in Jour. Inst. Metals (London), vol. 83, No. 11, July 1955, p. A 1098.
11 Halliday, W. M., The Use and Care of Crucibles: Foundry, vol. 83, No. 3, March 955, pp. 106-109.

TABLE 7.—World production of natural graphite, by countries,[1] 1946–50, (average) and 1951–55, in short tons [2]

(Compiled by Helen L. Hunt)

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	2,529	1,569	2,040	3,466	2,463	----------
Mexico	29,460	36,691	26,623	33,433	24,013	32,342
United States	6,224	7,135	5,606	6,281	(3)	(3)
South America:						
Argentina	[4] 440	(5)	(5)	(5)	(5)	2
Brazil	3,708	672	938	648	1,008	(5)
Europe:						
Austria	9,805	20,092	21,728	16,185	19,184	19,637
Czechoslovakia	[4] 12,125	(5)	(5)	(5)	(5)	(5)
Germany, West	5,764	11,970	9,880	8,222	10,448	11,556
Italy	6,939	4,976	4,837	5,731	4,139	3,035
Norway	1,971	3,806	4,542	3,255	3,993	5,970
Spain	316	302	863	352	451	1,207
Sweden	39	----------	----------	----------	----------	----------
Yugoslavia	----------	----------	757	----------	----------	1,033
Asia:						
Ceylon (exports)	12,577	14,136	8,578	8,084	8,655	11,064
Hong Kong	----------	----------	----------	220	2,061	1,722
India	1,583	1,943	2,405	859	1,657	(5)
Japan	8,114	5,361	5,126	4,488	4,515	3,385
Korea, Republic of	[4] 19,500	26,074	16,601	21,416	15,344	99,228
Taiwan (Formosa)	----------	----------	772	----------	----------	----------
Africa:						
Egypt	11	----------	----------	----------	----------	----------
French Morocco	325	144	23	108	----------	----------
Kenya	----------	----------	39	205	347	241
Madagascar	9,331	20,214	20,368	14,847	13,284	16,194
Mozambique	116	265	----------	----------	----------	----------
South-West Africa	1,787	2,895	1,305	----------	115	1,011
Spanish Morocco	[4] 65	----------	19	----------	----------	129
Tanganyika	----------	28	----------	21	----------	(5)
Union of South Africa	225	362	389	413	1,396	1,829
Oceania: Australia	258	52	89	17	78	24
World total (estimate) [1]	155,000	220,000	205,000	200,000	185,000	290,000

[1] In addition to countries listed, graphite has been produced in China, North Korea, 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. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[3] Production included in total: Bureau of Mines not at liberty to publish.
[4] Estimate.
[5] Data not available; estimate by senior author of chapter included in total.

Argentina.—Late in May 1955 the Argentine Mining Union made a formal request to the Central Bank asking it to cease granting import licenses for a number of minerals, including graphite, on the grounds that these materials were not only available locally in quantities sufficient to meet domestic needs but that further imports would be an unnecessary drain of foreign exchange.[16]

Australia.—Deposits 70 miles from Esperance, on the south coast of Australia, were reported to contain 5 million tons of ore averaging 35 percent graphite.[17]

Austria.—Exports of graphite from Austria in 1954 were 14,093 short tons (12,785 metric tons). The main countries of destination were West Germany, 8,139 short tons; Italy, 1,862 short tons; and Poland, 2,134 short tons; representing 86 percent of total exports.[18]

Canada.—Preliminary diamond drilling on a deposit of disseminated graphite in Thorne and Clarendon Townships, 10 miles north of

[16] Engineering and Mining Journal, vol. 156, No. 7, July 1955, p. 174.
[17] Foreign Commerce Weekly, vol. 54, No. 12, Sept. 19, 1955, p. 12.
[18] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 3, September 1955, p. 46.

457676—58——34

Shawville, Quebec, was reported to have disclosed a large tonnage of ore amenable to open-pit mining.[19]

Ceylon.—Graphite exports from Ceylon, 1951–55, by countries of destination, and 1955 exports to the United States, by grade, are given in tables 8 and 9. Minimum wage rates in the graphite industry of Ceylon, established by the Wages Board, are listed in table 10.

TABLE 8.—Graphite exported from Ceylon, 1951–55, by countries of destination, in short tons [1]

(Compiled by Corra A. Barry)

Country	1951	1952	1953	1954	1955
North America:					
Canada	191	28	112	196	453
United States	5,513	2,539	1,938	2,054	4,234
Europe:					
Belgium		103			
Denmark	56				
France	136	143	83	163	198
Germany	86	97	77	20	95
Italy	108	3		8	8
Netherlands	17			11	40
Poland	113				
Rumania		100			
Sweden	29				
United Kingdom	5,720	3,374	3,429	4,172	3,624
Yugoslavia		112			
Asia:					
Hong Kong	13			8	7
India	398	244	417	274	535
Japan	715	1,122	1,588	1,219	1,306
Malaya	2	212			
Pakistan	68	20		91	118
Thailand	47	3	9		
Oceania:					
Australia	886	476	303	437	444
New Zealand	1				
Other countries	36	1	128	1	2
Total	14,135	8,577	8,084	8,654	11,064

[1] Compiled from Ceylon Customs Returns.

TABLE 9.—Exports of graphite from Ceylon to the United States, by grades, 1955 [1]

Grade	Short tons	Percent of total	Value per ton
97 percent C, or higher	1,650	40.4	$168.92
90–96 percent C	1,930	47.2	130.99
Less than 90 percent C	505	12.4	105.50
Total	4,085	100.0	$143.16

[1] State Department Dispatches, Ceylon, No. 552, May 4, 1955, pp. 1–2; No. 131, Aug. 19, 1955, pp. 1–2; No. 342, Nov. 2, 1955, pp. 1–2; No. 689, Mar. 2, 1956, pp. 1–2.

Korea, Republic of.—The production of amorphous graphite in 1955 was more than 6 times that in 1954 and had a value of about $1.6 million. Most of the output went to Japan.

[19] Engineering and Mining Journal, vol. 156, No. 5, May 1955, p. 168.

TABLE 10.—Daily minimum wages in the graphite industry of Ceylon, 1955, in U. S. dollars [1]

	Basic rate	Average special allowance	Total
Underground workers:			
Bosses	$0.5746	$0.2424	$0.8170
Kanganies,[2] leaders, overseers	.4702	.2424	.7126
Shift bosses	.4347	.2424	.6771
Blasters, drillers (hand and machine), shaft drivers, stopers (excavators), timbermen	.4180	.2424	.6604
Muckers, trolleymen, unskilled laborers	.3134	.2424	.5558
Onsetters [3]	.4702	.2424	.7126
Underground and surface workers:			
Electricians, enginemen, fitters, hoistmen, mechanics, pumpmen, winchmen	.5225	.2424	.7649
Checkers	.4702	.2424	.7126
Electricians' and fitters' assistants, windlassmen	.3134	.2424	.5558
Surface workers (mine):			
Carpenters, masons	.5225	.2424	.7649
Overseers	.4702	.2424	.7126
Blacksmiths, boilermen, drill sharpeners	.4180	.2424	.6604
Firewood carriers and splitters	.3343	.2424	.5767
Carters, watchers	.3134	.2424	.5558
Bakkikarayas [4]	.4180	.2424	.6604
Cooks, smithy boys, unskilled laborers	.2591	.2424	.5015
Workers in curing and dressing yards:			
Overseers and kanganies	.4180	.2842	.7022
Others—in Colombo area: [5]			
Male, 18 or older	.2612	.2842	.5454
Female, 18 or older	.2089	.2236	.4325
Under 18 years	.1045	.2089	.3134
Others—outside Colombo area:			
Male, 18 or older	.2089	.2842	.4931
Female, 18 or older	.1755	.2236	.3991
Under 18 years	.0836	.2089	.2925

[1] U.S.$=4.786 Ceylon rupees (ave. 1955).
[2] Overseers of unskilled laborers.
[3] Probably skip attendants.
[4] Workers who maintain sluiceways that carry off water pumped to the surface.
[5] "Colombo area" includes any place within 5 miles of municipal limits of Colombo. Source: Ceylon Labor Gazette, vol. 6, Nos. 1–12, January–December 1955.

Tanganyika.—The Tanganyika Geological Survey Department reported that a member of the United Nations Technical Assistance Mineral Exploration team, working with the Survey Department, investigated large graphite deposits in the eastern Uluguru Mountains about 100 miles west of Dar es Salaam. The deposits appear to be low grade.[20]

Yugoslavia.—After extensive and difficult preparations in 1954 graphite mining was begun in 1955 on a deposit in Servia near Donja Ljubjana, in the Bosiljgrad district. The ore contained from 6 to 20 percent graphite. The extent of reserves was not established.[21]

[20] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 37.
[21] State Department Dispatch, Belgrade, Yugoslavia, No. 218, Nov. 22, 1955, pp. 19–20.

Gypsum

By Leonard P. Larson[1] and Nan C. Jensen[2]

SPURRED by the high level of building activity in 1955, the gypsum industry established new records for producing crude gypsum and many of its manufactured products. Capacity was increased during the year by expanding existing facilities and establishing mines and plants in new and important market areas. As a result of the unprecedented demand for gypsum products, several of

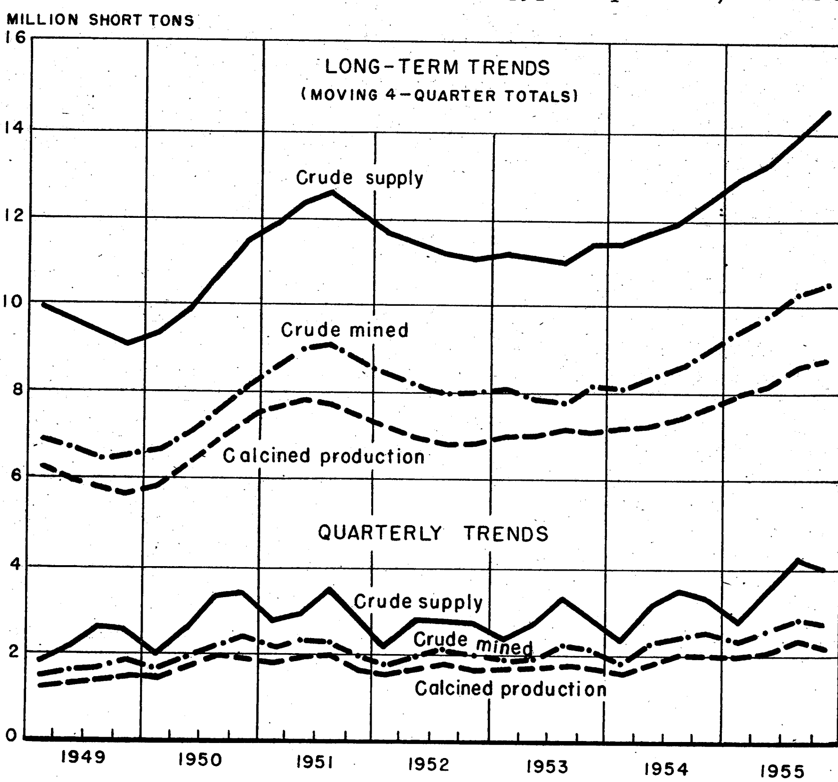

FIGURE 1.—Trends of new crude supply, domestic crude mined, and production of calcined gypsum 1949–55, by quarters.

the Nation's leading producers revised their programs for greater expansion, despite the fact that plants erected under the original program were just coming into production.

[1] Commodity specialist.
[2] Statistical assistant.

TABLE 1.—Salient statistics of the gypsum industry in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Active establishments [1]	89	85	89	94	86	83
Crude gypsum: [2]						
Mined short tons	6,778,578	8,665,534	8,415,300	8,292,876	8,995,960	10,683,733
Imported do	2,457,205	3,436,927	3,087,884	3,184,292	3,368,133	3,965,849
Apparent supply do	9,235,783	12,102,461	11,503,184	11,477,168	12,364,093	14,649,582
Calcined gypsum produced:						
Short tons	[3] 5,706,432	7,454,916	6,874,432	7,166,005	7,617,617	8,848,029
Value	[3] $44,415,833	$65,761,032	$59,696,410	$66,668,981	$76,170,562	$88,575,600
Gypsum products sold: [4]						
Uncalcined uses:						
Short tons	2,005,133	2,530,379	2,705,727	2,656,446	2,745,571	2,938,108
Value	$7,016,929	$9,413,098	$9,616,780	$9,844,330	$10,592,392	$11,435,694
Industrial uses:						
Short tons	222,341	288,713	252,216	254,148	250,088	299,119
Value	$3,682,935	$5,467,803	$4,999,779	$5,260,875	$5,383,874	$6,337,055
Building uses:						
Value	$142,470,770	$220,954,226	$210,307,189	$229,948,261	$256,176,655	$301,550,728
Total value	$153,170,634	$235,835,127	$224,923,748	$245,053,466	$272,152,921	$319,323,477
Gypsum and gypsum products:						
Imported for consumption	$2,780,778	$3,813,892	$3,694,975	$4,792,191	[5] $5,377,710	[5] $7,264,359
Exported	$1,392,895	$1,584,488	$1,216,294	$1,993,671	$1,600,477	$1,348,068

[1] Each mine, plant, or combination mine and plant is counted as 1 establishment.
[2] Excludes byproduct gypsum.
[3] Includes production from small quantity of byproduct gypsum in 1946.
[4] Made from domestic, imported, and byproduct gypsum.
[5] Owing to changes in tabulating procedures by U. S. Department of Commerce data known not to be comparable with previous years.

DOMESTIC PRODUCTION

Crude.—Production of crude gypsum from mines in the United States totaled 10.7 million short tons in 1955, an increase of 1.7 million tons over the previous record production of 9.0 million established in 1954. Tonnage-wise, this represents the greatest gain in output since 1946, when the net increase totaled 1.8 million tons. Compared with 1954, increased tonnages were mined in all States reporting separately and in groupings of States, despite the net loss of six active mines. Mining was discontinued at 4 mines in California and 1 each in Nevada, Colorado, New Mexico, and Wyoming; 2 properties were opened in Indiana. Of the 60 mines producing gypsum in 1955, 41 were open pit, 15 underground, and 4 combinations of the two types.

TABLE 2.—Crude gypsum mined in the United States, 1953–55, by States [1]

State	Active mines			1953		1954		1955	
	1953	1954	1955	Short tons	Value	Short tons	Value	Short tons	Value
California	16	15	11	1,199,489	$2,855,983	1,161,502	$2,803,862	1,307,625	$3,273,724
Iowa	4	4	4	1,151,692	2,939,654	1,106,626	3,035,651	1,337,160	4,176,710
Michigan	4	4	4	1,446,973	4,091,002	1,693,279	5,035,550	1,762,105	5,660,587
Nevada	4	4	3	701,584	1,975,053	654,422	2,217,273	836,744	2,835,922
New York	5	5	5	987,156	3,507,207	1,133,579	4,005,353	1,249,119	4,403,895
Texas	5	6	6	1,067,854	2,860,633	1,218,048	3,773,230	1,349,434	4,219,652
Other:									
Arizona	1	2	2						
Arkansas	1	1	1						
Colorado	5	5	4						
Idaho	1	1	1						
Indiana	----	----	2						
Kansas	2	2	2	586,301	1,323,430	696,215	1,613,529	1,291,933	3,181,245
Louisiana	1	1	1						
Montana	2	2	2						
New Mexico	----	1	----						
South Dakota	----	1	1						
Washington	1	1	1						
Wyoming	1	3	2						
Ohio	2	2	2						
Oklahoma	3	3	3	1,151,827	3,622,111	1,332,289	4,899,067	1,549,613	6,185,825
Utah	2	2	2						
Virginia	1	1	1						
Total	61	66	60	8,292,876	23,175,073	8,995,960	27,383,515	10,683,733	33,937,560

[1] Production of some States not shown separately to avoid disclosure of individual company operations.

Calcined.—Fifty plants, with 248 pieces of calcining equipment, produced a record tonnage of 8.8 million short tons of calcined gypsum during 1955. The quantity of gypsum produced during the year was 16 percent higher than in the previous year, when production totaled 7.6 million short tons. The tonnage of gypsum calcined is considered a good barometer of the industry, as it includes imported as well as domestic material.

TABLE 3.—Calcined gypsum produced in the United States, 1954–55, by districts

District	1954		1955	
	Short tons	Value	Short tons	Value
New Hampshire, Massachusetts, and Connecticut	280,957	$2,833,861	316,419	$2,900,903
Eastern New York, New Jersey, Pennsylvania, Georgia, and Florida	1,427,986	14,180,366	1,582,159	15,143,958
Ohio, Virginia, Indiana, and Maryland	1,106,321	12,496,485	1,445,730	14,985,471
Western New York	722,966	6,934,060	827,105	7,811,057
Michigan	679,511	6,325,619	686,346	6,833,912
Iowa	758,379	7,217,016	890,560	9,367,815
Kansas and Oklahoma	460,530	3,965,093	536,017	4,852,669
Texas	820,778	8,796,259	927,890	10,590,741
Colorado, Montana, Utah, and Washington	286,978	3,585,491	375,952	4,604,548
California and Nevada	1,073,211	9,836,312	1,259,851	11,484,526
Total	7,617,617	76,170,562	8,848,029	88,575,600

TABLE 4.—Active calcining plants and equipment in the United States, 1953–55, by States

State	1953			1954			1955		
	Calcining plants	Equipment		Calcining plants	Equipment		Calcining plants	Equipment	
		Kettles	Other calciners [1]		Kettles	Other calciners [1]		Kettles	Other calciners [1]
California	5	12	8	5	12	8	5	12	9
Iowa	5	22	4	5	21	4	4	21	4
Michigan	4	20	1	4	20		4	20	
New York	7	22	6	7	21	7	7	21	6
Texas	4	31	1	4	28		4	29	
Other States [2]	23	71	21	[3] 24	82	23	26	94	32
Total	48	178	41	[3] 49	184	42	50	197	51

[1] Includes rotary and beehive kilns, grinding-calcining units, and hydrocal cylinders.
[2] Comprises calcining plants in 1953–55 as follows: 1 each in Connecticut, Florida, Georgia, Maryland, Massachusetts, Montana, New Hampshire, New Jersey, Oklahoma, Pennsylvania, and Washington (1954–55); 2 each in Colorado, Kansas, Nevada, Ohio, Utah, and Virginia; 3 in Indiana (1 in 1953–54).
[3] Revised figure.

Mine and Products-Plant Development.—Power Gypsum Mining & Manufacturing Corp. obtained a mining lease on a gypsum deposit in the Circle Ridge area of the Wind River Indian Reservation in Wyoming. The lease granted the company the right to mine, process, and develop gypsum products.[3]

The Union Gypsum Co. began constructing a new gypsum wallboard plant at Phoenix, Ariz. When completed the firm will produce a complete line of wallboard, sheathing, lath, and plaster for Arizona, California, New Mexico, and west Texas.[4]

A ready-mixed perlite-and-gypsum plaster, designed for use over metal, gypsum lath, or masonry, has been added to the line of gypsum products manufactured by The Ruberoid Co., New York, N. Y. The ready-mixed perlite and gypsum is reported to be 50 percent lighter than conventional sand plasters.[5]

The Ruberoid Co., acquired an option on 12 acres of gypsum deposit discovered in Martin County, Ind. The company is planning a plant near Willow Valley, a short distance from where the United States Gypsum Co. has begun preliminary drilling operations. A new mine and plant were being opened by the National Gypsum Co., Buffalo, N. Y., in the same area.[6]

The Indiana State House of Representatives passed a bill legalizing the sale of gypsum rights on State-owned land. The measure legalizes existing contracts between the Indiana State Conservation Department and three gypsum-producing companies for gypsum rights in 1,300 acres of Martin County State Forest land.

The capacity of the Columbia Gypsum Co., Ltd., plant at Greenacres, Wash., was increased from 150 tons to 300 tons of gypsum daily by the addition of new mixing equipment. The plant produces agricultural gypsum containing active fertilizers. A borated gypsum also is produced.[7]

[3] Rock Products, vol. 58, No. 11, November 1955, p. 60.
[4] Pit and Quarry, vol. 48, No. 1, July 1955, p. 24.
[5] Rock Products, vol. 58, No. 3, March 1955, p. 81.
[6] Rock Products, vol. 58, No. 3, March 1955, p. 53.
[7] Rock Products, vol. 58, No. 6, June 1955, p. 59.

A reconditioned gypsum-processing plant was completed near Winkelman, Ariz., by the Arizona Gypsum Corp. of Phoenix, Ariz. All crushing and screening equipment was replaced.[8]

Shipments of gypsum for agricultural use were begun from the new mill of Superior Gypsum Co., 30 miles northwest of McKittrick, Calif. The rated capacity of the completely automatic crushing and screening mill is 65 tons of 20-mesh agricultural gypsum per hour.[9]

The Blue Diamond Corp. completed expansion of a gypsum and wallboard plant at Blue Diamond, Nev., and an article in the trade press describes the mining methods, transportation, and mill additions.[10]

C. H. Harper, vice president and general manager of the Kaiser Gypsum Co., announced that the company would not rebuild the Redwood City, Calif., gypsum-wallboard plant destroyed by fire on June 23, 1955, because the nonrenewable lease on the land had less than 4 years until expiration. The facilities had an annual capacity of 94 million square feet of gypsum wallboard and were to be replaced by adding to facilities originally planned at Pittsburgh, Calif.[11] However, a site at Antioch, Calif., subsequently was selected. The first of the new plants to be built at Antioch will have an annual capacity of 94 million square feet of gypsum-board products, and the second will produce 180 million square feet of gypsum board products and 20 thousand tons of plaster.[12]

A $3 million expansion program by Kaiser Gypsum Co. at its Long Beach, Calif., gypsum-products plant was to increase the capacity by more than 60 percent. Four new buildings were planned, along with alterations to the gypsum-board production line, drying capacity, and calcining facilities.[13]

National Gypsum Co., Buffalo, N. Y., increased its $75 million, 5-year expansion program by an additional $20 million, which will be spent for machinery, additions to warehouses, and labor-saving equipment. Six new plants will be constructed within the next 2 or 3 years under the original plant-expansion program. Plans called for construction of gypsum plants in Montreal and Toronto, an asbestos mine and plant in Quebec, two gypsum plants in California, and a new hardboard plant at Mobile, Ala.[14]

The National Gypsum Co. increased its production with a new gypsum plant at Shoals, Ind., and expanded plant capacity at Medicine Lodge, Kans., and Baltimore, Md. A gypsum wallboard and plaster plant was being constructed at Burlington, N. J., on the Delaware River to facilitate delivery of crude gypsum from the company gypsum deposits in Nova Scotia.[15]

The United States Gypsum Co., Chicago, Ill., was building a paper mill on the Houston ship canal, Houston, Tex., as part of a $40-million expansion program. The plant will process a special paper for manufacturing sheet rock, gypsum wallboard, and rock-lath plaster base. The firm also is spending $1 million to expand its gypsum plaster and wallboard plant at Norfolk, Va., and $1 million to expand

[8] Pit and Quarry, vol. 48, No. 6, December 1955, p. 22.
[9] California Mining Journal, vol. 25, No. 1, September 1955, p. 28.
[10] Lenhart, W. B., Blue Diamond Boosts Plaster and Wallboard Capacity: Rock Products, vol. 58, No. 5, May 1955, p. 52.
[11] Pit and Quarry, vol. 48, No. 3, September 1955, p. 36.
[12] Rock Products, vol. 58, No. 12, December 1955, p. 45.
[13] Western Industry, vol. 20, No. 2, February 1955, p. 94.
[14] Rock Products, vol. 58, No. 9 September 1955, p. 36.
[15] Rock Products, vol. 58, No. 8, August 1955, p. 58.

its facilities at Sigurd, Utah. Plans also were announced for enlarging and improving the manufacturing facilities at Jacksonville, Fla., and Plaster City, Calif. A new gypsum-wallboard plant is planned at Stoney Point, N. Y.

The Certainteed Products Co., Fort Dodge, Iowa, secured option agreements on 80 acres of land near its quarry [16] and also announced

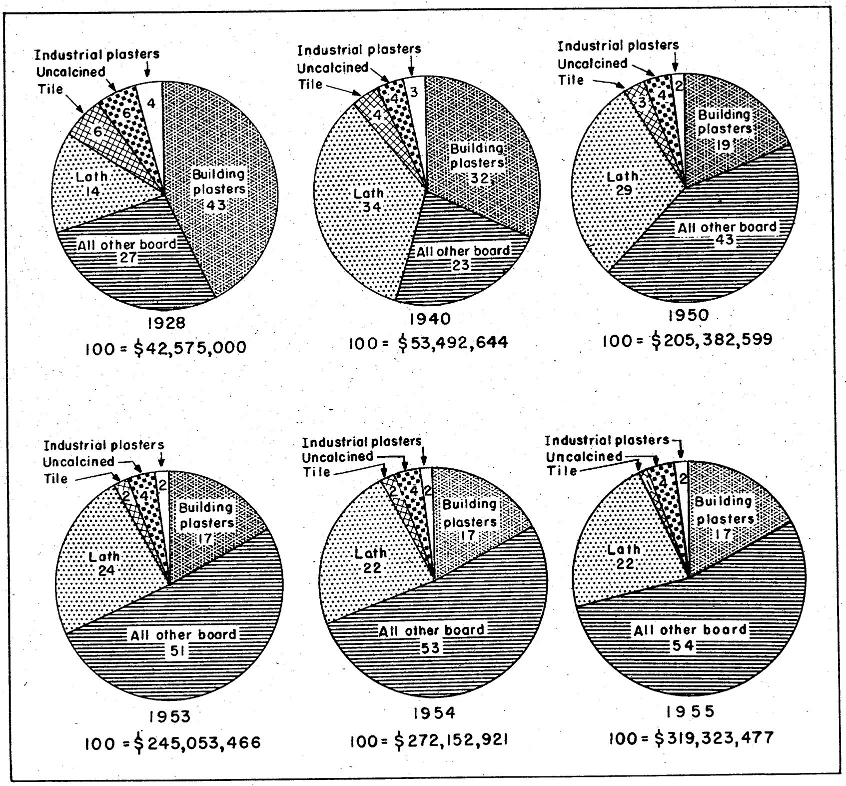

FIGURE 2.—Percentage distribution of total sales value, f. o. b. plant, of gypsum products in 1928, 1940, 1950, and 1953–55, by groups of products.

plans for a $100,000-expansion improvement program at its Acme gypsum plant near Fort Worth, Tex.

Pabco Products, Inc., San Francisco, Calif., was constructing a new multimillion-dollar gypsum-wallboard plant near Florence, Colo. Gypsum deposits at Coaldale and Cotopaxi, Colo., purchased from the Ideal Cement Co., Denver, will supply the plant with crude material.[17] The company also was constructing a gypsum-wallboard plant at Newark, Calif., and expanding its gypsum plant at South Gate, Calif.

[16] Pit and Quarry, vol. 48, No. 3, September 1955, p. 42.
[17] Pit and Quarry, vol. 47, No. 11, May 1955, p. 21.
Mines Magazine, Plans for Giant New Colorado Plant: Vol. 45, No. 8, August 1955, p. 12.

CONSUMPTION AND USES

Outlays for new construction, both private and public, in the United States during 1955 totaled $42.25 billion, 12 percent more than in 1954. The construction trend of private housing continued upward, exceeding 1.3 million units in 1955, compared with 1.2 million in 1954 and 1.1 in 1953. The steady growth in residential construction represented a 9-percent increase over 1954 construction and was only 3 percent less than in 1950. Expenditures for nonfarm residential construction in 1955 totaled $16.6 billion—a gain of $3

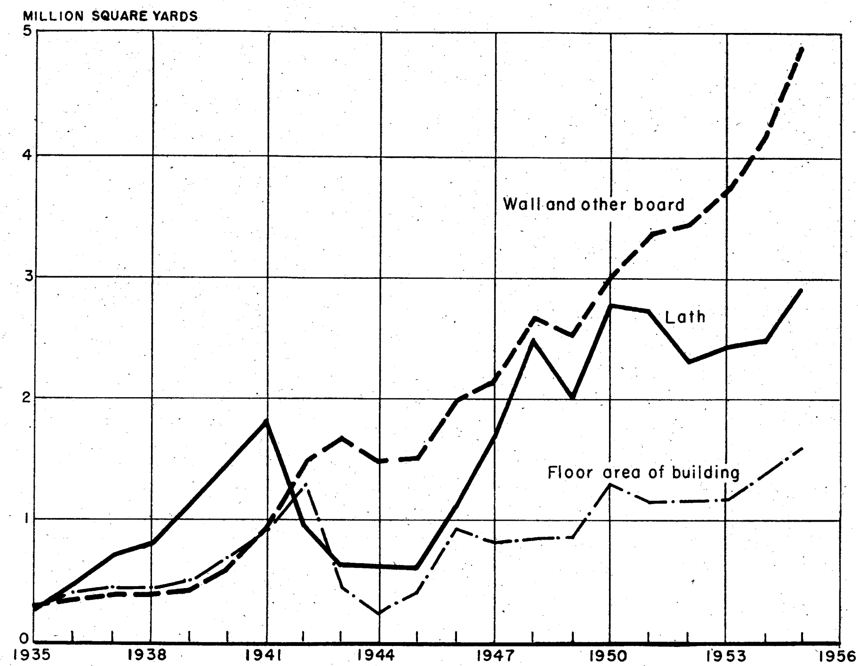

FIGURE 3.—Trends in sales of gypsum lath and wall and other boards (including wallboard, laminated board in terms of component board, formboard, and sheathing), compared with Dodge Corp. figures on combined floor area of residential and nonresidential building, 1935–55.

billion over 1954 and $4 billion over 1950. The increase of $3 billion between 1954 and 1955 represented not only a larger number of housing units but a higher unit value. Average costs per housing unit begun in 1955 rose 7 percent over 1954 and indicated a growing demand for larger houses.

A vigorous demand for such construction material as lath, wallboard, formboard, tile, and various plasters was experienced during the year. The increased use of wallboard as construction material was reflected in a 22-percent advance in production and an increase of $26.9 million in the total value over the previous year. Of all gypsum products marketed, only plaster for mixing plants, sheathing, and laminated board declined in use during the year. Continuing the trend established in 1952, sanded plaster gained 46 percent over 1954 production.

TABLE 5.—Gypsum products (made from domestic, imported, and byproduct crude gypsum) sold or used in the United States, 1954–55, by uses

Use	1954			1955			Percent of change in—	
	Short tons	Value		Short tons	Value			
		Total	Average		Total	Average	Tonnage	Average value
Uncalcined:								
Portland-cement retarder	2,050,985	$7,694,811	$3.75	2,225,781	$8,725,863	$3.92	+9	+4
Agricultural gypsum	663,042	2,498,601	3.77	678,332	2,298,831	3.39	+2	−10
Other uses [1]	31,544	398,980	12.65	33,995	411,000	12.09	+8	−4
Total uncalcined uses	2,745,571	10,592,392	3.86	2,938,108	11,435,694	3.89	+7	+1
Industrial:								
Plate-glass and terra-cotta plasters	53,492	725,597	13.56	67,664	931,528	13.77	+26	+2
Pottery plasters	43,576	838,703	19.25	49,744	966,578	19.43	+14	+1
Orthopedic and dental plasters	9,339	342,427	36.67	9,454	345,972	36.60	+1	(2)
Industrial molding, art, and casting plasters	80,602	1,564,670	19.41	84,159	1,589,972	18.89	+4	−3
Other industrial uses [3]	63,079	1,912,477	30.32	88,098	2,503,005	28.41	+40	−6
Total industrial uses	250,088	5,383,874	21.53	299,119	6,337,055	21.19	+20	−2
Building:								
Cementitious:								
Plasters:								
Base-coat	1,705,633	25,181,231	14.76	1,799,210	26,846,683	14.92	+5	+1
Sanded	406,391	8,974,116	22.08	594,275	13,159,252	22.14	+46	(2)
To mixing plants	9,645	118,428	12.28	7,977	90,422	11.34	−17	−8
Gaging and molding	154,441	2,663,544	17.25	165,168	2,844,306	17.22	+7	(2)
Prepared finishes	11,965	859,442	71.83	12,470	823,646	66.05	+4	−8
Roof-deck	336,889	4,895,436	14.53	385,094	5,666,736	14.72	+14	+1
Other [4]	19,613	1,487,175	75.83	19,673	2,144,539	109.01	(2)	+44
Keene's cement	49,285	1,175,251	23.85	54,496	1,270,518	23.31	+11	−2
Total cementitious	2,693,862	45,354,623	16.84	3,038,363	52,846,102	17.39	+13	+3
Prefabricated:								
Lath	1,910,622	60,744,726	[5] 24.40	2,274,258	71,340,593	[5] 24.27	[6] +18	−1
Wallboard	3,652,216	139,010,481	[5] 34.69	4,439,093	165,899,184	[5] 35.06	[6] +18	+1
Sheathing board	139,647	5,010,992	[5] 37.11	131,235	4,671,953	[5] 37.10	[6] −7	(2)
Laminated board	2,087	94,522	[5] 52.28	2,032	100,479	[5] 56.93	[6] −2	+9
Formboard for poured-in-place gypsum roof-deck	44,518	1,666,178	[5] 39.47	53,836	2,001,467	[5] 39.88	[6] +19	+1
Tile	174,472	4,295,133	[7] 86.20	200,174	4,690,950	[7] 87.13	[6] +15	+1
Total prefabricated	5,923,562	210,822,032	35.59	7,100,628	248,704,626	35.03	[6] +18	−2
Total building uses	----------	256,176,655	------	----------	301,550,728	------	------	------
Grand total value	----------	272,152,921	------	----------	319,323,477	------	------	------

[1] Includes uncalcined gypsum for use as filler and rock dust, in brewer's fixe, in color manufacture, and for unspecified uses.
[2] Less than 1 percent.
[3] Includes dead-burned filler, granite polishing, and miscellaneous uses.
[4] Includes joint filler, patching, painter's, insulating, and unclassified building plasters.
[5] Average value per thousand square feet.
[6] Percent of change in square footage.
[7] Average value per thousand square feet of partition tile only.

TABLE 6.—Gypsum board and tile sold or used in the United States, 1946–50 (average) and 1951–55, by types

Year	Lath			Wallboard			Sheathing		
	Thousand square feet	Value		Thousand square feet	Value		Thousand square feet	Value	
		Total	Average [1]		Total	Average [1]		Total	Average [1]
1946–50 (average)	2,033,032	$41,614,188	$20.47	2,362,610	$64,302,173	$27.22	104,770	$3,421,324	$32.66
1951	2,756,278	64,551,960	23.42	[2] 3,243,676	[2] 105,128,204	[3] 32.39	116,204	4,240,084	36.49
1952	2,317,191	54,402,346	23.48	[2] 3,312,543	[2] 108,974,618	[3] 32.88	117,080	4,281,772	36.57
1953	2,437,481	58,396,664	23.96	3,564,427	119,967,024	33.66	119,560	4,366,801	36.52
1954	2,489,665	60,744,726	24.40	4,006,951	139,010,481	34.69	135,027	5,010,992	37.11
1955	2,939,914	71,340,593	24.27	4,732,331	165,899,184	35.06	125,921	4,671,953	37.10

Year	Laminated board			Formboard			Tile [4]		
	Thousand square feet [5]	Value		Thousand square feet	Value		Thousand square feet	Value	
		Total	Average [1]		Total	Average [1]		Total	Average [6]
1946–50 (average)	5,987	$312,908	$52.26	(7)	(7)	(7)	29,273	$3,192,088	$70.08
1951	(2)	(2)	(8)	(7)	(7)	(7)	37,862	4,715,009	77.79
1952	(2)	(2)	(8)	(7)	(7)	(7)	27,044	3,632,397	78.54
1053	2,922	144,050	49.30	39,519	$1,519,180	$38.44	26,649	3,769,157	84.20
1954	1,808	94,522	52.28	42,213	1,666,178	39.47	31,059	4,295,133	86.20
1955	1,765	100,479	56.93	50,190	2,001,467	39.88	35,734	4,690,950	87.13

[1] Per thousand square feet, f. o. b. producing plant.
[2] Laminated board and formboard included with wallboard.
[3] Average value per thousand 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 thousand square feet, f. o. b. producing plant, of partition tile only.
[7] Separate data not available.
[8] Figure withheld to avoid disclosure of individual company operations.

TABLE 7.—Gypsum lath and wallboard sold or used in the United States, 1954–55, by thickness

	1954				1955			
	Thousand square feet	Short tons	Value		Thousand square feet	Short tons	Value	
			Total	Average [1]			Total	Average [1]
Lath:								
3/8-inch [2]	2,469,393	1,889,254	$60,133,114	$24.35	2,918,034	2,251,235	$70,686,408	$24.22
1/2-inch	20,272	21,368	611,612	30.17	21,880	23,023	654,185	29.90
Total	2,489,665	1,910,622	60,744,726	24.40	2,939,914	2,274,258	71,340,593	24.27
Wallboard:								
1/4-inch	102,038	57,608	2,880,972	28.23	84,819	48,410	2,412,285	28.44
3/8-inch [3]	1,926,793	1,535,287	62,831,536	32.61	2,043,560	1,651,949	66,579,279	32.58
1/2-inch	1,920,573	1,979,828	70,378,239	36.64	2,523,027	2,626,180	92,802,066	36.78
5/8-inch	57,547	79,493	2,919,734	50.74	80,925	112,554	4,105,554	50.73
Total	4,006,951	3,652,216	139,010.481	34.69	4,732,331	4,439,093	165,899,184	35.06

[1] Per thousand square feet, f. o. b. producing plant.
[2] Includes a small amount of 1/4-inch lath.
[3] Includes a small amount of 5/16-inch wallboard.

STOCKS

Producers reported stocks of crude gypsum totaling 1,894,000 short tons on hand December 31, 1955, compared with 1,664,000 tons on the same date of the preceding year and 1,529,000 tons at the end of 1953.

PRICES

The average value of crude gypsum mined in the United States in 1955 was $3.18 per ton, compared with $3.04 in 1954 and $2.79 in 1953. Among the uncalcined uses, the average values of agricultural gypsum and miscellaneous uncalcined-gypsum products were lowered, but the average value for portland-cement retarder was higher. The average value of industrial plasters in 1955 was 2 percent lower than in the previous year, while the average value of building plasters was 3 percent higher. Except for laminated board, none of the prefabricated gypsum products showed any appreciable change in average value from the previous year.

FOREIGN TRADE [18]

Imports of crude gypsum into the United States increased from 3.4 million short tons in 1954 to nearly 4 million tons in 1955, or approximately 18 percent. Canada, the principal exporter of crude gypsum to the United States, supplied 88 percent of the total quantity imported and 24 percent of the total domestic supply. Imports increased from every foreign source except Jamaica, which furnished approximately 61 percent less than in 1954. Mexico and Dominican Republic continued to expand their export trade with the United States, increasing shipments of crude gypsum 28 and 103 percent, respectively. Crude gypsum imported into the United States from all sources supplied the Nation with 27 percent of the domestic requirements.

TABLE 8.—Gypsum and gypsum products imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Crude (including anhydrite)		Ground or calcined		Keene's cement		Alabaster manufactures [1] (value)	Other manufactures, n. e. s. (value)	Total value
	Short tons	Value	Short tons	Value	Short tons	Value			
1946–50 (average)	2,457,205	$2,567,251	681	$18,349	35	$923	$105,030	$89,225	$2,780,778
1951	3,436,927	3,535,747	877	29,237	3	441	97,858	150,609	3,813,892
1952	3,087,884	3,246,143	854	32,200	3	193	189,478	226,961	3,694,975
1953	3,184,292	4,288,589	888	31,108	(2)	2	181,421	291,071	4,792,191
1954	3,368,133	[3] 4,878,405	684	[3] 25,438	11	433	[3] 210,503	[3] 262,931	[3] 5,377,710
1955	3,965,849	[3] 6,287,154	937	32,674	1	834	[3] 346,357	[3] 597,340	[3] 7,264,359

[1] Includes imports of jet manufactures, which are believed to be negligible.
[2] Less than 1 ton.
[3] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to years before 1954.

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

TABLE 9.—Crude gypsum (including anhydrite) imported for consumption in the United States, 1953–55, by countries

[U. S. Department of Commerce]

Country	1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
North America:						
Canada	2,832,077	$3,914,879	2,873,633	$4,352,767	3,471,923	$5,758,784
Dominican Republic	11,672	31,384	22,378	58,813	45,472	96,807
Jamaica	58,099	87,427	174,348	197,022	68,294	80,990
Mexico	282,444	254,899	297,774	269,803	380,160	350,573
Total	3,184,292	4,288,589	3,368,133	[1] 4,878,405	3,965,849	[1] 6,287,154

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to years before 1954.

TABLE 10.—Gypsum and gypsum products exported from the United States, 1946–50 (average) and 1951–55

[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		
1946–50 (average)	20,975	$446,097	23,052,138	$688,772	$258,026	$1,392,895
1951	25,045	608,940	25,556,712	848,777	126,771	1,584,488
1952	19,884	517,227	19,571,037	577,780	121,287	1,216,294
1953	23,690	693,632	45,767,496	1,195,168	104,871	1,993,671
1954	22,384	761,524	20,968,956	688,820	150,133	1,600,477
1955	22,539	737,531	8,686,854	412,397	198,140	1,348,068

[1] Effective Jan. 1, 1949, calcined gypsum not separable from crude, crushed, or calcined.

TECHNOLOGY

The ASTM Subcommittee on Structural Products C–11 on Gypsum is concerned with developing specifications for paper used in gypsum-board products; thickness, density, and fire hazards are the principal considerations. Consideration also is being given to the problems of mold resistance of gypsum-wallboard and formboard papers, characteristics of the paper used for these products, and specifications for joint tape and adhesive. Specifications were completed on gypsum concrete (C–317) for use in constructing poured-in-place roof decks or slabs.[19]

The Oklahoma Geological Survey investigated the possibility of developing gypsum and anhydrite deposits from seven areas in the State for industrial use.[20] The investigator concluded that commercial development of gypsum or anhydrite appeared practical in several areas after consideration of accessibility, transportation, fuel costs, and electric power. The development of these deposits depends on the expansion of current markets through research.

[19] American Society for Testing Materials: Bull. 203, January 1955, p. 9.
[20] Burwell, A., An Investigation of Industrial Possibilities of Oklahoma Gypsum and Anhydrite: Oklahoma Geol. Survey, Min. Rept. 29, 1955, 21 pp.

The National Bureau of Standards prepared a report [21] summarizing data on sound transmission of door, wall, and floor constructions and containing tables that give sound-transmission loss for walls of gypsum board and lath on wood studs; gypsum lath held by special nails, stiff clips, or spring clips on wood studs; gypsum lath held by spring clips or wire ties to steel studs; and wood and expanded-metal lath on wood or steel studs.

An article describes a system of automatic continuous proportioning of gypsum mix for making wallboard. The system helps to control the drying process and to minimize surge loading at the wallboard machine.[22]

Patents.—A patent describes the use of calcium sulfate as a substitute for elemental sulfur in manufacturing certain explosives. The purpose is to eliminate or reduce greatly the formation of poisonous oxides of nitrogen, thus permitting mine workers to return to a working place within 15 to 20 minutes after blasting.[23]

A patent discloses a method of treating the fibrous surface of wallboard, lath, or the like with solutions of calcium hydroxide and alkali sulfate, preferably potassium sulfate, to improve the adhesion of the plaster coating and to provide a plaster-receiving fibrous surface with improved water-absorption characteristics. It promotes rapid setting of the plaster and prevents deformation of the plaster-receiving base.[24]

A patent describes an apparatus for continuous production of a paper-encased gypsum-plaster strip of constant profile in cross section.[25]

Health Problems.—A report of a study on the effects of inhaled calcined-gypsum dust was released; it discusses parenchymal lesions, pleural changes, bronchial changes, vascular damage, pigment, and hilar lymph nodes.[26]

A published bulletin describes the effects of inhaled, commercial, hydrous, calcium-silicated dust on animal tissues and the biological effects of calcined-gypsum dust.[27]

WORLD REVIEW

NORTH AMERICA

Canada.—The geographical occurrences of gypsum in Canada have been described. Official statistics show a production of 4,798,200 short tons of crude gypsum in 1955 having a value of $8,455,173. Virtually all exports of crude gypsum, which totaled 3,039,279 short tons valued at $4,933,967, were for markets in the United States.[28]

---

[21] National Bureau of Standards, Sound Insulation of Wall and Floor Constructions: Building Materials and Structures Rept. 144, 1955, 66 pp.

[22] Rosenthal, Paul E., Automatic Proportioning Smooths Production Kinks: Western Ind., vol. 20, No. 2, February 1955, pp. 29–31.

[23] Davidson, Samuel Henry, and Sillitto, George Percy, Scotland (assigned to Imperial Chem. Ind. Ltd., a corporation of Great Britain), Blasting Explosives: U. S. Patent 2,711,366, June 21, 1955.

[24] Riddell, Wallace C. (assigned to Kaiser Gypsum Co., Inc., Washington), Construction Material and Method of Making: U. S. Patent 2,711,377, June 21, 1955.

[25] Eaton, William Toulmin, and Stroble, Frederick Ernest, England (assigned to Gyproc Products Ltd., Gravesend, England), Apparatus for the Continuous Production of Paper-Encased Gypsum Plaster Strip: U. S. Patent 2,722,262, Nov. 1, 1955.

[26] Schepers, G. W. H., and Dunkan, T. M., Pathological Study of the Effects of Inhaled Gypsum Dust on Human Lungs: Arch. Ind. Health, vol. 12, No. 2, August 1955, pp. 209–217.

[27] Schepers, G. W. H., Dunkan, T. M. and Delahant, A. B., The Biological Effects of Calcined Gypsum Dust: Arch. Ind. Health, vol. 12, No. 3, September 1955, pp. 329–347; Effect of Inhaled Commercial Hydrous Calcium Silicate Dust on Animal Tissue, pp. 348–360.

[28] Collings, R. K., Gypsum and Anhydrite in Canada, 1955 (Preliminary): Canada Dept. of Mines and Tech. Surveys, Mines Branch, Ottawa, No. 41, 6 pp.

Spokane Gypsum Manufacturing Co., Spokane, Wash., was made a subsidiary of Columbia Gypsum Co., Ltd., British Columbia. The gypsum reserves of the Kootenay district will be developed. The Windermere, B. C. quarry also was acquired by the Columbia Gypsum Co., Ltd. and plans for large-scale quarrying and a second gypsum-processing plant near Windermere were announced by the company.[29]

TABLE 11.—World production of gypsum, by countries,[1] 1946–50 (average) and 1951–55, in short tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada [3]	3,009,282	3,928,377	3,553,917	3,839,040	4,184,178	4,798,200
Cuba [4]	16,500	33,000	33,000	33,000	33,000	35,000
Dominican Republic	10,986	23,411	14,179	20,491	29,212	64,312
Jamaica	[5] 9,408	29,953	50,288	82,984	185,712	1,706
United States	6,778,578	8,665,534	8,415,300	8,292,876	8,995,960	10,683,733
Total [1 4]	9,852,000	12,724,000	12,177,000	12,380,000	13,538,000	15,693,000
South America:						
Argentina	135,682	143,300	176,370	[4] 138,000	[4] 138,000	143,300
Brazil	[4] 55,000	-----	-----	82,436	83,133	[4] 82,700
Chile	73,542	75,991	81,549	77,162	[4] 82,700	[4] 82,700
Colombia	4,327	5,386	5,385	9,370	16,535	24,251
Ecuador	293	152	43	-----	-----	-----
Peru	44,263	34,050	35,159	31,256	25,854	35,432
Venezuela	[6] 2,628	1,548	1,680	(7)	(7)	(7)
Total	[4] 316,000	260,427	300,186	[4] 340,000	[4] 350,000	[4] 370,000
Europe:						
Austria [3]	31,741	131,577	206,727	330,633	404,158	454,313
Bulgaria [4]	6,000	6,000	6,000	6,000	6,000	6,000
Finland	[4] 2,100	-----	-----	-----	-----	-----
France (saleable) [3]	2,266,618	1,883,498	2,851,099	3,192,913	3,306,930	3,670,692
Germany, West [8]	431,900	888,100	843,400	856,800	931,900	998,600
Greece	1,792	19,785	20,944	27,558	[4] 22,000	16,535
Ireland	63,259	95,230	82,283	101,775	(7)	(7)
Italy	406,213	638,770	743,482	661,386	685,165	817,317
Luxembourg	22,740	13,580	5,591	10,419	2,118	2,649
Poland	21,621	(7)	(7)	(7)	(7)	(7)
Portugal	40,451	33,062	43,666	51,115	63,804	(7)
Spain	1,632,474	2,008,052	1,759,322	1,153,660	956,964	(7)
Switzerland	123,018	132,277	[4] 135,000	137,789	165,347	(7)
United Kingdom [3]	2,203,622	2,558,724	2,682,069	2,994,886	3,092,773	3,264,520
Yugoslavia	[4] 11,000	17,360	19,136	49,038	113,538	84,878
Total [1 4]	8,700,000	11,900,000	13,000,000	13,000,000	13,400,000	14,300,000
Asia:						
Ceylon	101	460	756	480	257	128
China [4]	60,000	80,000	90,000	110,000	220,000	280,000
Cyprus (exports)	29,560	25,542	62,339	116,058	111,904	105,833
India	120,175	228,046	460,550	652,640	685,576	(7)
Iran [4 9]	300,000	130,000	140,000	180,000	170,000	220,000
Iraq [4]	240,000	275,000	275,000	275,000	275,000	275,000
Israel [4]	19,000	22,000	28,000	25,000	31,000	56,000
Japan	100,722	222,052	221,172	298,837	372,106	369,040
Pakistan	15,500	25,123	32,698	30,831	34,888	31,472
Philippines	1,413	440	-----	-----	-----	-----
Syria [10]	2,227	9,006	6,063	827	827	992
Taiwan (Formosa)	3,061	2,740	7,453	2,105	4,422	11,247
Thailand (Siam)	187	87	-----	-----	-----	-----
Total [4]	892,000	1,020,000	1,324,000	1,692,000	1,906,000	2,011,000

See footnotes at end of table.

[29] Rock Products, vol. 58, No. 4, April 1955, p. 62.

TABLE 11.—World production of gypsum, by countries,[1] 1946–50 (average) and 1951–55, in short tons[2]—Continued

Country[1]	1946–50 (average)	1951	1952	1953	1954	1955
Africa:						
Algeria	39, 282	90, 389	58, 643	99, 869	80, 346	(7)
Anglo-Egyptian Sudan	1, 754	202	1, 599	(7)	(7)	(7)
Angola	1, 297	7, 121	9, 777	6, 118	9, 650	3, 030
Belgian Congo	[4] 1, 600	4, 360	4, 360	7, 215	10, 074	10, 803
Egypt	90, 104	123, 520	156, 367	205, 030	157, 016	432, 328
French Morocco	21, 893	8, 482	8, 769	15, 840	22, 928	16, 220
Kenya	656	91	1, 785	941	563	953
Tanganyika	------	------	554	1, 904	5, 300	8, 749
Tunisia	20, 039	26, 880	25, 760	25, 133	27, 558	[4] 28, 000
Union of South Africa (sales and exports)	93, 095	137, 767	164, 147	165, 777	170, 637	192, 616
Total[4]	270, 000	399, 000	432, 000	530, 000	490, 000	780, 000
Oceania:						
Australia	291, 904	408, 070	393, 880	369, 591	492, 482	526, 361
New Caledonia	9, 382	17, 391	5, 711	21, 234	2, 910	(7)
Total	301, 286	425, 461	399, 591	390, 825	495, 392	[4] 530, 000
World total (estimate)[1]	20, 300, 000	26, 700, 000	27, 600, 000	28, 300, 000	30, 200, 000	33, 700, 000

[1] In addition to countries listed, gypsum is produced in Mexico, Rumania, and U. S. S. R., but production data are not available. Estimates for these countries included in totals.
[2] This table incorporates a number of revisions of data published in previous Gypsum chapters. Data do not add to totals shown owing to rounding where estimated figures are included in detail.
[3] Includes anhydrite.
[4] Estimate.
[5] Average for 1948–50.
[6] Production in Government quarries only; beginning in 1951 no longer under Government control.
[7] Data not available; estimate by senior author of chapter included in total.
[8] Crude production estimates based on calcined figures.
[9] Year ended March 20 of year following that stated.
[10] Some pure; some 80 percent gypsum and 20 percent limestone.

Atlantic Gypsum, Ltd., Corner Brook, Newfoundland, a producer of gypsum plaster and wallboard, increased its line of products by adding an aluminum-back lath and black outside sheathing. Warehouse and distribution facilities were established in Quebec and Ontario during the year. Plans were made to introduce a gypsum board containing a fire-resistant core of fiberglass and asbestos.[30]

The new million-dollar mine and crushing plant of National Gypsum Co., near Halifax, N. S., will furnish adequate supplies of crude material to enable the company to expand its processing plants on the eastern and southern coasts of the United States. Year-around shipments from the deposit, the largest known gypsum deposit in North America, are expected to total 2 million short tons annually.[31]

Beloe Rock Gypsum Industries, Ltd., of Glasgow, Scotland, has taken over operation of the Newfoundland Government plant, Atlantic Gypsum, Ltd., on the west coast of Newfoundland. The company received a 12-year option to purchase the plant; it plans eventually to establish 15 gypsum-processing plants in eastern Canada.[32]

Western Gypsum Products, Ltd., the largest manufacturer of gypsum products in the Prairie Provinces, was purchased by British Plaster Board (Holdings), Ltd., at a cost of $3 million. Western

[30] Rock Products, vol. 58, No. 10, October 1955, p. 58.
[31] Rock Products, National Gypsum Starts Halifax Plant: Vol. 82, No. 9, September 1955, pp. 82, 114.
[32] Northern Miner (Toronto), vol. 41, No. 34, Nov. 17, 1955, p. 8.

Gypsum has plants at Winnipeg and Calgary, a gypsum mine at Amaranth, Manitoba, and mining properties in British Columbia.[33]

Jamaica.—J. S. Webster & Sons was the only company in 1953 to calcine gypsum for manufacturing plaster of paris used in the production of gypsum board. A second company began operations in 1954. Production in 1955 declined to a mere fraction of its former volume.[34]

EUROPE

France.—The Paris region (Bassin parisien) of France produces 75 percent of the national output of gypsum; 70 percent of this production originates at the Vaux-sur-Seine quarry operated by the Société de Materiel de Construction, Vaux-sur-Seine, Seine-et-Oise.[35]

ASIA

India.—The Geological Survey of India disclosed the existence of gypsum deposits at Surashtra, Kutch, Nellore, and Tiruchirapalli districts of Madras and at several points in the Himalayan foothills of Uttar Pradesh and East Punjab.[36] Deposits estimated to contain about 15 million tons of gypsum were found at a depth of 50 feet in 2 areas in the Tiruchirapalli district in Madras.[37]

The Indian Government has approved the addition of two more units to the ammonium sulfate plant at Sindri for manufacturing urea and double salt. One unit will have a capacity of 70 tons and the other 400 tons a day. The Sindri plant is now producing 22,000 long tons of fertilizer per month.[38]

Iran.—The Teheran Gypsum Co., Ferdowsi Avenue, Teheran, a producer of gypsum at Hashemabad, with two mine-site concessions at Tuchah and Megarabad, planned to purchase new plant equipment to modernize its mining and gypsum-producing operations.[39]

Philippines.—Although little information is available on gypsum deposits, according to report they have been found in Batangas; Nabua, Camarines Sur; Tayasan, Negros-Oriental; and Ormoc Bay, Leyte. The principal deposits in Batangas are the Talahib deposit in Barrio Talahib, near Lobo, and the Mabini deposit west of Batangas. The Talahib deposit occurs in andesite as fissure-vein fillings, which range from a few inches to 4 feet in width. The Mabini deposit has a bed with a reported thickness of 50 feet and characteristics similar to the Talahib deposit. Owing to the low-grade material mined and the lack of beneficiation equipment, exploitation of these deposits has been halted.[40]

Turkey.—Azot Samayii T. A. S. (Turkish Nitrogen Industries, Ltd.) began constructing a 35,000-ton-per-year ammonium plant at Kutahya, which will be used to manufacture 60,000 tons of ammonium sulfate annually. The plant will use 100,000 tons of gypsum annually from the extensive deposits at Bicer and Sazilar.[41]

---

33 Canadian Mining Journal, vol. 76, No. 6, June 1955, p. 16.
34 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 3, March 1955, p. 42.
35 Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 1, January 1956, p. 26.
36 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, pp. 61–62.
37 Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 1, January 1956, pp. 26–27.
38 Oil, Paint and Drug Reporter, vol. 167, No. 8, February 1955, p. 5.
39 Foreign Commerce Weekly, Firm in Iran Wants Gypsum Plant: Vol. 54, No. 17, Oct. 24, 1955, p. 14.
40 Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 6, December 1955, p. 33.
41 Mining World, vol. 18, No. 1, January 1956, p. 75.

AFRICA

British Somaliland.—According to a report published by the Protectorate Government of British Somaliland, many million tons of massive calcium sulfate are exposed within 20 miles of Berbera Harbour, on the south coast of the Gulf of Aden, and about 14,000 square miles of the Protectorate consists of these rocks. The report discusses the geology, composition, position, extent, and origin of the deposit.[42]

Tanganyika.—According to a report by the Tanganyika Department of Mines, gypsum produced at Mkomasi on the Tanga branch railway line was used in Kenya and Uganda cement plants.[43]

[42] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 3, March 1955, p. 38.
[43] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 62.

Iodine

By Henry E. Stipp[1] and Annie L. Marks[2]

CONSUMPTION of crude iodine in the United States rose 2 percent in 1955. Increased use of combinations of iodine with organic compounds in pharmacy, medicine, and sanitation was indicated.

A form of iodine was discovered that was said to be stingless, nontoxic, and highly effective against a wide range of bacteria. The use of radioactive iodine–131 increased as new procedures for its application were found.

DOMESTIC PRODUCTION

In 1955 iodine was produced in the United States entirely from waste oil-well waters by Dow Chemical Co. at Seal Beach, Calif., and Deepwater Chemical Co. at Compton, Calif. The Bureau of Mines does not publish data on domestic production to avoid disclosure of individual company operations. A substantial portion of domestic requirements was supplied by domestic producers.

CONSUMPTION AND USES

Iodine and iodine compounds (see table 1) had numerous and varied uses in industry, agriculture, and medicine in 1955.

Iodine compounds were consumed by humans and animals. Iodized table salt, containing 1 part potassium iodide to each 10,000 parts of salt, was used to supply iodine for human nutritional needs. Iodized proteins were used in stock feeds to prevent various diseases and to increase the yield of milk and eggs.

TABLE 1.—Crude iodine consumed in the United States, 1954–55

Compound manufactured	1954			1955		
	Number of plants	Crude iodine consumed		Number of plants	Crude iodine consumed	
		Pounds	Percent of total		Pounds	Percent of total
Resublimed iodine	6	109,402	8	6	175,564	13
Potassium iodide	10	798,420	59	8	602,216	44
Sodium iodide	4	118,669	9	5	99,902	7
Other inorganic compounds	9	68,817	5	10	74,421	5
Organic compounds	13	252,000	19	12	424,101	31
Total	[1] 23	1,347,308	100	[1] 19	1,376,204	100

[1] A plant producing over 1 product is counted but once in arriving at total.

[1] Commodity specialist.
[2] Statistical assistant.

In industry, iodine and its compounds were used in the production of dyes and rubber products, and in analytical reagents, catalysts, metallurgy, photography, and wet-plate photoengraving.

A multitude of applications in medicine and public health have been found for iodine and iodine compounds. Radioactive iodine–131 was used in medical diagnosis, therapy, and many types of research. Numerous compounds used in antiseptics, fungicides, protozoacides, insecticides, and drugs contained iodine. It was also used as an aid in nutrition and sanitation, and in X-ray diagnostic procedures.

PRICES

According to the Oil, Paint and Drug Reporter the price of crude iodine and ammonium iodide remained firm during the year. Prices of iodine and iodine compounds were quoted as follows: Crude iodine, in kegs, $1.45 per pound throughout the year; resublimed iodine, U. S. P., bottles, drums, at $2.30 to $2.32 per pound for January to February; $2.55 to $2.57 from February to May; and $2.30 to $2.32 per pound throughout the remainder of the year; potassium iodide, drums, at $1.90 to $1.95 per pound from January to February; $2.15 to $2.20 per pound from February to May; and $1.90 to $1.95 throughout the remainder of the year; sodium iodide, U. S. P., bottles, drums, at $2.55 to $2.94 per pound from January to February; $2.80 to $2.85 per pound from February to April; $2.80 to $2.92 per pound from April to May; and $2.55 to $2.63 per pound for the remainder of the year; ammonium iodide, N. F., drums, bottles, was quoted at $4.26 to $4.38 per pound throughout the year.

FOREIGN TRADE[3]

Crude iodine was imported into the United States in 1955 from Chile and Japan. Imports of iodine from Chile increased substantially over 1954. Imports of the mineral from Japan increased from an average of 60,000 pounds in 1946–50 to a new record high of 364,000 pounds in 1955.

Exports of iodine and iodine compounds from the United States decreased approximately 28 percent from last year's high.

TECHNOLOGY

Trade journals and the scientific press contained numerous articles on radioactive iodine–131 during the year.

A report describing the equipment and process used for separating and purifying radioactive iodine–131 at Oak Ridge National Laboratory was declassified in 1955.[4]

A new plant for processing large quantities of iodine–131 was placed in operation at Oak Ridge National Laboratory.[5] The new facility provides equipment for dissolving uranium slugs and separating iodine from other fission products. It consists of a concrete cell block that

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

[4] Rupp, A. F., Beauchamp, E. E., and Farmakes, J. R., Production of Fission Product Iodine–131: U. S. Atomic Energy Commission ORNL–1047., Dec. 18, 1951, 25 pp.

[5] Chemical Engineering News, Large Quantities of Iodine–131 Processed At Oak Ridge National Laboratory: Vol. 33, No. 3, Jan. 17, 1955, p. 224.

TABLE 2.—Crude iodine imported for consumption in the United States, 1946–50 (average) and 1951–55, by countries

[U. S. Department of Commerce]

Country	1946–50 (average)		1951		1952		1953		1954		1955	
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
South America: Chile	930,686	$1,190,395	667,426	$1,036,414	471,077	$858,092	681,484	$1,197,379	615,744	$667,088	868,040	$1,034,834
Europe: France									110	493		
Asia: Japan	60,129	80,912	184,681	283,914	320,131	504,817	276,154	408,645	330,131	366,354	363,954	477,673
Grand total	990,815	1,271,307	852,107	1,320,328	791,208	1,362,909	957,638	1,606,024	945,985	1,033,935	1,231,994	1,512,507

has six processing cells, which house processing equipment, including handling, remote-control, and regulating equipment. The new plant has a designed capacity of 25 curies per week.

TABLE 3.—Iodine, iodide, and iodates exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Pounds	Value	Year	Pounds	Value
1946–50 (average)	350,711	$638,729	1953	274,690	$452,387
1951	320,165	612,556	1954	338,258	487,633
1952	120,789	264,952	1955	243,686	356,531

Direct experimentation on thyroid tissue was said to be possible with techniques involving the use of radioactive iodine–131 and methods of paper chromatography.[6] The thyroid gland of a rat given a dose of radioiodide ion was hydrolyzed and studied by paper chromatography. Radioactive thyroxine and diiodotyrosine were easily detected. Radioactive material was also found in the form of monoiodotyrosine in the gland.

A procedure for using radioactive iodine as a tracer in selective acidizing of oil wells is described.[7] Iodine–131, mixed in minute quantities in acid, was detected by using a gamma-ray instrument; the detector permitted careful control over the acid interface, which was formed by pumping radioactive acid down the tubing of the well and oil down the annulus, or vice versa. By varying the pumping rates of the oil and acid, the interface could be maintained at a desired level; this caused the acid to enter the strata to be acidized.

A means of producing iodine–124, which had not been reported previously in literature was observed.[8] Iodine isotopes 124, 126, 130, and 131 were produced with the deuteron beam of a cyclotron. Tellurium was exposed to a beam of 20 MEV. deuterons for 50 microampere hours. Iodine–124 was identified by the study of its gamma-ray spectrum with a well-type NaI scintillation crystal and an analyzer.

Germicidal properties of iodine are described as being due chiefly to the diatomic form of the element.[9] Solutions used as a local antiseptic contained a mixture of several different forms of iodine, and only a small part contained the element in the two-atom form. In addition to a very low toxicity, this type of iodine had highly effective vericidal, sporocidal, and bactericidal properties. Solutions of diatomic iodine were said to be stingless and noncorrosive on wounds.[10]

Wescodyne, a complex of nonionic synthetic detergent with iodine, was said to aid the bactericidal activity of iodine while making it nontoxic, nonirritating, and nonstaining.[11] The complex was held

[6] Chemical Engineering News, Thyroid Gland: Vol. 33, No. 24, June 13, 1955, pp. 2512, 2514.
[7] Russell, Maynard, Radioactive Iodine Used As Tracer in Selective Acidizing: World Oil, vol. 138, No. 7, June 1954, pp. 266–268.
[8] Hall, T., Stiegel, M., Sharpe, L. M., and Pressman, D., Production of Iodine–124 by the Deuteron Bombardment of Tellurium: Phys. Rev., vol. 95, No. 5, Sept. 1, 1954, p. 1208.
[9] Chemical Engineering News, Germicidal Iodine: Vol. 33, No. 40, Oct. 3, 1955, pp. 4170–4171.
[10] Chemical Week, Iodine Unmasked: Vol. 77, No. 24, Dec. 10, 1955, pp. 84–86.
[11] Chemical Engineering News, Iodine "Tamed" as Germicide—Won't Stain, Sting, or Poison: Vol. 32, No. 49, Dec. 6, 1954, p. 4888.

in an acid solution of pH 3 to 4. Approximately 15 to 20 percent of the iodine was bound to the detergent and unavailable for disinfecting. The remaining iodine was loosely bound and provided 1.6 percent available iodine. A water solution was stable under normal conditions of storage.

Two rapid processes for preparing anhydrous iodides of lithium and barium were reported.[12] Lithium iodide was prepared by the action of lithium hydride on iodine in ether solution.

A procedure for distinguishing types of hydrocarbons by means of the ultraviolet spectra of their complexes formed with iodine is described.[13] The determination of the tri- and tetra-alkyl-substituted olefins was of interest, because these types are difficult to determine by other spectroscopic methods.

A report describing spectrophotometric and electrical-conductance determinations of iodine and iodine halides in solutions of acetonitrile was published.[14] Both studies showed that iodine and iodine halides in nonaqueous solvents reacted slowly, increasing in conductance with time. Data obtained in the experiment seemed to indicate a reaction of the solute with moisture and/or other impurities.

Radioactivity of iodine samples recovered from an iodine solution to which radioactive heavy water (T_2O) had been added indicated a water content of 0.1 percent in the sample.[15] A method of analysis was devised which led to recoveries of pure, dry iodine.

A process that permitted direct production of sound ingots from hafnium-crystal bar produced by the iodide process is described.[16] Hafnium-crystal bars were tack-welded into a consumable electrode and arc-melted with currents of 2,800 to 2,900 amperes. The splatter ring was melted and the bottom remelted in a tungsten-tipped-electrode arc furnace. Ingots produced by consumable-electrode techniques were of lower average hardness than ingots produced by other methods. The use of a double-melting process eliminated chemical inhomogeneities and permitted the blending of solid scrap during melting. Rapid production of sound ingots resulted from a single melting process. Porosity beneath the surface of arc-melted ingots was eliminated by a process of surface fusion. Fabrication, forging, extrusion, cold rolling, machining, welding, and annealing of the metal are discussed.

A compilation of iodine abstracts and reviews was published by the Chilean Iodine Educational Bureau, Inc.[17]

---

[12] Taylor, Moodie D., and Grant, Louis R., New Preparations of Anhydrous Iodides of Groups I and II Metals: Jour. Am. Chem. Soc., vol. 77, No. 6, Mar. 20, 1955, pp. 1507–1508.

[13] Long, D. R., and Meuzil, R. W., Determination of Olefins by Means of Iodine Complexes: Anal. Chem., vol. 27, No. 7, July 1955, pp. 1110–1114.

[14] Copov, A. I., and Skelly, N. E., Studies on the Chemistry of Halogens and of Polyhalides. IV. On the Behavior of Iodine and of Iodine Halides in Acetonitrile: Jour. Am. Chem. Soc., vol. 77, No. 14, July 20, 1955, pp. 3722–3724.

[15] Washington, R. A., and Naldrett, S. N., Preparation of Pure, Dry Iodine: Jour. Am. Chem. Soc., vol. 77, No. 16, Aug. 20, 1955, p. 4232.

[16] Goodwin, J. G., and Hurford, W. J., Iodide Process Produces Ductile Hafnium for Fabrication: Jour. Metals, vol. 7, No. 11, Sec. 1, pp. 1162–1167.

[17] Chilean Iodine Educational Bureau, Inc. (120 Broadway, New York 5, N. Y.), Iodine Abstracts and Reviews: Vol. 3, No. 2, 1955, pp. 1–54.

WORLD REVIEW

Chile.—According to the Nitrate Superintendency of Chile, 1,131,482 kg. of iodine was produced during the 1955 calendar year. No value was given for the product.[18]

Indonesia.—Revised data for 1954 production of iodine was reported as 10,806 metric tons instead of 10,668 metric tons. Production of iodine in 1955 was listed as 7,649 metric tons.[19]

Japan.—Elemental iodine production in Japan during 1955 was listed as 511,753 kg.[20]

---

[18] U. S. Embassy, Santiago, Chile, State Department Despatch 889, May 28, 1956, 2 pp.
[19] U. S. Embassy, Djakarta, Indonesia, State Department Despatch 193, Oct. 12, 1956, 1 p.
[20] U. S. Embassy, Tokyo, Japan, State Department Despatch 910, Apr. 6, 1956, 8 pp.

Iron Ore

By Horace T. Reno[1]

DOMESTIC iron-ore production in 1955 followed the pattern of increased industrial activity and was the third highest in history. The Lake Superior district again exhibited the production flexibility for which it has been noted in the past and supplied 81 percent of the domestic total. Consumers insisted on high-grade material, and the trend toward more beneficiation continued.

Foreign countries supplied a larger percentage of the iron ore consumed in the United States than ever before. Canada displaced Venezuela as the principal supplier by shipping 185 percent more in 1955 than in 1954.

DOMESTIC PRODUCTION

The iron-ore industry started slowly in 1955 but operated at near peak capacity without interruption in the last 9 months of the year. In response to an encouraging business outlook, shipments from the Lake Superior district continued at a high rate through most of Novem-

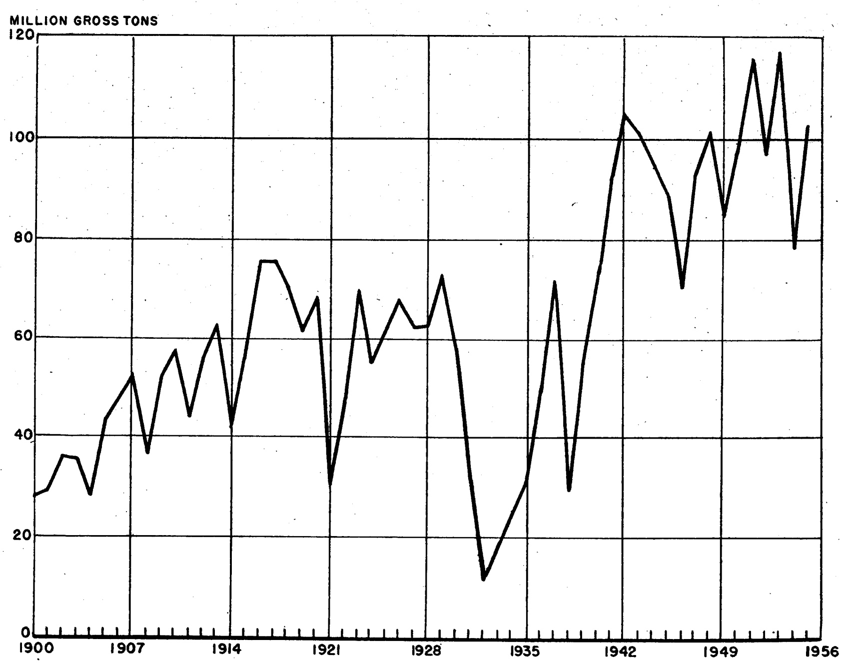

FIGURE 1.—Production of iron ore in the United States, 1900–55.

[1] Assistant chief, Branch of Ferrous Metals and Ferroalloys.

ber. All districts produced and shipped more iron ore in 1955 than in 1954. Stocks reached the lowest level since 1951 in May but were normal by the close of the Great Lakes shipping season in December. Beneficiation was again the item of principal interest in domestic iron-ore mining. However, emphasis was on agglomeration rather than ore dressing.

TABLE 1.—Salient statistics of iron ore in the United States, 1946–50 (average), and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Iron ore (usable;[1] less than 5 percent Mn):						
Production by districts:						
Lake Superior..long tons..	73,265,155	93,946,990	77,094,762	95,655,105	60,993,927	83,255,400
Southeastern........do....	7,449,827	8,587,408	7,623,779	7,691,745	6,150,260	7,105,706
Northeastern........do....	3,869,036	5,180,959	4,426,378	5,161,813	4,083,608	4,649,566
Western.............do....	4,472,050	8,181,465	8,030,331	8,868,658	[2] 6,064,947	6,954,295
Undistributed (byproduct ore)......long tons..	528,118	[3] 607,850	[3] 742,754	617,448	836,052	1,034,002
Total...............do....	89,584,186	116,504,672	97,918,004	117,994,769	[2] 78,128,794	102,998,969
Production by types of product:						
Direct..........long tons..	67,259,564	85,281,923	70,358,493	82,163,882	[2] 49,105,976	66,746,189
Concentrates........do....	17,827,204	25,708,840	22,037,106	29,161,642	23,172,948	28,771,960
Sinter..............do....	3,969,300	4,945,278	4,918,264	6,051,797	5,013,818	6,446,818
Byproduct material (pyrites cinder and sinter) long tons..	528,118	568,631	604,141	617,448	836,052	1,034,002
Total...............do....	89,584,186	116,504,672	97,918,004	117,994,769	[2] 78,128,794	102,998,969
Production by types ore:						
Hematite.......long tons..	80,873,717	101,530,954	83,515,561	102,553,404	[2] 66,384,324	92,957,669
Brown ore...........do....	1,644,991	3,014,761	2,729,524	2,238,236	2,315,407	2,457,236
Magnetite...........do....	6,537,220	11,390,326	11,068,778	12,585,681	8,593,011	6,550,062
Byproduct material (pyrites cinder and sinter) long tons..	528,118	568,631	604,141	617,448	836,052	1,034,002
Total...............do....	[4] 89,584,186	116,504,672	97,918,004	117,994,769	[2] 78,128,794	102,998,969
Shipments...........do....	89,335,689	116,230,052	97,972,584	117,821,981	[2] 76,954,081	106,253,804
Value......................	$359,967,679	$634,728,583	$596,306,850	$796,732,998	[2] $538,193,051	$756,830,037
Average value per ton at mine......................	$4.03	$5.46	$6.09	$6.76	$6.99	$7.12
Stocks at mines Dec. 31 long tons..	5,743,878	5,599,466	5,528,295	5,706,430	[2] 7,077,651	4,562,909
Imports.............do....	5,878,460	10,139,678	9,760,625	11,074,035	[2] 15,792,450	23,459,660
Value......................	$28,065,549	$59,520,046	$82,854,506	$96,788,218	[2] $119,458,945	$177,329,254
Exports.........long tons..	2,474,625	4,328,910	5,122,644	4,251,955	3,145,714	4,516,828
Value......................	$11,924,081	$30,996,784	$37,403,973	[4] $32,421,637	$24,783,997	$36,992,523
Consumption......long tons..	92,923,544	114,837,112	100,640,636	122,124,661	94,229,135	125,028,306
Manganese-bearing ore (5 to 35 percent Mn):						
Shipments.......long tons..	1,045,017	1,092,825	900,909	1,106,598	498,511	813,961
Value......................	$3,942,189	$5,385,986	$5,116,985	$6,946,862	$3,079,380	$5,128,255

[1] Direct shipping ore, washed ore, concentrates, sinter, and byproduct pyrites cinder and sinter.
[2] Revised figure.
[3] Includes Puerto Rican ore—39,219 tons in 1951 and 138,613 tons in 1952.
[4] Includes 140 tons carbonate ore (siderite).

Crude ore is the mine output before any treatment to eliminate waste constituents. Production in 1955 totaled 142 million tons, 31 percent more than in 1954 but 9 percent less than the record high established in 1953. Hematite ore was 84 percent, magnetite ore 10 percent, and brown ore 6 percent of the total. This division among mineral types was not precise, inasmuch as most iron ore contains two or more minerals and is classified according to the one that predominates. Nine-teen percent of the total crude ore produced was mined underground and 81 percent in open pits. Michigan, Alabama, and Minnesota, in that order, continued to rank as the principal States producing from underground workings. Minnesota was again the principal producer from open pits, with over 80 percent of the total. Crude ore shipped to beneficiation plants was 52 percent of the total, continuing an upward trend started in 1940.

TABLE 2.—Crude iron ore mined in the United States, 1954–55, by States and varieties, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State	Number of mines	Hematite	Brown ore	Magnetite	Total	Rank
1954						
Alabama	[1] 33	5,016,274	4,669,553		9,685,827	3
Arkansas	2	630	430		1,060	20
California	2			[2] 1,299,864	1,299,864	9
Colorado	1		6,049		6,049	17
Georgia	[1] 11	217	1,007,787		1,008,004	11
Michigan	40	11,209,152			11,209,152	2
Minnesota	130	65,883,381	223,297	1,917,254	68,023,932	1
Missouri	[1] 8	288,265	138,300		426,565	13
Montana	1			6,473	6,473	16
Nevada	6			350,654	350,654	14
New Jersey	5			1,025,057	1,025,057	10
New Mexico	1			3,316	3,316	18
New York	6	(3)		[3] 7,396,516	7,396,516	4
Pennsylvania	1			1,337,590	1,337,590	8
South Dakota	1	2,040			2,040	19
Tennessee	[4] 3	16,012	[4] 26,711		[4] 42,723	15
Texas	4		[5] 2,557,438		[5] 2,557,438	6
Utah	7			2,918,930	2,918,930	5
Wisconsin	2	1,491,470			1,491,470	7
Wyoming	2	493,557			493,557	12
Total	266	[5] 84,400,998	[5] 8,629,565	[3] 16,255,654	[5] 109,286,217	
Percent of total		77.4	7.6	15.0	100.0	
1955						
Alabama	[1] 32	6,165,458	3,802,275		9,967,733	3
Arkansas						
California	2			[2] 2,420,418	2,420,418	7
Colorado	1		4,031		4,031	18
Georgia	[1] 12	[6] 49,316	[6] 993,179		[6] 1,042,495	11
Michigan	40	12,927,012			12,927,012	2
Minnesota	166	94,187,287	415,002		94,602,289	1
Missouri	[1] 12	407,700	200,595		608,295	13
Montana	1			6,631	6,631	17
Nevada	8	105,127		291,329	396,456	14
New Jersey	4	776,157		679,734	1,455,891	10
New Mexico	1			9,218	9,218	16
New York	5			8,078,965	8,078,965	4
Oregon	1		1,786		1,786	21
Pennsylvania	1			1,551,438	1,551,438	9
South Dakota	1	2,048			2,048	20
Tennessee	3	(6)	(6)		(6)	15
Texas	4		3,107,421		3,107,421	6
Utah	6	[7] 2,784,683		1,021,684	3,806,367	5
Washington	1	2,339			2,339	19
Wisconsin	3	1,588,523			1,588,523	8
Wyoming	1	748,831			748,831	12
Total	305	119,744,481	8,524,289	14,059,417	142,328,187	
Percent of total		84.0	6.0	10.0	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] Small tonnage of hematite for nonmetallurgical use included with magnetite.
[4] Small tonnage mined in Virginia included with Tennessee.
[5] Revised figure.
[6] Tennessee included with Georgia to avoid disclosure of individual company operations.
[7] Contains minor amount of magnetite.

TABLE 3.—Crude iron ore mined in the United States, 1954–55, by States and mining methods, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State	1954			1955		
	Open pit	Underground	Total	Open pit	Underground	Total
Alabama	4,730,954	4,954,873	9,685,827	3,892,766	6,074,967	9,967,733
Arkansas	1,060		1,060			
California	1,299,864		1,299,864	2,420,418		2,420,418
Colorado	6,049		6,049	4,031		4,031
Georgia	1,008,004		1,008,004	[1] 1,042,495		[1] 1,042,495
Michigan	1,274,394	9,934,758	11,209,152	1,623,843	11,303,169	12,927,012
Minnesota	65,281,672	2,742,260	68,023,932	92,101,489	2,500,800	94,602,289
Missouri	142,800	283,765	426,565	200,595	407,700	608,295
Montana	6,473		6,473	6,631		6,631
Nevada	350,654		350,654	396,456		396,456
New Jersey		1,025,057	1,025,057		1,455,891	1,455,891
New Mexico	3,316		3,316	9,218		9,218
New York	5,384,341	2,012,175	7,396,516	5,979,599	2,099,366	8,078,965
Oregon				1,786		1,786
Pennsylvania		1,337,590	1,337,590		1,551,438	1,551,438
South Dakota	2,040		2,040	2,048		2,048
Tennessee	[2] 42,723		[2] 42,723	(1)		(1)
Texas	[3] 2,557,438		[3] 2,557,438	3,107,421		3,107,421
Utah	2,918,930		2,918,930	3,806,367		3,806,367
Virginia	(2)		(2)			
Washington				2,339		2,339
Wisconsin		1,491,470	1,491,470	108,119	1,480,404	1,588,523
Wyoming	54,000	439,557	493,557		748,831	748,831
Total	[3] 85,064,712	24,221,505	[3] 109,286,217	114,705,621	27,622,566	142,328,187
Percent of total	77.7	22.3	100.0	81.0	19.0	100.0

[1] Tennessee included with Georgia to avoid disclosure of individual company operations.
[2] Small tonnage mined in Virginia included with Tennessee.
[3] Revised figure.

TABLE 4.—Crude iron ore shipped from mines in the United States, 1954–55, by States and disposition, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State	1954			1955		
	Direct to consumers	To beneficiation plants	Total	Direct to consumers	To beneficiation plants	Total
Alabama	3,470,060	6,225,836	9,695,896	3,773,781	6,184,108	9,957,889
Arkansas	630	430	1,060			
California	650,611	719,653	1,370,264	780,457	1,619,105	2,399,562
Colorado	6,049		6,049	3,666		3,666
Georgia	23,604	984,400	1,008,004	[1] 73,565	[1] 968,930	[1] 1,042,495
Michigan	9,438,076	762,005	10,200,081	13,721,356	1,040,955	14,762,311
Minnesota	29,418,768	38,469,805	67,888,573	43,638,270	50,733,839	94,372,109
Missouri		426,565	426,565		608,295	608,295
Montana	6,473		6,473	6,631		6,631
Nevada	351,250		351,250	324,602		324,602
New Jersey	18,584	989,913	1,008,497	164,238	1,373,577	1,537,815
New Mexico	3,316		3,316	9,218		9,218
New York	10,809	7,385,908	7,396,717	38,440	8,038,925	8,077,365
Oregon				1,786		1,786
Pennsylvania		1,280,163	1,280,163		1,544,176	1,544,176
South Dakota	2,040		2,040	2,048		2,048
Tennessee	[2] 20,335	[2] 21,700	[2] 42,035	(1)	(1)	(1)
Texas	35,422	[3] 2,522,016	[3] 2,557,438	36,002	3,071,419	3,107,421
Utah	3,040,646		3,040,646	3,847,402		3,847,402
Washington				2,339		2,339
Wisconsin	1,428,910		1,428,910	1,886,029		1,886,029
Wyoming	439,557	54,000	493,557	748,831		748,831
Total	[3] 48,365,140	[3] 59,842,394	[3] 108,207,534	69,058,661	75,183,329	144,241,990
Percent of total	44.8	55.2	100.0	47.9	52.1	100.0

[1] Tennessee included with Georgia to avoid disclosure of individual company operations.
[2] Small tonnage mined in Virginia included with Tennessee.
[3] Revised figure.

Usable ore is that produced by both mines and beneficiating plants, measured in the form shipped to the consumer. Production in 1955 totaled 102 million tons—32 percent more than in 1954 but 13 percent less than the high established in 1953. Excluding byproduct ore, the Lake Superior district supplied 82 percent of the total, the Southeastern and Western districts each 7 percent, and the Northeastern district 4 percent. These percentages are essentially the same as those established in 1950, 1951, and 1953, years when iron-ore production was considered normal in contrast to the low production years of 1952 and 1954. Minnesota again ranked first among the usable iron-ore-producing States and furnished 67 percent of the total compared with 63 percent in 1954 and 68 percent in 1953. Michigan ranked second, with 12 percent; Alabama third, with 7 percent; Utah fourth, with 4 percent; and New York fifth, with 3 percent. Eighteen States together furnished the remaining 7 percent.

Domestic iron-ore produced in 1955 contained an average of 51.25 percent iron compared with 50.90 percent in 1954, 50.44 percent in 1953, and 50.27 percent in 1952. Selectivity by consumers and more beneficiation were primarily responsible for the increase in average iron content.

TABLE 5.—Iron ore mined in the United States, 1954–55, by mining districts and varieties, in long tons

(Exclusive of ore containing 5 percent or more manganese)

Variety of ore	Lake Superior district	Southeastern States	Northeastern States	Western States	Total
1954					
Crude ore:					
Hematite	78,584,003	5,032,503	(1)	[1 2] 784,492	[2] 84,400,998
Brown ore	[3] 223,297	5,704,051		[2] 2,702,217	[2] 8,629,565
Magnetite	1,917,254		[1] 9,759,163	[1] 4,579,237	16,255,654
Total	80,724,554	10,736,554	[1] 9,759,163	[2] 8,065,946	[2] 109,286,217
Usable iron ore:					
Hematite	[3] 60,836,246	4,941,501	(1)	[1 2] 606,577	[2] 66,384,324
Brown ore	[4] 157,681	1,208,759		948,967	[2] 2,315,407
Magnetite			[1] 4,083,608	[1] 4,509,403	8,593,011
Total	60,993,927	6,150,260	[1] 4,083,608	[2] 6,064,947	[2] 77,292,742
1955					
Crude ore:					
Hematite	108,702,822	6,214,774	776,157	4,050,728	119,744,481
Brown ore	[4] 415,002	4,795,454		3,313,833	8,524,289
Magnetite			10,310,137	3,749,280	14,059,417
Total	109,117,824	11,010,228	11,086,294	11,113,841	142,328,187
Usable iron ore:					
Hematite	82,984,730	5,868,884	253,020	3,851,035	92,957,669
Brown ore	[4] 270,670	1,236,822		949,744	2,457,236
Magnetite			4,396,546	2,153,516	6,550,062
Total	83,255,400	7,105,706	4,649,566	6,954,295	101,964,967

[1] Small tonnage of hematite included with magnetite to avoid disclosure of individual company operations.
[2] Revised figure.
[3] Includes 557,310 tons of magnetite concentrate produced in Minnesota and converted to usable ore by sintering.
[4] Produced in Fillmore County, Minn.; not in the true Lake Superior district.

TABLE 6.—Iron ore produced in the United States, 1954–55, by States and types of product, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State	1954					1955				
	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	3,461,539	606,200	1,835,582	5,903,321	37.58	3,739,594	882,000	2,168,673	6,790,267	36.60
Arkansas	630		86	716	50.98					
California	580,211		649,819	1,230,030	56.59	824,654			824,654	54.55
Colorado	6,049			6,049	69.71	4,031			4,031	53.20
Georgia	23,604		197,972	221,576	41.45	[2] 73,565		[2] 241,874	[2] 315,439	[2] 40.42
Michigan	10,445,074		305,612	10,750,686	51.10	11,866,383		444,228	12,310,611	54.71
Minnesota	29,274,031	1,356,606	18,121,134	48,751,771	50.94	43,508,432	1,930,997	23,916,837	69,356,266	50.65
Missouri			173,394	173,394	52.73			260,560	260,560	52.24
Montana	6,473			6,473	40.00	6,631			6,631	40.00
Nevada	350,654			350,654	62.81	396,456			396,456	60.28
New Jersey	35,144		472,655	507,799	64.98	92,889		566,006	658,895	63.84
New Mexico	3,316			3,316	61.01	9,218			9,218	56.82
New York	10,809	2,452,126	404,765	2,867,700	63.02	38,440	2,755,128	353,576	3,147,144	71.73
Oregon						1,786			1,786	60.00
Pennsylvania		495,755	212,354	708,109	58.96		708,646	134,881	843,527	56.55
South Dakota	[3] 2,040			[3] 2,040	37.50	2,048			2,048	37.50
Tennessee	[4] 21,023		4,340	[4] 25,363	40.31	(2)		(2)	(2)	(2)
Texas	35,422	103,131	[3] 776,555	[3] 915,108	46.82	36,002	170,047	685,325	891,374	46.79
Utah	2,918,930			2,918,930	53.09	3,806,367			3,806,367	53.70
Washington						2,339			2,339	
Virginia	(4)			(4)						
Wisconsin	1,491,470			1,491,470	51.84	1,588,523			1,588,523	52.09
Wyoming	439,557		18,680	458,237	52.43	748,831			748,831	50.90
Total mined ore	[3] 49,105,976	5,013,818	[3] 23,172,948	[3] 77,292,742	50.75	66,746,189	6,446,818	28,771,960	101,964,967	51.14
Byproduct ore [5]		836,052		836,052	64.32		1,034,002		1,034,002	62.44
Grand total	[3] 49,105,976	5,849,870	[3] 23,172,948	[3] 78,128,794	50.90	66,746,189	7,480,820	28,771,960	102,998,969	51.25

[1] Exclusive of sinter produced at consuming plants.
[2] Tennessee included with Georgia to avoid disclosure of individual company operations.
[3] Revised figure.
[4] Small tonnage mined in Virginia included with Tennessee.
[5] Cinder and sinter obtained from treating pyrites.

TABLE 7.—Iron ore produced in the United States, 1954–55, by States and varieties, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State	1954				1955			
	Hematite	Brown ore	Magnetite	Total	Hematite	Brown ore	Magnetite	Total
Alabama	4,925,272	978,049		5,903,321	5,819,568	970,699		6,790,267
Arkansas	630	86		716				
California			1,230,030	1,230,030			824,654	824,654
Colorado		6,049		6,049		4,031		4,031
Georgia	217	221,359		221,576	[1] 49,316	[1] 266,123		[1] 315,439
Michigan	10,750,686			10,750,686	12,310,611			12,310,611
Minnesota	48,594,090	157,681		48,751,771	69,085,596	270,670		69,356,266
Missouri	145,670	27,724		173,394	208,007	52,553		260,560
Montana			6,473	6,473			6,631	6,631
Nevada			350,654	350,654	105,127		291,329	396,456
New Jersey			507,799	507,799	253,020		405,875	658,895
New Mexico			3,316	3,316			9,218	9,218
New York	(2)		[2] 2,867,700	[2] 2,867,700			3,147,144	3,147,144
Oregon						1,786		1,786
Pennsylvania			708,109	708,109			843,527	843,527
South Dakota	[3] 2,040			[3] 2,040	2,048			2,048
Tennessee	16,012	[4] 9,351		[4] 25,363	(1)	(1)		(1)
Texas		[3] 915,108		[3] 915,108		891,374		891,374
Utah			2,918,930	2,918,930	[5] 2,784,683		1,021,684	3,806,367
Washington					2,339			2,339
Wisconsin	1,491,470			1,491,470	1,588,523			1,588,523
Wyoming	458,237			458,237	748,831			748,831
Total	[3] 66,384,324	[3] 2,315,407	8,593,011	[3] 77,292,742	92,957,669	2,457,236	6,550,062	101,964,967
Byproduct ore [6]				836,052				1,034,002
Grand total	[3] 66,384,324	[3] 2,315,407	8,593,011	[3] 78,128,794	92,957,669	2,457,236	6,550,062	102,998,969

[1] Tennessee included with Georgia to avoid disclosure of individual company operations.
[2] Small tonnage of hematite included with magnetite to avoid disclosure of individual company operations.
[3] Revised figure.
[4] Small tonnage mined in Virginia included with Tennessee.
[5] Contains minor amount of magnetite.
[6] Cinder and sinter obtained from pyrites.

Production of usable iron ore in 1955, by States, classified according to the mineral constituent that predominates, is presented in table 7. Minnesota led in the output of hematite, Alabama in brown ore, and New York in magnetite. Limonite is the principal mineral constituent of brown ore. Although ore classified as magnetite totaled over 6 million tons, there was a scarcity of pure lump magnetite ore to supply the market that developed for its use as a shielding material in nuclear powerplants and for heavy aggregate in concrete casing for underwater pipelines.

Shipments are in long tons, with the value given at the mines, exclusive of transportation costs. The average value at the mines was $7.12 per long ton compared with $6.99 in 1954 and $6.76 in 1953. Direct shipping ore comprised 65 percent of the total, concentrates 28 percent, sinter 5 percent, and miscellaneous less than 2 percent. Iron-ore shipments to cement plants almost doubled those in 1954, shipments to paint plants were about the same as in 1954. and miscellaneous shipments increased 71 percent.

TABLE 8.—Shipments of iron ore in the United States in 1955, by States and uses, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State	Iron and steel			Cement	Paint	Miscel-laneous	Total	
	Direct shipping	Sinter [1]	Concen-trates				Gross tons	Value
Mined ore:								
Alabama	3,773,781	882,000	2,157,889				6,813,670	$44,657,215
Arkansas								
California	733,681		996,079	46,776			1,776,536	(2)
Colorado					3,666		3,666	(2)
Georgia	[3] 73,565		[3] 241,874				[3] 315,439	[3] 1,333,589
Michigan	13,692,704		422,043		28,762		14,143,509	104,258,188
Minnesota	43,638,270	1,793,125	23,986,349			1,590	69,419,334	465,169,412
Missouri			260,560				260,560	(2)
Montana				6,631			6,631	(2)
Nevada	324,602						324,602	1,667,098
New Jersey	164,238		595,312				759,550	13,633,370
New Mexico				7,963		1,255	9,218	(2)
New York	38,440	1,378,453	336,866			1,448,168	[4] 4,040,276	38,018,783
Oregon						1,786	1,786	(2)
Pennsylvania		708,646	129,703				(4)	(2)
South Dakota				2,048			2,048	(2)
Tennessee	(3)		(3)				(3)	(3)
Texas		150,999	688,442	36,002			875,443	(2)
Utah	3,843,544			3,858			3,847,402	24,687,485
Washington				2,339			2,339	(2)
Wisconsin	1,886,029						1,886,029	(2)
Wyoming	748,831						748,831	(2)
Undistributed								55,176,925
Total	68,917,685	4,913,223	29,815,117	105,617	32,428	1,452,799	105,236,869	748,602,065
Byproduct ore: [5]		1,016,935					1,016,935	8,227,972
Grand total	68,917,685	5,930,158	29,815,117	105,617	32,428	1,452,799	106,253,804	756,830,037

[1] Exclusive of sinter produced at consuming plants.
[2] Values that may not be shown separately are combined as "Undistributed."
[3] Tennessee included with Georgia to avoid disclosure of individual company operations.
[4] Pennsylvania included with New York to avoid disclosure of individual company operations.
[5] Cinder and sinter obtained from treating pyrites.

Table 9 shows iron ore mined in the United States in 1955 by States and counties, in long tons, and lists the number of active mines in each county. St. Louis County, Minn., had by far the largest number of active mines, three times as many as Michigan, the State ranking second in number. Minnesota, as usual, ranked first, with 165; Michigan second, with 40; Alabama third, with 32, and Georgia and Missouri tied for fourth, with 12 each.

At the end of 1955 the Mesabi range had produced over 2 billion long tons of iron ore since 1854, and the Lake Superior district had produced over 3 billion tons.

Iron ore was produced in the United States in 1955 by 305 mines; 42 produced over 1 million long tons of crude ore each, 36 produced 500,000 to 1 million tons, 101 produced 100,000 to 500,000 tons, and 126 produced less than 100,000 tons each. Together the 42 million-ton mines produced 62 percent of all the domestic crude ore and 60 percent of all the usable ore, excluding byproduct ore; the 32 mines next in size produced 18 percent of both the crude and usable ore; the next 101 mines produced 17 percent of the crude ore and 19 percent of the usable ore; and the 126 mines producing under 100,000 long tons of crude ore produced 3 percent of the domestic total crude and usable ore. Mines that produced more than 1 million long tons of crude ore, with State, nearest town, range or district, and mining method, are listed in table 13.

TABLE 9.—Iron ore mined in the United States in 1955, by States and counties, in long tons

(Exclusive of ore containing 5 percent or more manganese)

State and county	Active mines	Crude ore	Usable ore
Alabama:			
Bibb	1		
Blount	1	1,049,000	262,233
Butler	1		
Cherokee	2		
Crenshaw	2	2,232,191	576,336
Franklin	7		
Jefferson	7		
Pike	9	6,686,542	5,951,698
Talladega	2		
Total	[1] 32	9,967,733	6,790,267
California:			
Riverside	1	2,373,642	777,878
San Bernardino	1	46,776	46,776
Total	2	2,420,418	824,654
Colorado: San Miguel	1	4,031	4,031
Georgia:			
Bartow	7	1,042,495	315,439
Polk	5		
Total	[1] 12	[2] 1,042,495	[2] 315,439
Michigan:			
Barga	1	208,404	120,277
Dickinson	2	87,279	87,279
Gogebic	8	2,879,357	2,879,357
Iron	14	4,086,314	3,931,019
Marquette	15	5,665,658	5,292,679
Total	40	12,927,012	12,310,611
Minnesota:			
Crow Wing	17	3,582,201	2,770,738
Fillmore	2	415,002	270,670
Itasca	27	32,007,411	15,776,435
St. Louis	120	58,597,675	50,538,423
Total	166	94,602,289	69,356,266
Missouri:			
Howell	6	97,810	24,452
Oregon	3		
Ozark	1		
Shannon	1	510,485	236,108
St. Francois	1		
Total	[1] 12	608,295	260,560
Montana: Broadwater	1	6,631	6,631
Nevada:			
Churchill	1	27,108	27,108
Douglas	1		
Nevada—Con.			
Eureka	1	157,234	157,234
Humboldt	1		
Nye	1	212,114	212,114
Pershing	3		
Total	8	396,456	396,456
New Jersey:			
Morris	3	1,455,891	658,895
Warren	1		
Total	4	1,455,891	658,895
New Mexico: Grant	1	9,218	9,218
New York:			
Clinton	1		
Essex	3	8,078,965	3,147,144
St. Lawrence	1		
Total	5	8,078,965	3,147,144
Oregon: Columbia	1	1,786	1,786
Pennsylvania: Lebanon	1	1,551,438	843,527
South Dakota: Lawrence	1	2,048	2,048
Tennessee:			
Monroe	2	(2)	(2)
Roane	1		
Total	3	(2)	(2)
Texas:			
Cass	1		
Cherokee	2	3,107,421	891,374
Morris	1		
Total	4	3,107,421	891,374
Utah: Iron	6	3,806,367	3,806,367
Washington: Stevens	1	2,339	2,339
Wisconsin:			
Iron	2	1,588,523	1,588,523
Florence	1		
Total	3	1,588,523	1,588,523
Wyoming: Platte	1	748,831	748,831
Grand total	305	142,328,187	101,964,967

[1] Excludes undetermined number of small pits. Estimated output of these mines included in tonnage given.
[2] Tennessee included with Georgia to avoid disclosure of individual company operations.

TABLE 10.—Iron ore produced in the Lake Superior district, 1854–1955, by ranges, in long tons

(Exclusive after 1905 of ore containing 5 percent or more manganese)

Year	Marquette	Menominee	Gogebic	Vermilion	Mesabi	Cuyuna	Total
1854–1950	257,273,896	228,091,645	271,458,342	84,431,513	1,717,298,575	44,410,121	2,602,964,092
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
1953	5,785,118	4,604,765	5,179,608	1,643,039	75,324,236	2,900,579	95,437,345
1954	4,670,603	3,640,320	3,931,233	1,371,967	45,724,827	1,497,296	60,836,246
1955	5,412,956	4,126,417	4,359,761	1,454,365	64,860,493	2,770,738	82,984,730
Total	283,429,058	249,496,443	294,375,352	92,281,450	2,036,153,577	56,599,638	3,012,335,518

TABLE 11.—Average analyses of total tonnages (bill-of-lading weights) of all grades of iron ore from all ranges of Lake Superior district, 1946–50 (average) and 1951–55

[Lake Superior Iron Ore Association]

Year	Long tons	Content (natural), percent				
		Iron	Phosphorus	Silica	Manganese	Moisture
1946–50 (average)	73,304,593	50.67	0.092	9.38	0.75	11.22
1951	93,549,414	50.25	.090	9.87	.77	11.22
1952	77,225,818	50.49	.111	10.05	.77	10.78
1953	95,438,743	50.37	.090	10.25	.75	10.90
1954	59,585,720	50.86	.095	10.22	.70	10.47
1955	85,404,796	50.63	.099	10.11	.72	10.81

TABLE 12.—Beneficiated iron ore shipped from mines in the United States, 1925–29 (average) and 1930–55, in long 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 (average)	8,653,590	66,697,126	13.0	1943	20,117,685	98,817,470	20.4
1930	8,973,888	55,201,221	16.3	1944	20,303,422	94,544,635	21.5
1931	4,676,364	28,516,032	16.4	1945	19,586,782	87,580,942	22.4
1932	407,486	5,331,201	7.6	1946	15,588,763	69,494,052	22.4
1933	3,555,892	24,624,285	14.4	1947	21,407,760	92,670,188	23.1
1934	4,145,590	25,792,606	16.1	1948	23,629,265	100,274,965	23.6
1935	6,066,601	33,426,486	18.2	1949	20,658,232	84,174,399	24.5
1936	9,658,699	51,465,648	18.8	1950	26,717,928	97,150,704	27.5
1937	12,350,136	72,347,785	17.1	1951	30,664,648	115,660,775	26.5
1938	4,836,435	26,430,910	18.3	1952	27,023,982	97,375,010	27.8
1939	9,425,809	54,827,100	17.2	1953	35,895,529	117,197,537	30.6
1940	12,925,741	75,198,084	17.2	1954 [1]	27,756,129	76,123,624	36.4
1941	19,376,120	93,053,994	20.8	1955	36,178,208	105,236,869	34.3
1942	23,104,945	105,313,653	21.9				

[1] Revised figures.

TABLE 13.—Iron-ore mines in the United States in 1955, by size of crude output

Name of mine	State	Nearest town	Range or district	Mining method	Production (long tons)	
					Crude ore	Usable ore
Sherman Group	Minnesota	Fraser	Mesabi	Open pit	6,382,955	6,382,955
Rouchleau	do	Virginia	do	do	5,913,665	5,847,554
Benson	New York	Star Lake	Adirondack	do	4,738,432	1,591,483
Hull Rust Group	Minnesota	Hibbing	Mesabi	do	3,576,122	3,476,183
Wenonah	Alabama	Bessemer	Birmingham	Underground	3,528,892	3,484,861
Patrick A Group	Minnesota	Nashwauk	Mesabi	Open pit	2,817,636	1,103,519
Monroe Group	do	Chisholm	do	do	2,802,597	2,800,145
Plummer	do	do	do	do	2,785,388	2,191,969
King	do	Coleraine	do	do	2,641,083	1,446,676
Mississippi Group	do	Keewatin	do	do	2,513,727	1,748,040
Harrison Group	do	Nashwauk	do	do	2,424,270	769,464
Eagle Mountain	California	Desert Center	Eagle Mountain	do	2,373,642	824,654
Lone Star	Texas	Daingerfield	East Texas	do	2,373,513	561,169
Mather	Michigan	Ishpening	Marquette	Underground	2,278,631	2,278,631
Hollman Cliffs	Minnesota	Taconite	Mesabi	Open pit	2,141,994	1,105,062
Gilbert	do	Gilbert	do	do	2,107,572	2,100,138
Pilotac	do	Mount Iron	do	do	2,073,533	622,976
Hill Trumbull	do	Marble	do	do	2,051,531	648,110
Hawkins	do	Nashwauk	do	do	2,034,650	822,824
Canisteo	do	Coleraine	do	do	2,027,349	1,015,337
Hill Annex	do	Calumet	do	do	1,939,202	721,955
Canton	do	Biwabik	do	do	1,841,241	1,840,639
Spruce	do	Eveleth	do	do	1,608,193	1,496,077
Enterpise	do	Virginia	do	do	1,552,438	1,552,438
Lebanon	Pennsylvania	Lebanon	Cornwall	Underground	1,551,438	843,527
West Hill	Minnesota	Coleraine	Mesabi	Open pit	1,529,080	772,086
Pyne	Alabama	Bessemer	Birmingham	Underground	1,508,000	1,206,141
Mahoning Gap 3 and 4	Minnesota	Hibbing	Mesabi	Open pit	1,429,357	1,429,357
New Bed Harmony and Old Bed	New York	Minerville	Adirondack	Underground	1,390,133	768,492
Mountain Iron	Minnesota	Mount Iron	Mesabi	Open pit	1,349,943	1,115,486
Agnew No. 2 and So. Agnew	do	Hibbing	do	do	1,293,787	1,050,456
Arcturus	do	Marble	do	do	1,290,398	672,420
Babbitt	do	Babbitt	do	do	1,266,006	333,352
Iron Mountain	Utah	Cedar City	Iron Springs	do	1,256,321	1,256,321
Danube	Minnesota	Bovey	Mesabi	do	1,221,358	705,483
Susquehanna	do	Hibbing	do	do	1,182,707	923,589
Carlz No. 2	do	Keewatin	do	do	1,148,550	430,135
Mac Intyre	New York	Tahawus	Adirondack	do	1,122,503	562,731
Mary Ellen	Minnesota	Biwabik	Mesabi	do	1,084,945	452,152
Embarrass	do	do	do	do	1,046,434	1,046,434
Perry	do	Keewatin	do	do	1,022,311	495,944
Desert Mound	Utah	Cedar City	Iron Spring	do	1,007,819	1,007,819
Output of 42 mines producing more than 1,000,000 tons of crude ore each					89,229,346	61,504,784
Output of 36 mines producing 500,000 to 1,000,000 tons of crude ore each					25,002,792	18,332,748
Output of 101 mines producing 100,000 to 500,000 tons of crude ore each					24,224,963	19,458,795
Output of 126 mines producing under 100,000 tons of crude ore each					3,871,086	2,668,640
Grand total United States (305) mines					142,328,187	101,964,967

CONSUMPTION AND USES

United States iron-ore consumption in 1955 reached an all-time high—33 percent more than in 1954 and 2 percent more than the previous high of 1953. Of the total, 76 percent was consumed in blast furnaces, 18 percent in sintering plants, 6 percent in steel furnaces, and less than 1 percent for ferroalloys, cement, paint, and other. Material consumed at mines to make sinter included several types of concentrate agglomerates and totaled 5,648,294 long tons.

As shown in table 15, blast furnaces received most of the sinter. The quantity of iron ore consumed in steel furnaces given in table 14 is probably a close approximation but is not exact, inasmuch as the figures were obtained from mine operators who reported only the use for which the material was shipped and did not control the ultimate destination. Hard lump magnetite was used in concrete aggregate for covering underwater pipelines—a new use; it was also ordered for use in nuclear powerplants as a shielding material, although it may not have been employed for this purpose in 1955.

Sinter.—Sintering plants at mines and steel plants consumed 30,049,175 long tons of material, including 22,365,368 tons of iron-ore fines and concentrate agglomerates, 6,998,559 tons of flue dust, 628,085 tons of mill scale, and 57,163 tons of pyrite cinder. Plant output totaled 27 million tons. Output to input yield was 89 percent.

TABLE 14.—Consumption of iron ore in the United States in 1955, by States and uses, in long tons

State	Metallurgical uses				Miscellaneous uses			
	Iron blast furnaces	Steel furnaces	Sintering plants	Ferroalloy furnaces	Cement	Paint	Other	Total [1]
Alabama	7,909,152	113,479	1,232,773	1,342	49,803			9,306,549
California	3,158,507	514,300	2,494,053		28,665	(2)		6,195,525
Colorado					(2)			
Utah					(2)			
Illinois	9,522,405	512,908	472,778			(2)		10,508,091
Indiana	12,415,338	837,540	1,021,724	836				14,275,438
Kentucky	1,169,945	131,522						1,301,467
Maryland	4,435,517	587,124	900,143		(2)	(2)		5,922,784
Massachusetts								
Michigan	4,000,588	187,297	773,280					4,961,165
Minnesota	1,210,704	107,593	2,207,078				(2)	3,525,375
New Jersey						(2)		(2)
New York	4,724,136	549,115	4,369,654	170,801	(2)	(2)	(2)	9,813,706
Ohio	19,210,446	1,387,970	3,244,168	125,428	4,027	(2)		23,972,039
Pennsylvania	22,808,299	2,124,596	5,410,586	1,967	27,069	(2)		30,372,517
Tennessee	187,098				7,671			194,769
Texas	846,591	24,700	193,961		54,811			1,120,063
West Virginia	3,212,757	36,274	45,170		(2)			3,294,201
Undistributed [3]					84,255	102,949	77,413	264,617
Total	94,811,483	7,114,418	22,365,368	300,374	256,301	102,949	77,413	[4]125,028,306

[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, Arizona, Arkansas, Florida, Idaho, Iowa, Georgia, Kansas, Louisiana, Missouri, Montana, Oklahoma, Oregon, South Dakota, Virginia, Washington, and Puerto Rico; for paint, Georgia, and Virginia.

[4] Includes 1,119,704 gross tons of manganiferous iron ore.

TABLE 15.—Production and consumption of sinter in the United States in 1955, by States, in long tons

State	Sinter produced	Sinter consumed	
		In blast furnaces	In steel furnaces
Alabama	1,386,777	1,756,176	44,944
California			
Colorado	} 2,360,129	2,368,644	----------
Utah			
Delaware	110,629	----------	----------
Illinois	953,074	935,792	86,978
Indiana	2,133,445	1,896,023	423,954
Maryland			
Kentucky			
Tennessee	} 1,687,671	1,774,421	8,831
West Virginia			
Michigan	1,051,667	1,092,578	1,627
Minnesota	1,930,997	----------	----------
New York	4,471,146	2,118,770	43,866
Ohio	3,823,222	4,153,482	456,957
Pennsylvania	6,801,051	8,030,146	496,828
Texas	----------	150,999	----------
Total	26,709,808	24,277,031	1,563,985

STOCKS

Usable iron-ore stocks at mines on December 31, 1955, were 35 percent less than at the same time in 1954. The decrease brought the total down from about 1 million long tons more than normal in 1954 to about 1 million tons less than normal in 1955. Minnesota mines held the most iron ore, with 43 percent of the total; Michigan mines held 36 percent, New York and Utah mines each 6 percent, and mines in 8 other States 9 percent.

According to the Lake Superior Iron Ore Association, stocks on Lake Erie docks totaled 6,819,872 long tons on January 1, 1956. Consuming plant inventories of iron ore plus sinter totaled 44,357,638 long tons on December 31, 1955. Thus, United States stocks of iron ore and sinter at the end of the year totaled 55,740,419 long tons, an increase of 12 percent compared with 1954.

TABLE 16.—Stocks of usable iron ore at mines, Dec. 31, 1954–55, by States, in long tons

State	1954	1955	State	1954	1955
Alabama	57,972	34,569	Pennsylvania	6,696	12,946
California	50,121	64,657	Tennessee	[1] 1,929	----------
Colorado	----------	365	Texas	[2] 114,015	104,459
Michigan	3,460,801	1,627,903	Utah	304,535	258,104
Minnesota	2,218,889	1,990,512	Virginia	(1)	----------
Nevada	3,687	81,541	Wisconsin	396,936	99,430
New Jersey	115,915	10,760			
New York	346,155	277,663	Total	[2] 7,077,651	4,562,909

[1] Virginia included with Tennessee.
[2] Revised figure.

PRICES

The average value of iron ore per long ton f. o. b. mines was $7.12 in 1955 compared with $6.99 in 1954, $6.76 in 1953, and $6.09 in 1952. From 1949 to 1953 the average value of iron ore increased 10 to 11 percent each year, reflecting increased wages and material costs at the mines; but in 1954 the value increased only 3 percent and in 1955 only 2 percent, showing domestic producers' strong determination to hold prices down to meet foreign competition. Table 17 gives the average value of iron ore at the mines of different types of product and varieties of ore for each producing State. These data are taken directly from producers' statements and probably approximate the commercial selling price. Usually the value is given minus transportation cost 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. Apparently this value also is applied to iron ore not sold on the open market.

TABLE 17.—Average value per long ton of iron ore at mines in the United States, 1954–55

(Exclusive of ore containing 5 percent or more manganese)

State	1954							1955						
	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	$5.38	$6.15	-----	$7.20	$5.11	------	([1])	$6.49	$6.99	-----	$7.20	$4.69	------	([1])
Colorado	-----	8.11	-----	-----	-----	------	------	-----	5.04	-----	-----	-----	------	------
Georgia	([1])	1.79	-----	-----	4.18	------	------	([1])	-----	-----	-----	4.03	------	------
Michigan	7.19	-----	-----	8.01	-----	------	------	7.36	-----	-----	7.78	-----	------	------
Minnesota	6.41	-----	-----	6.68	5.82	------	([1])	6.50	-----	-----	6.93	([1])	------	([1])
Montana	-----	-----	$6.00	-----	-----	------	------	-----	-----	$6.72	-----	-----	------	------
New Jersey	-----	-----	([1])	-----	-----	$13.92	------	-----	-----	([1])	([1])	-----	$15.27	------
New York	-----	-----	([1])	([1])	-----	7.09	$11.90	-----	-----	([1])	-----	-----	9.92	$12.12
Pennsylvania	-----	-----	-----	-----	-----	([1])	([1])	-----	-----	-----	-----	-----	([1])	([1])
Utah	-----	-----	6.34	-----	-----	------	------	6.25	-----	6.87	-----	-----	------	------
Other States [2]	7.10	3.64	7.52	9.86	6.47	8.47	([1])	6.90	6.39	7.55	10.80	7.22	8.64	([1])
Average, all States	6.52	3.76	6.67	6.75	5.58	10.29	10.58	6.68	6.38	7.87	7.15	5.72	10.41	10.76
Byproduct ore [3]	-----	-----	-----	-----	-----	------	14.94	-----	-----	-----	-----	-----	------	8.09

[1] Included with average for all States to avoid disclosure of individual company operations.
[2] Includes California, Missouri, Nevada, New Mexico, Oregon, South Dakota, Tennessee, Texas, Washington, Wisconsin, and Wyoming.
[3] Cinder and sinter obtained from pyrites.

E&MJ Metal and Mineral Markets quoted Lake Superior iron ore, 51.5 percent iron, per long ton lower Lake ports in 1955, as follows: From January 1 to February 24—Mesabi Non-Bessemer $9.90, Old Range Non-Bessemer $10.15, Mesabi Bessemer $10.05, and Old Range Bessemer $10.30; and from February 24 to December 29—Mesabi Non-Bessemer $10.10, Old Range Non-Bessemer $10.25, Mesabi Bessemer \$10.25, and Old Range Bessemer \$10.40. These are base prices, adjusted for iron, phosphorus, and manganese content according to a formula adopted in 1925. The same publication quoted eastern ores, foundry and basic, delivered at the furnaces 56 and 62 percent iron at 17 and 18 cents per long-ton unit throughout the year.

TRANSPORTATION

Increased movement of iron ore throughout the world in 1955 emphasized the need for more ore carriers as a shipping crisis was averted only by continuing to modify American-built Liberty ships to handle bulk cargoes. The shipping shortage was widespread but was most acute for seagoing iron-ore carriers to transport ore to the United States from rapidly developing mines in Labrador and Venezuela.

Great Lakes.—Great Lakes iron-ore transportation companies in 1955 marked the fourth largest season in history by moving 86,895,098 long tons from upper Lake ports and 2,370,229 tons all-rail haulage to consuming centers from United States ranges and Canadian districts. The 1955 shipping season started slowly on April 12, owing to low estimates for 1955 requirements and exceptionally heavy ice on the upper lakes. After continuing slowly through the early summer, however, shipments increased rapidly and were at a high rate until the season closed the week of December 5.[2]

Foreign.—To meet the ship shortage that developed from foreign ore operations, 27 bulk ore carriers totaling 615,450 tons were ordered abroad from late 1953 through 1955. England and Scotland were building 30 percent of them, with Japan and Germany a close second and third.[3]

Several Liberty ships were modified in 1954 for bulk carrier service by lengthening the hull and installing a false deck over the shaft alley. By early 1955 the advantages of such modification became evident; Japanese shipyards agreed to virtual mass production, and orders were placed for an estimated 50 such conversions.[4]

An iron-ore transfer dock was being constructed by the Iron Ore Co. of Canada, Ltd., at Contrecoeur, 25 miles down the St. Lawrence River from Montreal, Canada. It will be used to transfer iron ore from deep-draft, ocean-going ships to St. Lawrence Canal-size vessels. The main unloading dock is 750 feet long, with a minimum of 35 feet of water at the dock face; the adjacent loading dock is 485 feet long, with a minimum of 17 feet of water at the dock face.[5]

---

[2] Skillings Mining Review, vol. 44, No. 2, Apr. 16, 1955, p. 14; vol. 44, No. 35, Dec. 24, 1955, pp. 1–4.
[3] Rohan, T. M., Iron Ore Shipping Crisis Looms: Iron Age, vol. 176, No. 2, July 14, 1955, pp. 64–65.
[4] Bardelmeier, W. E., A New Lease on Life for Liberty Ships in Fast Growing World Ore Trades: Skillings, Min. Rev. vol. 44, No. 41, Jan. 14, 1956, pp. 2–3.
[5] Skillings Mining Review, Iron Ore Transfer Facilities at Contrecoeur, Quebec: Vol. 43, No. 47, Feb. 26, 1955, pp. 1, 4.

Freight Rates.—Total freight charges via the Great Lakes from the Mesabi range to the Pittsburgh-Wheeling district were $5.1306 per long ton in 1955, unchanged since 1953. Component charges were $1.1799, Mesabi range to Duluth, including $0.1495 dock handling charge; $1.83 Duluth to Lake Erie ports, including $0.23 hold to rail of vessel handling charge; and $2.1207, Lake Erie ports to the Pittsburgh-Wheeling district, including $0.1495 vessel rail to car handling charge. All-rail freight charges from the Mesabi range to the Pittsburgh-Wheeling district were $7.3104 per long ton in 1955, unchanged from 1954.

FOREIGN TRADE [6]

Iron ore imported for consumption in the United States reached a new high in 1955, as new properties financed by United States capital in Canada and Venezuela approached full production. The average value per long ton was $7.56, equal to the average value of 1954 imports.

Canada increased shipments of iron ore to the United States 185 percent and supplied 43 percent of the United States total iron-ore imports, displacing Venezuela as the principal supplier. Venezuela increased shipments 37 percent and supplied 31 percent of the total to rank second. Peru supplied 7 percent of the total, Sweden 5 percent, Chile, Brazil, and Liberia each 4 percent, and 6 other countries together the remaining 2 percent. Canada was the only country that supplied pyrites cinder to the United States.

Exports of iron ore from the United States in 1955, as in previous years went principally to Canada.

Table 21 gives world iron-ore export-import statistics for 1953, the latest data available. The fact that the statistical pattern does not emerge with acceptable accuracy for at least 2 years is responsible for the difference in time with this issue of the Minerals Yearbook.

Foreign trade in iron ore expanded with recovery of the European economy after World War II and increasing United States imports after 1952. In 1953 the iron-ore trade in Europe leveled, and the world total of exports increased only 4 percent compared with 1952. Peru and Turkey entered international trade in iron ore for the first time in 1953. Peru exported almost 1 million tons to the United States from its newly developed Marcona deposit, and Turkey exported 60-percent iron ore to Germany, Italy, and the Netherlands. Yugoslavia virtually withdrew from the world market and exported only 4,000 tons that appeared in the international pattern.

[6] Figures on imports and exports compiled by May B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 18.—Iron ore imported for consumption in the United States, 1946–50 (average) and 1951–55, by countries, in long tons

[U. S. Department of Commerce]

Country	1946–50 (average)		1951		1952		1953		1954		1955	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
North America:												
Canada	1, 414, 421	$8, 372, 177	1, 961, 990	$14, 399, 135	1, 822, 038	$13, 884, 030	1, 840, 983	$16. 050, 131	[1] 3, 537, 489	[1] $28, 622, 647	10, 077, 238	$79, 025, 454
Newfoundland-Labrador	3, 100	12, 400										
Costa Rica					449	1, 005	3, 076	4, 588				
Cuba	77, 281	342, 337	4, 223	29, 926	87, 536	882, 684	196, 676	1, 853, 187	32, 165	313, 563	40, 197	316, 086
Dominican Republic					18, 408	197, 943	80, 401	947, 442	89, 160	1, 066, 861	101, 934	1, 173, 494
Mexico	115, 937	239, 615	169, 563	506, 482	114, 309	356, 845	241, 636	1, 048, 617	140, 863	417, 539	176, 293	573, 867
Total	1, 610, 739	8, 966, 529	2, 135, 776	14, 935, 543	2, 042, 740	15, 322, 507	2, 362, 772	19, 903, 965	[1] 3, 799, 677	[1] 30, 420, 610	10, 395, 662	81, 088, 901
South America:												
Argentina	8	4, 989										
Brazil	286, 785	1, 792, 023	1, 037, 828	8, 921, 991	1, 010, 919	14, 938, 163	458, 282	6, 386, 308	595, 907	7, 016, 488	1, 010, 579	11, 224, 489
Chile	2, 124, 686	5, 684, 528	2, 767, 207	8, 587, 746	1, 861, 575	8, 240, 661	2, 363, 401	12, 347, 510	1, 664, 300	7, 865, 692	1, 035, 399	5, 379, 900
Peru							844, 481	5, 955, 545	1, 931, 929	15, 594, 978	1, 554, 101	13, 629, 972
Venezuela			635, 416	3, 780, 692	1, 845, 776	14, 610, 871	1, 949, 618	17, 026, 862	5, 209, 812	36, 034, 782	7, 154, 564	45, 518, 498
Total	2, 411, 479	7, 481, 540	4, 440, 451	21, 290, 429	4, 718, 270	37, 789, 695	5, 615, 782	41, 716, 225	9, 401, 948	66, 511, 940	10, 754, 643	75, 752, 859
Europe:												
Belgium-Luxembourg	244	820										
Denmark							123	4, 408				
France	2, 702	15, 173										
Greece	200	600										
Italy	1, 993	13, 198										
Netherlands	1, 423	12, 805										
Norway	32, 264	189, 972										
Spain	3, 131	29, 101	74, 306	599, 350	4, 600	33, 482	10, 690	124, 779	235	5, 291		
Sweden	1, 390, 630	8, 772, 805	2, 522, 011	16, 920, 468	2, 111, 100	24, 504, 292	2, 097, 522	27, 207, 210	1, 543, 753	14, 241, 188	1, 221, 334	12, 334, 640
United Kingdom	468	27, 801	446	28, 837	690	23, 369	444	24, 011	354	30, 129	2, 079	58, 461
Total	1, 433, 055	9, 062, 275	2, 596, 763	17, 548, 655	2, 116, 390	24, 561, 143	2, 108, 779	27, 360, 408	1, 544, 342	14, 276, 608	1, 223, 413	12, 393, 101
Asia:												
Iran	1, 800	94, 800	1, 500	60, 000	2, 972	165, 755	2, 953	205, 053	2, 953	200, 858		
Philippines	2, 602	23, 339										
Total	4, 402	118, 139	1, 500	60, 000	2, 972	165, 755	2, 953	205, 053	2, 953	200, 858		

See footnotes at end of table.

TABLE 18.—Iron ore imported for consumption in the United States, 1946–50 (average) and 1951–55, by countries, in long tons—Con.

[U. S. Department of Commerce]

Country	1946–50 (average)		1951		1952		1953		1954		1955	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
Africa:												
Algeria	286,036	$1,558,730	446,273	$2,919,490	66,008	$518,994	21,150	$273,888	29,100	$339,550	20,255	$245,176
British West Africa	58,743	474,736	255,817	1,586,940	217,760	1,108,055	231,600	1,305,910	250,820	1,404,547	137,699	800,426
Egypt	1,500	17,730										
French Morocco	2,848	15,686										
Liberia	7	48	110,123	552,694	572,485	3,156,561	710,290	5,764,548	763,610	6,304,832	927,988	7,048,791
Spanish Africa	9,636	59,918	8,750	62,335								
Tunisia	58,228	300,307	134,775	528,617	19,200	188,260	19,700	231,243				
Union of South Africa	1,787	9,911	9,450	35,343	4,800	43,536	1,009	26,978				
Total	418,785	2,437,066	965,188	5,685,419	880,253	5,015,406	983,749	7,602,567	1,043,530	8,048,929	1,085,942	8,094,393
Grand total	5,878,460	28,065,549	10,139,678	59,520,046	9,760,625	82,854,506	11,074,035	96,788,218	[1] 15,792,450	[1,2] 119,458,945	23,459,660	177,329,254

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce data known to be not comparable with other years.

TABLE 19.—Pyrites cinder [1] imported for consumption in the United States, 1946–50 (average) and 1951–55, by countries, in long tons

[U. S. Department of Commerce]

Country	1946–50 (average)		1951		1952		1953		1954		1955	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
North America: Canada	12,295	$41,446	8,675	$34,758	11,149	$48,028	12,053	$54,172	898	$3,556	3,879	$15,801
Europe:												
Belgium-Luxembourg	(2)	18										
France	140	148										
Italy	(2)	2										
Total	140	168										
Grand total	12,435	41,614	8,675	34,758	11,149	48,028	12,053	54,172	898	3,556	3,879	[3] 15,801

[1] Byproduct iron ore.
[2] Less than 1 ton.
[3] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not comparable with earlier years.

TABLE 20.—Iron ore exported from the United States, 1946–50 (average) and 1951–55, by countries of destination, in long tons

[U. S. Department of Commerce]

Destination	1946–50 average		1951		1952		1953		1954		1955	
	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value	Long tons	Value
North America:												
Canada	2,411,180	$11,342,808	3,340,170	$21,734,997	3,790,253	$24,507,789	3,853,580	$28,094,069	2,812,367	$21,669,146	4,231,806	$34,076,880
Canal Zone	4	85	4	138	7	212						
Mexico	9	79	46	127					88	2,379		
Other North America	23	591										
Total	2,411,216	11,343,563	3,340,220	21,735,262	3,790,260	24,508,001	3,853,580	28,094,069	2,812,455	21,671,525	4,231,806	34,076,880
South America:												
Brazil			4	326								
Colombia									46	1,700	18	680
Other South America	(1)	15										
Total	(1)	15	4	326					46	1,700	18	680
Europe:												
Netherlands	20	1,503										
Norway	15	158	854	11,129								
United Kingdom	3	840	9	2,200								
Other Europe	4	237										
Total	42	2,738	863	13,329								
Asia:												
Japan	62,532	567,930	987,814	9,245,943	1,332,379	12,893,934	398,374	4,327,448	332,231	3,065,285	284,602	2,874,243
Philippines	811	7,489	5	485	1	120	1	120			400	40,000
Total	63,343	575,419	987,819	9,246,428	1,332,380	12,894,054	398,375	4,327,568	332,231	3,065,285	285,002	2,914,243
Africa:												
French Morocco	20	990										
Gold Coast	(1)	93										
Union of South Africa									978	43,808		
Total	20	1,083							978	43,808		
Oceania: Australia	4	1,263	4	1,439	4	1,918			4	1,679	2	720
Grand total	2,474,625	11,924,081	4,328,910	30,996,784	5,122,644	37,403,973	4,251,955	32,421,637	3,145,714	24,783,997	4,516,828	36,992,523

[1] Less than 1 ton.

TABLE 21.—World trade of iron ore, in thousand long tons, in 1953

[Compiled by Corra A. Barry]

Exports by countries of origin	Fe (percent)	Production	Exports	Exports, by countries of destination															
				North America		Europe												Asia	
				Canada	United States	Austria	Belgium-Luxembourg	Czechoslovakia	France	Germany, West	Italy	Netherlands	Poland	Saar	Spain	Switzerland	United Kingdom	Japan	Other countries
North America:																			
Canada	55	5,813	4,304		1,843					529							1,077	855	
Cuba	34	197	206		201						5								
Mexico	68	538	239	(1)	238														1
United States	49	117,995	4,252	3,853														399	(1)
South America:																			
Brazil	68	3,560	1,523	57	499	32	20	20	7	460		50	49				319	10	
Chile	64	2,131	2,403		2,334					50		1						18	
Peru	62	985	933		933														
Venezuela	64	2,260	1,942		1,942														
Europe:																			
Austria	32	2,713	192							192									
Belgium-Luxembourg	28	7,154	870						604	264		2							(1)
France	33	41,777	16,115				8,860			335		184	12	6,278			445		1
Germany, West	27	14,388	193			134			10		1	(1)		47					1
Greece	49	85	97			16				24							57		
Italy	29	975	4							4									
Norway	65	1,167	893				32	19		602		32	149				54		5
Portugal	50	120	133							29	37						67		(1)
Spain	45	2,976	1,446		11	16	28			667		209				51	412		52
Sweden	60	16,715	14,323		2,076	11	2,403	5	107	4,688	49	337	754				3,854		39
Switzerland	31	103	104			21				83									
Yugoslavia	45	782	4			4													
Asia:																			
Hong Kong	45	123	116															110	6
India	53	3,845	1,094			79	51	421		108								435	
Malaya	45	1,063	1,019														174	845	(1)
Philippines	54	1,199	1,187															1,187	
Portuguese India	55	929	849							409		62						378	
Turkey	60	489	110							25	34	37					4		10

Africa:																			
Algeria	52	3, 335	3, 199	------	21	11	139	------	76	362	445	229	44	------	------	------	1, 872	------	------
French Morocco	45	501	506	------	------	------	------	------	4	72	(1)	149	------	------	------	------	281	------	------
Liberia	68	1, 264	1, 434	78	791	------	------	------	------	238	------	67	------	------	------	------	260	------	------
Sierra Leone	60	1, 368	1, 200	------	212	------	------	------	------	241	------	------	------	------	------	(1)	747	------	------
Spanish Morocco	67	970	904	------	------	------	------	------	51	229	10	63	------	------	287	5	259	------	------
Tunisia	53	1, 040	1, 021	------	20	14	------	------	30	68	202	90	27	------	------	------	570	------	------
Union of South Africa	62	1, 940	4	------	------	------	------	------	------	2	------	2	------	------	------	------	------	------	------
Oceania: Australia	60	3, 299	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Other countries	(2)	[3] [4] 88, 201	(2)	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------	------
Total	------	[4] 332, 000	62, 819	3, 988	11, 121	338	11, 533	465	889	9, 681	783	1, 514	1, 035	6, 325	287	56	10, 452	4, 237	115

[1] Less than 500 tons.
[2] Data not available.
[3] Includes 59,000,000 tons produced in U. S. S. R. and 15,817,000 tons produced in the United Kingdom.
[4] Estimate.

TECHNOLOGY

The geologic, geographic, and economic aspects of the iron-ore deposits of Canada were subjects of an iron-ore symposium February 16, 1955, at the Ottawa Branch, Minerals Resources Division, Canada Department of Mines and Technical Surveys.[7] Geologic evidence uncovered by mining operations at Steep Rock Lake, Canada, since 1945 clearly sets this region apart from other Lake Superior iron ranges, but a comprehensive presentation on the ores and geology of the deposits will not be available for several years.[8] Reconstruction of an environment favorable for the formation of banded ores indicated that temperatures during periods of deposition apparently were similar to the average temperature of sea and lake water today.[9] The silica bands in iron ore correspond to the warm season and hematite bands to the cool season.

The Bureau of Mines experimental blast furnace, producing about 12 tons of iron daily, was operated with varying portions of anthracite replacing a corresponding quantity of coke. The furnace operated well with anthracite comprising up to 40 percent of the total fuel and produced metal of uniformly low sulfur and normal silicon content.[10] In Belgium, low-silicon pig iron was produced in a low-shaft blast furnace utilizing ore fines.[11] A commercial blast furnace with a hearth diameter of 25 feet, 16 tuyères, and a working volume to hearth area ratio of 68 was operated with a 100-percent sinter burden. It was proved to the satisfaction of the investigators that a blast furnace can be operated successfully and efficiently on 100 percent sinter, with a definite increase in iron production, a lower coke rate, and less fluedust.[12]

Taconite mining and ore-dressing processes were items of principal technologic interest in 1955, and the methods employed in mining and processing taconite at its Mesabi property by the Reserve Mining Co. were described.[13] A process was patented for treating iron ore composed of heterogeneous, fine particles of magnetizable iron minerals associated with gangue by disintegrating the loosely compacted masses of iron minerals and gangue with a stream of water, washing gangue particles out in an overflow, and collecting iron minerals in an underflow.[14] Investigations were continued on agglomeration of iron-ore concentrate, and it was determined that oxidation plays an important role in the bonding of magnetite pellets.[15] The properties of an experimental pellet-sinter were described.[16] Data were presented

[7] Department of Mines and Technical Surveys, Minerals Resources Division, Mines Branch, Ottawa, Canada, Iron Ore in Canada, a Symposium: Feb. 16, 1955, 14 pp.
[8] Jolliffe, A. W., Geology and Iron Ores of Steep Rock Lake: Econ. Geol., vol. 50, No. 4, June–July 1955, pp. 373–398.
[9] Alexandrov, E. A., Contribution to Studies of Origin of Precambian Banded Iron Ore: Econ. Geol., vol. 50, No. 5, August 1955, pp. 459–468.
[10] Buehl, R. C., and Royer, M. B., Smelting Iron Ore With Anthracite: Bureau of Mines Experimental Blast Furnace: Bureau of Mines Rept. of Investigations 5165, 1955, 15 pp.
[11] Coheur P., Ore Fines Utilized in Low-Shaft Furnace to Produce Thomas Pig Iron: Jour. Metals, vol. 7, No. 8, August 1955 pp. 872–876.
[12] Sundquist, R. W., One-Hundred-Percent Sinter Burden at Gary Works: Iron and Steel Eng., vol. 32, No. 8, August 1955, pp. 120–121.
[13] Grindrod, J., Open-Pit Taconite Mining at Mesabi, U. S.: Min. Jour. (London) vol. 245, No. 6263, Sept. 2, 1955, pp. 258–260.
[14] Roe, L. A., Concentration of Iron Ores: U. S. Patent No. 2,711,248, June 21, 1955.
[15] Joseph, T. L., Pelletizing of Iron-Ore Concentrates: Blast Furnace and Steel Plant, vol. 43, No. 7, July 1955, pp. 745–752.
[16] Hamilton, F. M., and Ameon, H. F., Production and Properties of Experimental Pellet-Sinter: Iron and Steel Eng., vol. 32, No. 8, August 1955, p. 84.

on the product obtained when taconite, magnetite, and hematite concentrate and several titanium oxide ores were agglomerated with limited quantities of carbon, using low-temperature coke as the binder.[17]

RESERVES

Iron-ore reserves of Michigan, and of Minnesota, represent only taxable and State-owned reserves and not the total that may become available. Reserves in the Lake Superior district are changed each year as deposits are explored and mined further. This can result in either a net gain or loss, but operating companies try to keep reserves approximately static. The Minnesota reserve, however, has steadily declined since 1950, thus indicating that the current mining limits of known deposits are being reached. Taconite deposits are not included in the Minnesota reserves, but in view of their successful exploitation these deposits constitute an iron-ore reserve many times larger than that of the listed taxable and State-owned reserve.

TABLE 22.—Iron-ore reserves in Michigan, Jan. 1, 1947–51 (average) and 1952–56, in long tons

[Michigan Department of Conservation]

Range	1947–51 (average)	1952	1953	1954	1955	1956
Gogebic	31,269,225	34,162,005	31,467,972	28,606,915	31,325,522	30,810,235
Marquette	65,880,062	65,119,690	64,943,858	65,364,095	69,549,132	63,820,116
Menominee	54,481,288	62,940,226	62,188,665	60,086,244	59,322,347	58,284,296
Total Michigan	151,630,575	162,221,921	158,600,495	154,057,254	160,197,001	152,914,647

TABLE 23.—Unmined iron-ore reserves in Minnesota, May 1, 1946–50 (average) and 1951–55, in long tons

[Minnesota Department of Taxation]

	1946–50 (average)	1951	1952	1953	1954	1955
Mesabi	915,142,080	893,007,833	854,280,596	839,732,761	825,291,618	787,992,201
Vermillion	11,470,675	11,660,302	12,390,557	12,989,074	12,062,931	11,307,120
Cuyuna	46,628,652	41,415,581	43,472,578	43,983,246	58,903,347	58,859,058
Total, Lake Superior district (taxable)	973,241,407	946,083,716	910,143,731	896,705,081	896,257,896	858,158,379
Fillmore County	[1] 427,878	908,996	574,908	607,500	573,492	665,687
Morrison County	17,657	43,986	15,000			
Aitkin County			850,000	850,000	869,571	869,571
Mower County					118,160	118,160
State ore (not taxable)	8,323,972	2,643,033	2,486,297	117,197	117,197	117,197
Total, Minnesota	982,010,914	949,679,731	914,069,936	898,279,778	897,936,316	859,928,994

[1] 1947–50 (average).

EMPLOYMENT

Employment at iron-ore mines and beneficiation plants, the quantity and the tenor of ore produced, and the average output per man in 1954, by districts and States are given in table 24. The average

[17] Lesher, C. E., Agglomerating Fine Sized Ores With Low-Temperature Coke: Jour. Metals, vol. 7, No. 10, October 1955, pp. 1114–1118.

TABLE 24.—Employment at iron-ore mines and beneficiating plants, quantity and tenor of ore produced, and average output per man in 1954, by districts and States

District and State	Employment					Production									
	Average number of men employed	Time employed				Crude ore (long tons)	Usable ore			Average per man (long tons)					
		Average number of days	Total man-shifts	Average per shift	Man-hours		Long tons	Iron contained		Crude ore		Usable ore			
					Total			Long tons	Natural (percent)	Per shift	Per hour	Per shift	Per hour	Iron contained	
														Per shift	Per hour
Lake Superior:[1]															
Michigan, Wisconsin	8,672	219	1,903,405	8.00	15,229,438	12,714,337	12,255,871	6,284,835	51.28	6.680	0.835	6.439	0.805	3.302	0.413
Minnesota	12,172	229	2,784,363	8.00	22,280,529	68,584,822	49,197,485	25,015,015	50.85	24.632	3.078	17.669	2.208	8.984	1.123
Total	20,844	225	4,687,768	8.00	37,509,967	81,299,159	61,453,356	31,299,850	50.93	17.343	2.167	13.109	1.638	6.677	.834
Southeastern States:															
Alabama	3,596	185	663,868	8.15	5,407,524	9,685,827	5,903,321	2,218,468	37.58	14.590	1.791	8.892	1.092	3.342	.410
Georgia	70	237	16,623	9.05	150,477	1,008,004	221,576	91,846	41.45	60.639	6.699	13.329	1.472	5.525	.610
Tennessee[2]	5	200	1,000	8.00	8,000	42,723	25,363	10,224	40.31	42.723	5.340	25.363	3.170	10.224	1.278
Total	3,671	186	681,491	8.00	5,566,001	10,736,554	6,150,260	2,320,538	37.73	15.755	1.929	9.025	1.105	3.405	.417
Northeastern States:															
New Jersey	586	225	131,788	8.00	1,054,304	1,025,057	507,799	329,968	64.98	7.778	.972	3.853	.482	2.504	.313
New York, Pennsylvania	1,549	234	362,894	8.00	2,903,151	8,734,106	3,575,809	2,224,849	62.22	24.068	3.008	9.854	1.232	6.131	.766
Total	2,135	232	494,682	8.00	3,957,455	9,759,163	4,083,608	2,554,817	62.56	19.728	2.466	8.255	1.032	5.165	.646
Western States:															
California, Nevada, Colorado	214	254	54,363	8.03	436,509	1,656,567	1,586,733	920,469	58.01	30.472	3.795	29.188	3.635	16.932	2.109
Missouri	167	163	27,232	8.00	217,857	426,565	173,394	91,407	52.73	15.664	1.958	6.367	.796	3.357	.420
New Mexico, Texas	178	236	42,026	7.98	335,398	2,560,754	918,424	430,113	46.83	60.932	7.635	21.854	2.738	10.234	1.282
Utah, Wyoming	631	228	144,109	8.01	1,154,309	3,412,487	3,377,167	1,789,926	53.00	23.680	2.956	23.435	2.926	12.421	1.551
Total	1,190	225	267,730	8.01	2,144,073	8,056,373	6,055,718	3,231,915	53.41	30.091	3.758	22.619	2.824	12.072	1.507
Total 1954[2]	27,840	220	6,131,671	8.02	49,177,496	109,860,822	77,752,171	39,408,509	50.69	17.917	2.234	12.680	1.581	6.427	.801

[1] Includes manganese-bearing ore in the Lake Superior district.
[2] Man-hour data for Arkansas, Montana, South Dakota, and Virginia are not available and are therefore excluded from all totals; however, production data for Virginia are included with Tennessee and for Arkansas, Montana, and South Dakota (9.573 tons of crude ore and 9,229 tons of usable ore) are included with total production.

output of usable ore per man-hour in 1954 was 1.581 long tons, 0.190 ton less than in 1953 but 0.030 ton more than in 1952. Iron-mining companies maintain a stable labor force; therefore, within limits, the yearly average output per man-hour is determined by the total quantity of ore produced in a year. Accordingly, the low output per man-hour in 1954 reflected low total production and not a decrease in the efficiency of mining operations.

The labor force at iron mines and beneficiating plants in 1954 was 9 percent less and worked an average of 51 fewer days than in 1953. The total number of man-hours decreased 26 percent.

WORLD REVIEW

World iron-ore production reached an alltime record high of 366 million long tons in 1955, a 22-percent increase over 1954. New records were established for all continents except North America. However, North American production increased 39 percent compared with 1954. South American iron-ore production increased 29 percent, European 13 percent, Asian 15 percent, and African 24 percent. The total world iron-ore production in 1955 was 81 percent higher than the 5-year average for 1946–50 and 74 percent higher than the 5-year average for 1941–45. World demand for iron ore continued unabated throughout the year; in most areas transportation was the only factor that limited still higher production.

TABLE 25.—World production of iron ore, by countries,[1] 1946–50 (average) and 1951–55, in thousand long tons [2]

[Compiled by Pearl J. Thompson]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	2,990	4,179	4,707	5,813	6,573	15,515
Cuba	60	17	99	197	25	[3] 44
Dominican Republic	------	------	19	91	105	98
Mexico	340	453	515	538	514	705
United States	89,584	116,505	97,918	117,995	78,129	102,999
Total	93,000	121,200	103,300	124,600	85,300	119,400
South America:						
Argentina	[4] 4	54	66	72	60	69
Brazil	1,110	2,369	3,112	3,560	3,023	4,084
Chile	2,177	3,201	2,174	2,131	1,958	1,685
Colombia	------	------	------	------	82	344
Peru	------	------	------	985	2,188	1,702
Venezuela	[5] 195	1,250	1,939	2,260	5,335	8,306
Total	3,500	6,900	7,300	9,000	12,600	16,200
Europe:						
Austria	1,159	2,333	2,611	2,713	2,678	2,793
Belgium	54	78	133	97	80	104
Bulgaria [4]	13	42	59	66	76	100
Czechoslovakia	[4] 1,435	1,770	2,070	2,260	2,260	2,560
Finland	------	------	------	17	130	181
France	23,514	34,647	40,158	41,777	43,132	49,525
Germany:						
East	[4] 275	481	761	1,278	1,382	1,575
West	7,015	12,719	15,161	14,388	12,830	15,436
Greece	26	52	135	85	76	189
Hungary	276	306	311	353	421	347
Italy	381	544	778	975	1,048	1,328
Luxembourg	3,075	5,536	7,131	7,057	5,794	7,091
Norway	189	327	757	1,167	1,077	1,237

See footnotes at end of table.

TABLE 25.—World production of iron ore, by countries,[1] 1946–50 (average) and 1951–55, in thousand long tons [2]—Continued

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
Europe—Continued						
Poland	600	890	1,010	1,325	1,600	1,875
Portugal	----	21	88	120	81	138
Rumania [4]	230	470	645	680	685	690
Spain	1,714	2,351	2,818	2,976	2,869	3,825
Sweden	11,099	15,140	16,681	16,715	15,083	16,851
Switzerland	52	85	105	103	100	127
U. S. S. R.[4 6]	29,860	47,200	49,200	59,000	63,300	70,800
United Kingdom	12,543	14,777	16,233	15,817	15,557	16,175
Yugoslavia	705	573	665	782	1,093	1,376
Total [4]	94,200	140,300	157,500	169,800	171,400	194,300
Asia:						
China [4]	550	3,400	4,300	5,600	7,200	8,600
Hong Kong	46	160	128	123	91	115
India	2,594	3,657	3,926	3,845	4,308	4,567
Iran [7]	----	14	10	[4] 10	10	[4] 10
Japan [8]	659	1,150	1,372	1,517	1,605	1,492
Korea:						
North	102	(9)	(9)	(9)	(9)	(9)
Republic of	----	49	21	19	31	29
Lebanon	----	----	7	30	49	30
Malaya	102	846	1,055	1,063	1,213	1,466
Philippines	194	889	1,152	1,199	1,402	1,410
Portuguese India	57	429	478	929	1,359	[3] 1,424
Thailand (Siam)	[5] 3	6	3	8	3	7
Turkey	177	222	474	489	577	860
Total [4 6]	4,500	10,900	13,000	14,900	18,300	21,000
Africa:						
Algeria	2,010	2,778	3,043	3,335	2,881	3,539
Belgian Congo	----	----	----	----	4	12
French Guinea	----	----	----	393	583	640
French Morocco	249	536	645	501	330	305
Liberia	----	168	890	1,264	[3] 1,190	1,840
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia	----	----	6	2	1	2
Southern Rhodesia	28	51	64	62	63	83
Sierra Leone	956	1,141	1,164	1,368	817	[3] 1,332
Spanish Morocco	863	922	919	970	916	1,017
Tunisia	541	908	962	1,040	935	1,122
Union of South Africa	1,123	1,399	1,731	1,940	1,863	1,967
Total	5,800	7,900	9,400	10,900	9,600	11,900
Oceania:						
Australia	1,966	2,436	2,684	3,299	3,519	3,573
New Caledonia	[5] 15	----	----	----	----	----
Total	2,000	2,400	2,700	3,300	3,500	3,600
World total (estimate)[1]	203,000	289,600	293,200	332,500	300,700	366,400

[1] In addition to countries listed Burma, Egypt, and Madagascar report production of iron ore, 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. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] Exports.
[4] Estimate.
[5] Average for 1 year only, as 1950 was the first year of commercial production.
[6] U. S. S. R. in Asia included with U. S. S. R. in Europe.
[7] Year ended March 21 of year following that stated.
[8] Includes iron sand production as follows: 1946–50 (average), 29,821 tons: 1951, 251,942 tons; 1952, 316,923 tons; 1953, 430,954 tons: 1954, 501,439 tons; and 1955, 541,890 tons.
[9] Data not available: estimate by author of chapter included in the total.

NORTH AMERICA

Canada.[18]—Canadian iron-ore production in 1955 totaled 15.5 million long tons, 136 percent more than the quantity produced in 1954. The Iron Ore Co. of Canada, producing from its high-grade ore deposits in Labrador and New Quebec, for the first full year, was responsible for most of the increase, but all major iron-ore-producing companies produced more in 1955 than in 1954.

Alberta.—The Province of Alberta issued an iron-ore prospecting permit to Canadian Collieries, permitting the company to conduct surveys for ore on 38,268 acres of land around the Waterton National Park.

British Columbia.—The Texada Argonaut deposits on Vancouver Island were the only iron-ore deposits exploited in British Columbia in 1955, although a number of low-grade magnetite deposits have been outlined. Quatsino Copper-Gold Mines, Ltd., negotiated with Japanese steel interests for delivery of 1 million tons of beneficiated iron ore over a 3-year period. The company has an iron-ore claim about 80 miles north of Quinsam Lake on Vancouver Island.

Newfoundland-Quebec.—The Labrador trough area of Labrador and New Quebec contains an iron formation extending almost continuously in an arc from the northern part of the west coast of Quebec adjacent to Ungava Bay through Labrador to the Mount Wright area of Quebec. In the Ungava Bay and neighboring areas severe weather, isolation, and an extremely short shipping season, together with heavy cost to be incurred for constructing roads, harbors, and other facilities, have constituted formidable obstacles to the opening of new mines.

The Iron Ore Co. of Canada was the only company that exploited iron-ore deposits in the Labrador trough in 1955. It operated in the Root Lake series of ore bodies in Labrador and the Gagnon and French series in New Quebec. The French series was first mined in 1955.

The Dominion Wabana Ore Co., a subsidiary of the Dominion Steel & Coal Co., mined 2.4 million gross tons of ore in 1955. The deposits extend several miles under the Atlantic Ocean from Bell Island, Newfoundland, and are said to be among the richest ore reserves in the world. The chemical quality of the ore, however, makes it unattractive to United States buyers.

Northwest Territories.—The Belcher Mining Corp. discovered a magnetite deposit on Innetalling Island as a result of an airborne magnetometer survey. Widely spaced drill holes indicated a flat-lying magnetite ore horizon averaging 100 to 160 feet in width over a length of more than 18 miles. The deposit is at tidewater, adjacent to a deep, sheltered harbor, and may be mined from an open pit.

Saskatchewan.—Following discovery of 2 anomalies by an airborne magnetometer survey in Saskatchewan, a staking rush with more than 800 claims recorded was reported near the end of 1955.

Ontario.—Steep Rock Iron Mines, Ltd., produced 2.3 million long tons from the Hogarth open-pit mine in 1955—almost double the 1954 quantity. Stripping an estimated 50 million cubic yards of silt from

[18] Buck, W. Keith, Iron Ore in Canada, 1955 (Preliminary) Canadian Dept. of Mines and Technical Surveys, Foreign Service Dispatch 152, Toronto, Feb. 1, 1956 (C. W. Gray, drafting officer).

the "G" ore body between the Errington and Hogarth mines was begun, and a 600-foot extension added to the company dock at Port Arthur, 142 miles east of Steep Rock, doubled its ore capacity.

Algoma Ore Properties, a wholly owned subsidiary of the Algoma Steel Corp., broke production records at its Helen and Victoria mines, the souce of all the ore mined by Algoma in 1955. The company shipped 1.4 million long tons of iron sinter—1 million tons to the United States and 0.4 million tons to Canadian steel producers. After 5 years of exploration and development work the Marmoraton Mining Co. began mining the Marmora iron-ore deposit southeast of Marmora, Ontario. The deposit is a low-grade magnetite ore body averaging about 37 percent iron. The company shipped 195,776 long tons of pellets from the Picton dock from May 11 to November 30, 1955.

Noranda Mines Co. began commercial operation of its sulfur-iron plant at Robinson, Ontario. Although the plant operated only intermittently in 1955, about 30,000 tons of iron oxide sinter was produced and shipped.

The first unit of the International Nickel Co. of Canada atmospheric pressure ammonia leaching plant at Copper Cliff, Ontario, was virtually completed at the end of the year. This plant will produce 1 million tons of iron-ore pellets annually when operating at full capacity.

Mexico.—Official Mexican Government statistics report production in 1955 of 704,364 gross tons of ore containing 422,556 gross tons of iron. This is an increase of nearly 40 percent over the quantity produced in 1954. Exports, all to the United States, totaled 105,158 gross tons of contained iron. Three companies—Cerro de Mercado, S. A., Mineral de Piscila S. A., and Mineral de Durango S. A.—had limited iron-ore export permits. La Consolidada, the American-owned steel company, through its subsidiary Minas del Norte, has not been able to reach an agreement with the Mexican Government that would permit exploitation of La Perla and La Negra iron deposits in Chihuahua near the Coahuila border. Measured, indicated, and inferred high-grade, low-sulfur iron ore in the La Perla and La Negra deposits has been estimated at 42 million long tons.

SOUTH AMERICA

Brazil.—Iron-ore production in Brazil increased 35 percent—from 3 million long tons in 1954 to 4 million in 1955. Exports totaled 2 million long tons, an increase of 53 percent. The value of the exports, however, increased only 39 percent. United States, United Kingdom, Germany (West), Czechoslovakia, Poland, and the Netherlands received Brazilian iron ore in 1955.

The Export-Import Bank loaned the Brazilian firm, Cia Vale do Rio Doce, $3 million to finance purchase of United States equipment for expansion of the company Itabira iron-ore mine.

Chile.—Iron-ore production in Chile decreased 14 percent compared with 1954, although the output of small producers probably more than doubled that in the preceding year. The large decrease was caused by approaching depletion of the El Tofo deposit of Bethlehem Chile Iron Mine Co. The Bethlehem Co. began production at the El Romeral mine, north of La Serena, but output in the first year of operation was below expected eventual capacity and not enough to make up the loss from El Tofo.

Peru.—Although 1955 was a banner year for most of the Peruvian mining industry, difficulties in marketing the type and grade of iron ore produced in Peru were responsible for a 22-percent decrease in iron-ore production compared with 1954. Most of the difficulty was overcome by the end of the year; in December the mines were back on a full production schedule, and Peruvian iron ore was readily marketed in both the United States and Europe. Exports, principally to the United States, totaled 1 million long tons.

Standard Ore & Alloys Corp. of the United States staked a large iron-ore concession, consisting of approximately 2,250 acres, near the harbor of Llo, where several million tons of high-grade ore was reportedly in sight. Marcona Mining Co. investigated iron-ore deposits in the vicinity of Santa Lucia, northeast of Arequipa.

Venezuela.—The iron-ore-mining industry of Venezuela in the 5 years 1951–55 achieved a position second only to Canada as a supplier of ore to the United States. Production in 1955 was 56 percent more than in 1954. The increase resulted principally from stepped-up operation of the Orinoco Mining Co. at Cerro Bolivar.

EUROPE

Austria.—Iron-ore production in Austria increased 4 percent—from 2.7 million tons in 1954 to 2.8 million in 1955. However, imports more than doubled—from 588,960 long tons to 1,195,233 tons. The value of iron-ore imports increased 190 percent to about $162 million.

France.—French iron-ore production totaling almost 50 million long tons in 1955 increased 15 percent compared with 1954. Exports totaled 13.5 million long tons, a 23-percent increase. Exports to Belgium-Luxembourg increased 22 percent and comprised 92 percent of the total. Five percent of the total went to Great Britain, 2 percent to West Germany, and less than 1 percent to the Netherlands. Exports to other countries were negligible.

Germany, West.—Friedrich Krupp A. G., started construction late in 1955 of a plant at Salzgitter-Wattenstedt to process low-grade, silicious, German iron ores into nodules containing 90 to 95 percent iron. The new plant will replace a similar plant owned by Krupp, which was dismantled after World War II.

Iron-ore production in Germany in 1955 was 20 percent more than in 1954; imports increased 62 percent.

Belgium-Luxembourg.—Establishment of a common market for the countries of the European Coal and Steel Community had an adverse effect on the production of iron ore in Luxembourg, but mine production increased 22 percent in 1955 compared with 1954. Luxembourg's iron ore contains only 22 to 28 percent iron; and, with tariffs and import restrictions abolished, its steel mills increasingly showed preference for foreign ore.

Norway.—Norwegian iron-ore production in 1955 increased 15 percent compared with 1954. Preparatory work was begun to drain Djornebann Lake and make several million tons of iron ore accessible at the A. Sydvaranger mine, Kirkenes.

Sweden.—Swedish iron-ore production increased 12 percent in 1955 compared with 1954; exports increased 11 percent. Both iron ore produced and that exported averaged about 60 percent iron. Exports totaled 15 million long tons. The increased iron-ore production was made possible largely by expansion and modernization of the nation's leading producer, Luosabaara-Kiirunavaara AB.

ASIA

India.—Iron-ore production in India in 1955 totaled 4.6 million long tons, a 6-percent increase over the quantity produced in 1954. Exports totaled 1.2 million long tons, 13 percent more than in 1954. Japan was the principal recipient of Indian iron ore, with 70 percent of the total. Czechoslovokia received 12 percent, Germany (West) 6 percent, Belgium 2 percent, and other countries together 10 percent. India's iron-ore exports were limited to the capacity of transportation facilities from mines to ocean ports.

Japan.—Japanese steel mills actively sought new sources of iron ore in 1955 as domestic production decreased 7 percent below the quantity produced in 1954. Three mills contracted with a Philippine iron-ore producer to supply 1.2 million tons of lump ore for sinter feed for a 5-year period beginning in 1956. Imports totaled 5.4 million long tons—9 percent more than in 1954. Malaya supplied 30 percent of this total, Philippines 29 percent, India 18 percent, Canada 9 percent, United States 4 percent, and other countries together 10 percent.

Malaya.—Iron-ore production in 1955 in Malaya increased 21 percent compared with 1954. The Eastern Mining & Metals Co. mine at Dukitbesi Trangganu supplied most of the increase, but two small Chinese-owned mining companies—the Malayan Mining Co. and Ipoh Mining Co.—began operation in the Ipoh area of Perak. Oriental Mining Ltd., a joint British-Japanese company, was organized in June to operate an iron mine at Temangan Kelantan.

Philippines.—Owing to deferment in shipments required by Japanese ore buyers, Philippine iron-ore production was about the same in 1955 as in 1954. Japan was the principal recipient of Philippine iron ore. Of the total of 1.3 million long tons exported in 1955, Japan received 99 percent and the United States and China (Taiwan) each less than 1 percent.

Despite leveling off of Philippine iron-ore production in 1955, interest in iron ore continued and one new property, the Mati project in Davau province on Pujada Bay was put in operation in August. The property was owned by Philippine Iron Mines, Inc., and was exploited by the Atlas Consolidated Mining & Development Corp. The Utah Construction Co. was the first nonresident American concern to become directly interested in Philippine iron ore, when it took up several iron claims north of Zamboanga City, Mindanao in the latter part of the year.

AFRICA

Algeria.—Algerian iron-ore production reached an alltime high in 1955, increasing 23 percent over 1954 and 6 percent over the previous high established in 1953. The production record was set despite a reign of terrorism that swept the country. The one Algerian mine that produced iron pyrite stopped operating after its installations were wrecked and its European personnel massacred August 20. Ovenza mine, near the Tunisian border, which accounts for about 80 percent of the Algerian iron-ore production, set an alltime production record, although terrorists made several attacks against the mine and railway line to the port of Done.

Liberia.—Production of high-grade iron ore in Liberia reached an alltime high in 1955. The Liberia Mining Co. produced almost 1.9 million long tons of 68-percent iron ore. Before 1955 the company confined its operations to production of high-grade ore, but toward the end of the year it announced plans to spend $5 million on a beneficiation plant at Bohmi Hills. The building for the plant was begun in 1955.

The Liberian-American-Swedish Minerals Co. negotiated a supplementary exploration agreement with the Liberian Government, which provided additional rights for the company and the impetus for additional exploration work in the orefield on Mount Jeddah at Putu in the Eastern Province.

Sierra Leone.—Iron-ore production in Sierra Leone increased 63 percent in 1955 compared with 1954. The ore was mined by the Sierra Leone Development Co., Ltd., from two deposits in the Marampa Chiefdom on the Ghafal and Masaboin Hills. Hard, lateritic hematite, lump ore in these deposits was almost worked out. Investigations of development of the Tonkolili deposits in the hills east and southeast of Bunbuna, about 75 miles Northeast of Marampa, continued and over 100 million tons of high-grade ore was proved by drilling an underground development.

Iron and Steel

By James C. O. Harris,[1] and Mary E. Palfrey[2]

HEAVY DEMAND for all steel products in 1955 resulted in a record output of 76.8 million tons of pig iron and 117 million tons of steel, and at the end of the year the industry had enough orders to assure near-capacity operations for the first quarter of 1956. Blast and steel furnaces operated at 92.6 and 93.0 percent of capacity, respectively, for the year. For pig iron, capacity increased 1.5 million tons to a new high of 85.5 million short tons. The capacity of steelmaking furnaces increased 2.5 million tons to a new high of 128.4 million short tons. Since World War II the United States population has increased about 21 percent; the steel-capacity increase was 40 percent. At the end of the year the capacity per capita was 1,550 pounds, compared with 1,340 pounds in 1946.

TABLE 1.—Salient statistics of iron and steel in the United States, 1946–50 (average) and 1951–55, in short tons

	1946–50 (average)	1951	1952	1953	1954	1955
Pig iron:						
Production	56, 213, 104	70, 277, 938	61, 308, 424	74, 853, 319	57, 947, 551	76, 848, 509
Shipments	56, 207, 983	70, 250, 379	61, 234, 790	74, 162, 829	57, 782, 686	77, 300, 681
Imports	234, 114	1, 066, 513	380, 200	589, 825	290, 716	283, 559
Exports	40, 358	6, 555	14, 085	18, 837	10, 247	34, 989
Steel:[1]						
Production of ingots and castings:						
Open-hearth:						
Basic	74, 088, 036	92, 387, 447	82, 143, 400	99, 827, 729	80, 019, 628	104, 804, 570
Acid	599, 409	779, 071	703, 039	646, 094	307, 866	554, 847
Bessemer	4, 056, 933	4, 890, 946	3, 523, 677	3, 855, 705	2, 548, 104	3, 319, 517
Electric[2]	4, 245, 925	7, 142, 384	6, 797, 923	7, 280, 191	5, 436, 054	8, 357, 151
Total	82, 990, 303	105, 199, 848	93, 168, 039	111, 609, 719	88, 311, 652	117, 036, 085
Capacity, annual, as of Jan. 1	94, 575, 800	104, 229, 650	108, 587, 670	117, 547, 470	124, 330, 410	125, 828, 310
Percent of capacity	87. 8	100. 9	85. 8	94. 9	71. 0	93. 0
Production of alloy steel:						
Stainless	[3] 595, 586	[3] 938, 749	[3] 935, 012	[3] 1, 054, 113	852, 021	1, 222, 316
Other	[3] 6, 695, 257	[3] 9, 185, 838	[3] 8, 199, 739	[3] 9, 274, 081	6, 340, 842	9, 437, 775
Total	7, 290, 843	10, 124, 587	9, 134, 751	10, 328, 194	7, 192, 863	10, 660, 091
Shipments of steel products:						
For domestic consumption	58, 318, 865	76, 164, 539	64, 732, 412	77, 472, 162	60, 618, 843	81, 134, 367
For export	3, 309, 559	2, 764, 411	3, 271, 200	2, 679, 731	2, 533, 883	3, 583, 077
Total	61, 628, 424	78, 928, 950	68, 003, 612	80, 151, 893	63, 152, 726	84, 717, 444

[1] American Iron and Steel Institute.
[2] Includes small quantity of crucible and oxygen steel process for 1954-55.
[3] Revised figure.

[1] Commodity specialist.
[2] Statistical clerk.

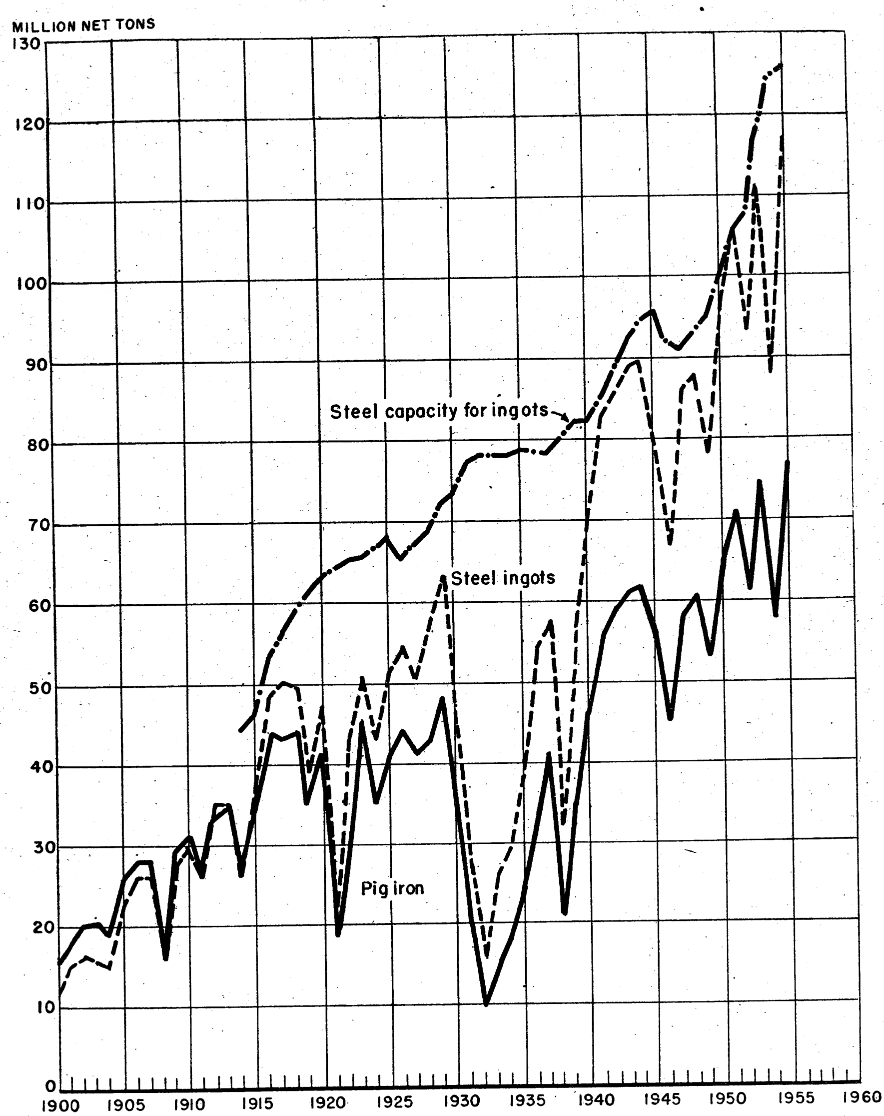

FIGURE 1.—United States trends in production of pig iron and steel ingots (1900–1955) and steel-ingot capacity (1914–1955).

Outstanding developments for the year included blowing in the world's largest blast furnace, tapping the Nation's largest vacuum furnace (2,200 pounds), and successfully operating for the entire year the first oxygen-steelmaking plant in the United States.

Shipments of steel products for the year reached a new high of 84.7 million tons, compared with 63.2 million tons in 1954. Shipments to all consuming industries increased, with the greatest increase to the automotive, construction, and container industries. The average value, f. o. b. mill, of all steel products, computed from figures supplied by the Bureau of the Census, United States Department of Commerce, was 7.099 cents per pound in 1955, compared with 6.956 cents per pound in 1954. The average value of pig iron at furnaces increased 75 cents per net ton to $50.68. Steel exports for 1955 were 3,583,077 short tons, an increase of 41 percent over the 1954 total of 2,533,883.

Average statistics on employment in the steel industry in 1955 (1954 figures in parentheses) were as follows: 545,000 employees (493,000) worked 40.5 hours per week (37.9) for $2.37 per hour ($2.20).

PRODUCTION AND SHIPMENTS OF PIG IRON

Domestic production of pig iron, exclusive of ferroalloys, was 76.8 million short tons—an increase of 33 percent over 1954 and 3 percent above the previous record year, 1953. Production and shipments increased in all producing States. Owing to the increased demand for pig iron during the year, the blast-furnace operating rate increased from 81 percent of capacity in January to 91 percent in March and 98 percent in December. There were 14 furnaces out of blast at the end of the year, compared with 55 on January 1. Pig-iron production in 1955 required 89,990,847 short tons of domestic iron and manganiferous ores and 16,198,015 tons of foreign ores. Consumption of foreign ore almost doubled. Canada, Venezuela, and Peru supplied 42, 35, and 12 percent, respectively, of imports. Most Canadian ore was from the Iron Ore Co. of Canada's Ungava areas in Labrador and New Quebec. During the year this company shipped 8.5 million tons to the recently opened Seven Islands Terminal, the majority destined for the United States.

TABLE 2.—Pig iron produced and shipped in the United States, 1954–55, by States

State	Produced		Shipped from furnaces			
	1954 (short tons)	1955 (short tons)	1954		1955	
			Short tons	Value	Short tons	Value
Alabama	4,064,921	4,923,552	3,986,336	$187,256,826	4,930,579	$236,105,703
California	860,162	1,122,091	872,301		1,111,279	
Colorado						
Texas	2,606,604	3,150,534	2,680,394	173,372,870	3,171,015	220,873,220
Utah						
Illinois	4,516,872	6,489,015	4,534,969	227,159,687	6,466,534	331,126,618
Indiana	7,489,911	8,716,885	7,485,520	375,496,935	8,734,168	443,621,548
Kentucky	592,083	817,115	592,083	(1)	817,115	(1)
Maryland	3,792,487	4,043,401	3,786,897	(1)	4,055,413	(1)
Massachusetts	134,986	136,586	107,594	(1)	146,690	(1)
Michigan	2,010,733	3,294,823	2,033,965	(1)	3,345,538	(1)
Minnesota	539,293	708,738	521,811	(1)	752,393	(1)
New York	3,658,099	5,038,451	3,589,079	181,610,385	5,128,759	264,338,459
Ohio	11,184,567	15,372,349	11,160,022	545,901,439	15,444,439	762,162,095
Pennsylvania	14,717,549	20,788,373	14,652,426	740,221,256	20,949,219	1,074,680,915
Tennessee						
West Virginia	1,779,284	2,246,596	1,779,289	(1)	2,247,540	(1)
Undistributed [1]				454,220,339		584,427,329
Total	57,947,551	76,848,509	57,782,686	2,885,239,737	77,300,681	3,917,335,887

[1] Concealed to prevent revealing individual company operations.

Shipments of pig iron increased 34 percent in quantity and 36 percent in value over 1954. Data on total shipments consisting predominantly of molten pig iron transferred to steel furnaces on the site are given in table 4. Values for merchant pig iron are included; however, the average value per ton of pig iron was lower than market prices published in trade journals because handling charges, selling commissions, freight costs, and other related items were excluded. The term "shipped" as distinguished from "production" refers (as in the case of on-site transfers) to departmental transfers, upon which value was placed for bookkeeping purposes, rather than to actual sales (as in the case of merchant pig iron).

TABLE 3.—Foreign iron and manganiferous ores consumed in manufacturing pig iron in the United States, 1954–55, by sources of ore, in short tons

Source	1954	1955	Source	1954	1955
Africa	181, 086	156, 911	Peru	977, 189	2, 009, 280
Brazil	42, 295	58, 288	Sweden	596, 104	577, 056
Canada	1, 573, 786	6, 755, 035	Venezuela	3, 725, 336	5, 640, 683
Chile	1, 375, 297	686, 381	Unclassified	60, 548	98, 984
Cuba	31, 926	7, 227			
India	2, 326	3, 573	Total	8, 769, 033	16, 198, 015
Mexico	203, 140	204, 597			

TABLE 4.—Pig iron shipped from blast furnaces in the United States, 1954–55, by grades [1]

Grade	1954			1955		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Foundry	4, 795, 471	$228, 570, 455	$47.66	3, 268, 468	$159, 611, 970	$48.83
Basic	45, 285, 844	2, 269, 324, 903	50.11	64, 268, 630	3, 260, 139, 719	50.73
Bessemer	4, 812, 890	240, 682, 526	50.01	5, 693, 360	288, 786, 970	50.72
Low-phosphorus	188, 283	10, 810, 762	57.42	280, 971	15, 657, 626	55.73
Malleable	2, 573, 054	129, 520, 499	50.34	3, 623, 386	184, 286, 212	50.86
All other (not ferroalloys)	127, 144	6, 330, 592	49.79	165, 866	8, 853, 390	53.38
Total	57, 782, 686	2, 885, 239, 737	49.93	77, 300, 681	3, 917, 335, 887	50.68

[1] Includes pig iron transferred directly to steel furnaces at same site.

Metalliferous Materials Used.—The production of pig iron in 1955 required 133.4 million short tons of iron ore, sinter, and manganiferous ore; 4.1 million tons of mill cinder and roll scale; 5.5 million tons of open-hearth and Bessemer slags; 3.8 million tons of scrap (purchased and home, excluding blast-furnace home scrap); and 22,500 tons of other materials—an average of 1.910 tons of metalliferous materials (exclusive of flue dust) per ton of pig iron.

Alabama furnaces consumed hematite from the Birmingham district and Missouri, brown ores from Alabama and Georgia, and byproduct ore from Tennessee; imported iron ores from Brazil, Labrador, Peru, Sweden, and Venezuela; and foreign manganese-bearing ores from Brazil and India.

Blast furnaces at Fontana, Calif., were supplied with iron ore from the Eagle Mountain mine, Riverside County, Calif.

Pueblo, Colo., furnaces (Colorado Fuel & Iron Corp.) used iron ores from Wyoming and Utah.

Iron ores consumed at Sparrows Point, Md., were imported almost entirely from Labrador, Venezuela, Chile, Peru, and Sweden. The manganiferous ore came from Egypt and South Africa.

The Lake Superior region was the primary source of iron ores for Pennsylvania blast furnaces. The major foreign sources were Venezuela, Peru, and Canada; and a small quantity of manganiferous ore came from Africa.

Blast furnaces in Illinois, Indiana, and West Virginia were supplied with iron and manganiferous ores from the Lake Superior region of the United States and Canada. Furnaces in West Virginia also used iron ore from the new Canadian development in Labrador.

Blast furnaces in Ohio used iron ore from the Lake Superior region of the United States and Canada and an increased quantity of foreign ore from Africa, Labrador, and Venezuela.

The Everett, Mass., blast furnace used iron ore from Algeria, Brazil, Labrador, Newfoundland, Peru, Spain, and Venezuela, as well as from the Lake Superior region.

In New York 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 manganiferous ores from Minnesota and India and Labrador. The Troy furnace at Troy, N. Y., consumed magnetite from Chateaugay mine at Lyon Mountain, N. Y., and manganiferous ore from South Africa.

Texas furnaces used brown ores from east Texas, foreign iron ore from Brazil and Mexico, and manganese ore from Mexico.

Utah furnaces used iron ore from Iron County, Utah, manganiferous ore from Nevada and Utah, and manganese ore from Mexico.

TABLE 5.—Number of blast furnaces (including ferroalloy blast furnaces) in the United States, December 31, 1954–55

[American Iron and Steel Institute]

State	Dec. 31, 1954			Dec. 31, 1955		
	In blast	Out of blast	Total	In blast	Out of blast	Total
Alabama	16	5	21	20	1	21
California	2	1	3	3		3
Colorado	4		4	4		4
Illinois	17	5	22	21	1	22
Indiana	21	2	23	22	1	23
Kentucky	3		3	3		3
Maryland	9		9	9		9
Massachusetts	1		1		1	1
Michigan	6	2	8	8		8
Minnesota	3		3	3		3
New York	14	3	17	16	1	17
Ohio	41	12	53	48	5	53
Pennsylvania	56	22	78	74	4	78
Tennessee	2	1	3	3		3
Texas	2		2	2		2
Utah	4	1	5	5		5
Virginia	1		1	1		1
West Virginia	4	1	5	5		5
Total	206	55	261	247	14	261

TABLE 6.—Iron ore and other metallic materials, coke and fluxes consumed, and pig iron produced in the United States, 1954–55, by States, in short tons

State	Metalliferous materials consumed						Net coke	Fluxes	Pig iron produced	Metalliferous materials consumed per ton of pig iron made					Coke and fluxes consumed per ton of pig iron	
	Iron and manganiferous ores		Sinter [1]	Net scrap [2]	Miscellaneous [3]	Total				Ores	Sinter [1]	Net scrap [2]	Miscellaneous [3]	Total	Coke	Fluxes
	Domestic	Foreign														
1954																
Alabama	6,392,211	1,004,069	1,759,873	182,691	86,320	9,425,164	4,215,365	1,496,833	4,064,921	1.820	0.433	0.045	0.021	2.319	1.037	0.368
Illinois	7,198,512	32,168	990,692	189,704	677,158	9,088,234	3,901,882	1,719,239	4,516,872	1.601	.219	.042	.150	2.012	.864	.381
Indiana	11,653,838	50,925	1,975,007	144,987	1,063,372	14,888,129	6,207,650	2,745,608	7,489,911	1.563	.264	.019	.142	1.988	.829	.367
Ohio	14,303,658	750,750	3,946,300	730,350	1,480,093	21,211,151	9,911,664	4,783,389	11,184,567	1.346	.353	.065	.132	1.896	.886	.428
Pennsylvania	14,662,762	2,565,932	7,223,233	814,574	2,043,585	27,310,086	12,446,961	5,966,038	14,717,549	1.171	.491	.055	.139	1.856	.846	.405
California, Colorado, Utah	2,625,563	17,417	2,153,016	23,872	241,525	5,061,393	2,166,352	773,443	2,795,319	.946	.770	.009	.086	1.811	.775	.277
Kentucky, Tennessee, Texas	1,730,612	248,927	267,527	100,394	185,946	2,533,406	1,249,849	683,917	1,376,549	1.438	.194	.073	.135	1.840	.908	.497
Maryland, West Virginia	3,078,983	3,949,576	1,824,511	113,775	670,295	9,637,140	4,521,733	1,834,325	5,458,752	1.287	.334	.021	.123	1.765	.828	.336
Michigan, Minnesota	3,416,628	7,999	952,716	263,924	197,581	4,838,848	2,198,830	1,146,607	2,550,026	1.343	.374	.103	.077	1.897	.862	.450
New York, Massachusetts	4,241,222	141,270	2,017,219	278,202	370,776	7,048,689	3,183,895	1,519,859	3,793,085	1.155	.532	.073	.098	1.858	.839	.401
Total	69,303,989	8,769,033	23,110,094	2,842,473	7,016,651	111,042,240	50,004,181	22,669,258	57,947,551	1.347	.399	.049	.121	1.916	.863	.391
1955																
Alabama	6,969,971	1,888,279	1,966,917	211,006	61,925	11,098,098	4,828,558	1,734,142	4,923,552	1.799	.399	.043	.013	2.254	.981	.352
Illinois	10,505,762	159,332	1,048,087	345,129	912,469	12,970,779	5,637,406	2,366,665	6,489,015	1.644	.161	.053	.141	1.999	.869	.365
Indiana	13,348,592	556,587	2,123,546	99,346	1,336,585	17,464,656	7,424,267	3,116,035	8,716,885	1.595	.244	.011	.153	2.003	.852	.357
Ohio	18,154,115	3,361,585	4,651,900	919,055	2,015,202	29,101,857	13,554,053	6,258,245	15,372,349	1.400	.302	.060	.131	1.893	.882	.407
Pennsylvania	21,458,320	4,086,975	8,993,763	1,187,847	3,131,274	38,858,179	17,710,743	8,496,209	20,788,373	1.229	.433	.057	.150	1.869	.852	.409
California, Colorado, Utah	3,534,887	2,641	2,652,881	65,078	206,631	6,462,118	2,724,984	1,105,955	3,560,789	.993	.745	.018	.058	1.814	.765	.311
Kentucky, Tennessee, Texas	2,018,307	449,763	339,950	164,266	239,496	3,211,782	1,495,188	770,650	1,724,872	1.431	.197	.095	.139	1.862	.867	.447
Maryland, West Virginia	3,075,717	5,241,333	1,816,521	117,957	691,524	10,943,052	5,017,319	1,966,016	6,094,076	1.365	.298	.019	.114	1.796	.823	.323
Michigan, Minnesota	5,828,785	7,862	1,223,687	340,236	262,617	7,663,187	3,480,606	1,727,381	4,003,561	1.458	.306	.085	.065	1.914	.869	.431
New York, Massachusetts	5,096,391	443,658	2,373,022	362,880	768,507	9,044,458	4,364,127	2,000,148	5,175,037	1.071	.459	.070	.148	1.748	.843	.386
Total	89,990,847	16,198,015	27,190,274	3,812,800	9,626,230	146,818,166	66,237,251	29,541,446	76,848,509	1.382	.354	.049	.125	1.910	.862	.384

[1] Includes sintered flue dust.
[2] Excludes home scrap produced at blast furnaces.
[3] Does not include recycled material.

PRODUCTION AND SHIPMENTS OF STEEL

Steel production in 1955 in the United States was 117 million short tons, or 93 percent of capacity, with an AISI index of 139.7 (1947–49=100). The corresponding figures for 1954 were 88.3, 71.0, and 105.4, respectively. Of the total tonnage of steel ingots produced in the United States in 1955, 90 percent was made in open-hearth furnaces, compared with 91 percent in 1954 and 90 percent in 1953; 7 percent in the electric furnace, compared with 6 percent in 1954 and 7 percent in 1953; and 3 percent in the Bessemer converter, the same as in 1954 and 1953.

In 1955, 35 percent of domestic steel was produced in the Pittsburgh-Youngstown district, 23 percent in the Chicago district, 21 percent in the Eastern district, 10 percent in the Cleveland-Detroit district, 6 percent in the Western district, and 5 percent in the Southern district, compared with 35, 23, 20, 10, 6, and 6 percent, respectively, in 1954. The above districts are those designated by AISI.

During the year, open-hearth capacity increased 2,082,880 short tons to 112,317,040 tons and electric-furnace capacity, 451,900 to 11,259,010; Bessemer capacity remained unchanged. The figure for electric-furnace capacity includes 540,000 short tons of oxygen-converter capacity.

Steelmaking-capacity figures represent net-steel capacity after the producers deducted an average of 8.8 percent for operating time lost for rebuilding, relining, repairs, and holiday shutdowns (AISI). The output from steel foundries that did not produce steel ingots was not included in the production data.

Shipments of steel, including exports, in 1955 totaled 84,717,444 short tons, a 34.1-percent increase over the 1954 total of 63,152,726 tons. The automotive industry was again the largest steel consumer, receiving 18,721,880 short tons or 23.1 percent of total domestic shipments, compared with 19.5 percent in 1954.

The construction and container industries ranked second and third as consumers, receiving 9,681,778 and 6,723,074 short tons, respectively. The 1955 percentages of domestic shipments were 11.9 and 8.3, compared with 14.2 and 9.7 in 1954.

Rail transportation and ordnance and other military uses showed little change in the percentage of shipments received.

Alloy Steel.—The Bureau of Mines uses the American Iron and Steel Institute specifications for alloy steels in which the minimum of the range specified for one or more of the elements named exceeds the following percentages: Manganese 1.65, silicon 0.60, copper 0.60, and aluminum, boron, chromium, cobalt, columbium, molybdenum, nickel, titanium, tungsten, vanadium, zirconium, and other alloying elements in any added percent.

The 1955 steel production included 10,660,091 short tons of alloy steel, an increase of 48 percent over 1954; it was 9 percent of the total steel output, compared with 8 percent in 1954 and 9 percent in 1953.

Stainless steel (11 percent of the 1955 alloy-steel output) had its second million-ton year, with the production of 1,218,213 short tons of ingots. The output for the year was 44 percent higher than in

457676—58——38

1954 and 16 percent greater than in the previous record million-ton year, 1953. The production of austenitic stainless steel AISI 300 (nickel-bearing) and 200 series (manganese-nickel-bearing), representing 54 percent of the total stainless-steel production, increased 38 percent over 1954; and the ferritic and martensitic, straight chromium types, AISI 400 series, increased 52 percent. Production of the 200 series (1,914 tons) was reported for the first time by the steel industry in 1955. Some sources indicate that the AISI 200 series, grades 201 and 202, may be used as a substitute for up to 100 percent of the higher nickel 301 and 302 grades. The output of types 501, 502, and other high-chromium, heat-resisting steels included in the stainless-steel-production figure increased 43 percent over 1954. Production of all grades of alloy steel, other than stainless, increased. Carbon-boron steels more than doubled, and all other boron-treated alloy grades increased 27 percent. Chromium-vanadium steels increased 80 percent, chromium steels 60 percent, manganese-molybdenum 7 percent, and silicomanganese 72 percent. The percentages of alloy steel produced in the basic open-hearth, acid open-hearth, and electric furnaces were 63, 2, and 35 percent, respectively, the same as in 1954.

TABLE 7.—Steel capacity, production, and percentage of operations in the United States, 1946–50 (average) and 1951–55, in short tons [1]

[American Iron and Steel Institute]

Year	Annual capacity as of Jan. 1	Production				
		Open hearth	Bessemer	Electric [2]	Total	Percent of capacity
1946–50 (average)	94, 575, 800	74, 687, 445	4, 056, 933	4, 245, 925	82, 990, 303	87. 6
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
1953	117, 547, 470	100, 473, 823	3, 855, 705	7, 280, 191	111, 609, 719	94 9
1954	124, 330, 410	80, 327, 494	2, 548, 104	5, 436, 054	88, 311, 652	71. 0
1955	125, 828, 310	105, 359, 417	3, 319, 517	8, 357, 151	117, 036, 085	93. 0

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. Omitted portion is about 2 percent of total steel production.
[2] Includes small quantity of crucible and oxygen steel process for 1954-55.

TABLE 8.—Open-hearth steel ingots and castings manufactured in the United States, 1946–50 (average) and 1951–55, by States, in short tons [1]

[American Iron and Steel Institute]

State	1946–50 (average)	1951	1952	1953	1954	1955
New England States	423, 563	535, 014	436, 993	489, 967	327, 108	468, 893
New York and New Jersey	4, 114, 687	5, 271, 387	[2] 4, 521, 685	[2] 5, 771, 684	[2] 4, 596, 359	[2] 6, 304, 168
Pennsylvania	21, 685, 152	26, 977, 599	24, 224, 361	28, 805, 249	20, 549, 346	29, 357, 878
Ohio	13, 387, 162	16, 842, 144	14, 759, 616	17, 570, 814	13, 661, 994	18, 446, 670
Indiana	9, 819, 246	11, 888, 961	10, 414, 109	13, 818, 187	12, 330, 815	15, 032, 809
Illinois	6, 009, 173	7, 271, 633	6, 508, 525	7, 735, 397	5, 963, 127	8, 025, 030
Other States	19, 248, 462	24, 379, 780	21, 981, 150	26, 282, 525	22, 898, 745	27, 723, 969
Total	74, 687, 445	93, 166, 518	82, 846, 439	100, 473, 823	80, 327, 494	105, 359, 417

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. Omitted portion is about 2 percent of total steel production.
[2] New York only; New Jersey included in "Other States."

TABLE 9.—Bessemer-steel ingots and castings manufactured in the United States, 1946–50 (average) and 1951–55, by States, in short tons [1]

[American Iron and Steel Institute]

State	1946–50 (average)	1951	1952	1953	1954	1955
Ohio	1,825,285	2,208,456	1,922,776	2,326,983	1,658,176	2,268,715
Pennsylvania	1,262,669	1,345,297	751,297	689,814	451,845	589,249
Other States	968,979	1,337,193	849,604	838,908	438,083	461,553
Total	4,056,933	4,890,946	3,523,677	3,855,705	2,548,104	3,319,517

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.

TABLE 10.—Steel electrically manufactured in the United States, 1946–50 (average) and 1951–55, in short tons [1]

[American Iron and Steel Institute]

Year	Ingots	Castings	Total [2]	Year	Ingots	Castings	Total [2]
1946–50 (average)	4,149,555	96,370	4,245,925	1953	7,226,030	54,161	7,280,191
1951	7,043,366	99,018	7,142,384	1954	5,381,209	54,845	5,436,054
1952	6,703,734	94,189	6,797,923	1955	8,303,933	53,218	8,357,151

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.
[2] Includes very small quantity of crucible steel and oxygen steel process for 1954-55

TABLE 11.—Alloy-steel ingots and castings manufactured in the United States, 1946–50 (average) and 1951–55, by processes, in short tons [1]

[American Iron and Steel Institute]

Process	1946–50 (average)	1951	1952	1953	1954	1955
Open hearth:						
Basic	5,212,332	6,585,635	5,807,191	6,599,038	4,528,336	6,735,450
Acid	120,437	238,034	218,867	185,341	130,559	185,473
Electric [2]	1,958,074	3,300,918	3,108,693	3,543,815	2,533,968	3,739,168
Total	7,290,843	10,124,587	9,134,751	10,328,194	7,192,863	10,660,091

[1] Includes only that portion of steel for castings produced in foundries operated by companies manufacturing steel ingots. See table 7.
[2] Includes very small quantity of crucible steel and oxygen steel process for 1954-55.

Metalliferous Materials Used in Steelmaking.—Scrap and pig iron consumed in steel furnaces in 1955 totaled 129.7 million net tons; the percentage of each was 48 and 52, respectively, compared with 47 and 53 in 1954 and 1953. In addition, steel furnaces consumed 3,352,182 tons of domestic ore and 4,615,966 tons of foreign ore. Again in 1955, more foreign ore than domestic was consumed in steelmaking furnaces. Sources of the foreign ore were Liberia, Brazil, Canada, Chile, Cuba, Dominican Republic, Mexico, Peru, Santo Domingo, Sweden, and Venezuela. Also used was 1,751,663 tons of sinter made from both domestic and foreign ores.

Iron ore was employed both as a source of metallics and oxygen in the refining process. Ore included in the furnace charge is called "charge ore" and ore added after the charge has melted is "feed ore". The characteristics required of charge and feed ore are similar—hard-lump structure, high iron content, and freedom from fines.

CONSUMPTION OF PIG IRON

Consumption of pig iron in 1955 was 77,216,335 tons—an increase of 32 percent over 1954. In 1955, 88 percent of the pig iron went to steelmaking furnaces (open-hearth, Bessemer, and electric) to be processed into steel, 4 percent was used to make direct castings, and 8 percent was consumed in ironmaking furnaces. Although plants in all 48 States and the District of Columbia used some pig iron, 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 1955 consumed 93 percent of the pig iron. Pennsylvania (the leading consumer) used 27 percent of the total and Ohio (second largest) 20 percent.

TABLE 12.—Metalliferous materials consumed in steel furnaces in the United States, 1946–50 (average) and 1951–55, in short tons

Year	Iron ore		Sinter	Pig iron	Ferro-alloys [1]	Iron and steel scrap
	Domestic	Foreign				
1946–50 (average)	3,474,095	1,045,406	1,076,086	48,714,243	1,172,800	44,053,460
1951	3,774,770	2,369,165	1,701,404	61,750,383	1,470,000	57,087,329
1952	3,511,221	2,275,868	1,614,512	53,491,734	1,461,000	52,217,060
1953	4,178,398	3,459,075	1,817,722	65,839,018	[2] 1,654,000	59,100,900
1954	2,619,871	3,640,771	1,143,160	51,658,482	1,270,000	46,064,651
1955	3,352,182	4,615,966	1,751,663	67,957,207	[3] 1,620,000	61,774,897

[1] Includes ferromanganese, speigeleisen, silicomanganese, manganese briquets, ferrosilicon, and ferrochromium alloys.
[2] Revised. [3] Preliminary.

TABLE 13.—Consumption of pig iron in the United States, 1952–55, by type of furnace

Type of furnace or equipment	1952		1953		1954		1955	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Open hearth	49,374,315	80.2	61,306,565	82.1	48,632,261	82.9	63,750,490	82.6
Bessemer	3,998,751	6.5	4,351,117	5.8	2,848,691	4.9	3,932,920	5.1
Electric	118,668	.2	181,336	.3	177,530	.3	273,797	.3
Cupola	5,438,294	8.8	5,549,522	7.4	4,896,703	8.3	5,961,861	7.7
Air	317,500	.5	313,054	.4	232,422	.4	295,209	.4
Crucible	152	(1)	268	(1)	42	(1)	38	(1)
Direct castings	2,303,281	3.8	3,005,882	4.0	1,874,400	3.2	3,002,020	3.9
Total	61,550,961	100.0	74,707,744	100.0	58,662,049	100.0	77,216,335	100.0

[1] Less than 0.05 percent.

TABLE 14.—Consumption of pig iron in the United States, 1951–55 by States and districts, in short tons

District and State	1951	1952	1953	1954	1955
New England:					
Connecticut	83,101	60,598	63,436	48,981	50,126
Maine	9,647	4,072	5,928	3,057	3,357
Massachusetts	231,897	165,324	174,513	140,194	160,664
New Hampshire	4,762	4,607	3,503	3,731	3,731
Rhode Island	57,792	46,842	49,432	38,583	53,316
Vermont	17,331	14,643	8,974	9,033	10,626
Total	404,530	296,086	305,786	243,579	281,820
Middle Atlantic:					
New Jersey [1]	295,182	244,320	200,572	207,610	234,153
New York	3,416,408	3,128,013	3,689,763	2,984,809	3,891,870
Pennsylvania [1]	20,314,328	17,026,406	20,608,854	14,601,423	20,600,273
Total	24,025,918	20,398,739	24,499,189	17,793,842	24,726,296
East North Central:					
Illinois [1]	5,948,201	4,893,725	6,055,031	4,320,164	5,877,830
Indiana [1]	8,339,759	7,044,738	8,928,835	7,713,815	9,411,067
Michigan	3,605,019	3,294,753	3,811,411	3,140,805	4,642,449
Ohio [1]	13,230,964	11,650,525	14,641,399	11,117,854	15,203,917
Wisconsin	341,120	278,670	258,786	206,221	259,552
Total	31,465,063	27,162,411	33,695,462	26,498,859	35,394,815
West North Central:					
Iowa	152,275	101,833	89,467	71,868	88,072
Kansas, Nebraska	10,395	6,682	12,378	6,559	7,322
Minnesota, North Dakota, South Dakota	620,166	506,084	518,930	486,718	601,199
Missouri	103,115	80,995	77,075	36,002	51,864
Total	885,951	695,594	697,850	601,147	748,457
South Atlantic:					
Delaware, District of Columbia, Maryland	3,871,880	3,144,907	3,919,420	3,877,686	4,260,786
Florida, Georgia	79,929	60,528	65,111	24,600	45,371
North Carolina	29,946	27,194	22,644	17,886	23,456
South Carolina	21,521	12,911	10,501	13,107	14,165
Virginia, West Virginia	1,929,435	1,862,646	1,933,541	1,706,519	2,006,306
Total	5,932,711	5,108,186	5,951,217	5,639,798	6,350,084
East South Central:					
Alabama	3,902,199	3,527,809	4,163,931	3,554,765	4,319,869
Kentucky [1], Mississippi, Tennessee	1,041,910	845,718	1,055,604	764,232	1,137,360
Total	4,944,109	4,373,527	5,219,535	4,318,997	5,457,229
West South Central:					
Arkansas, Louisiana, Oklahoma	13,981	11,961	12,464	8,673	10,229
Texas	578,593	418,964	568,161	661,821	749,298
Total	592,574	430,925	580,625	670,494	759,527
Mountain:					
Arizona, Nevada, New Mexico	866	144	195	266	82
Utah and Colorado	1,864,848	1,776,397	2,506,885	1,889,089	2,259,694
Montana	276	181	243	99	150
Idaho, Wyoming	689	504	235	225	30
Total	1,866,679	1,777,226	2,507,558	1,889,679	2,259,956

See footnote at end of table

TABLE 14.—Consumption of pig iron in the United States, 1951–55 by States and districts, in short tons—Continued

District and State	1951	1952	1953	1954	1955
Pacific:					
California [1]	1,271,574	1,288,561	1,233,898	1,000,576	1,223,264
Oregon; Washington	25,208	19,706	15,357	5,078	14,887
Total	1,296,782	1,308,267	1,249,255	1,005,654	1,238,151
Undistributed [1]			1,267		
Total United States	71,414,317	61,550,961	74,707,744	58,662,049	77,216,335

[1] Small tonnages of pig iron, not separable, shown as "Undistributed."

PRICES

The average value of all grades of pig iron, f. o. b. blast furnaces, was $50.68 in 1955, compared with $49.93 in 1954. The figures in table 4 were compiled from producers' reports to the Bureau of Mines; they do not include ferroalloys.

The weighted averages, f. o. b. value of all grades of steel, given in table 17, were computed from statistics supplied by the Bureau of the Census.

The 1955 average composite price (published by Iron Age) was 4.977 cents per pound, compared with 4.716 cents per pound in 1954. Prices increased in June and July.

TABLE 15.—Average value of pig iron at blast furnaces in the United States, 1946–50 (average) and 1951–55, by States, per short ton

State	1946–50 (average)	1951	1952	1953	1954	1955
Alabama	$32.66	$43.87	$45.10	$46.63	$46.97	$47.89
California; Colorado; Utah	37.45	48.50	50.83	51.14	51.08	53.82
Illinois	35.69	46.53	48.31	49.85	50.09	51.21
Indiana	36.11	46.59	48.16	49.29	50.16	50.79
New York	34.48	48.01	49.31	50.46	50.60	51.54
Ohio	35.75	45.67	47.65	49.44	48.92	49.35
Pennsylvania	35.93	47.08	49.16	50.69	50.52	51.30
Other States [1]	38.24	47.98	48.70	49.66	50.61	50.78
Average	35.94	46.75	48.43	49.83	49.93	50.68

[1] Comprises Kentucky, Maryland, Massachusetts, Michigan, Minnesota, Tennessee, Texas, Virginia, and West Virginia.

TABLE 16.—Average monthly prices per short ton of chief grades of pig iron, 1954–55

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	
	1954	1955	1954 [1]	1955	1954 [1]	1955	1954	1955
January	$47.22	$47.22	$50.45	$50.45	$50.89	$50.89	$50.00	$50.00
February	47.22	47.22	50.45	50.45	50.89	50.89	50.00	50.00
March	47.22	47.22	50.45	50.45	50.89	50.89	50.00	50.00
April	47.22	47.22	50.45	50.45	50.89	50.89	50.00	50.00
May	47.22	47.22	50.45	50.45	50.89	50.89	50.00	50.00
June	47.22	47.22	50.45	50.45	50.89	50.89	50.00	50.00
July	47.22	48.66	50.45	52.12	50.89	52.56	50.00	51.67
August	47.22	49.11	50.45	52.68	50.89	51.96	50.00	52.23
September	47.22	49.11	50.45	52.68	50.89	51.96	50.00	52.23
October	47.22	49.11	50.45	52.68	50.89	51.96	50.00	52.23
November	47.22	49.11	50.45	52.68	50.89	51.96	50.00	52.23
December	47.22	49.11	50.45	52.68	50.89	51.96	50.00	52.23
Average	47.22	48.13	50.45	51.52	50.89	51.96	50.00	51.07

[1] Revised figure.

FOREIGN TRADE [3]

Pig-iron imports decreased slightly from the 1954 figure of 290,716, and exports of this commodity almost tripled the 1954 figure of 10,247. Canada supplied 92 percent of the pig iron imported into the United States. Exports of pig iron totaled 34,989 short tons ($1,917,641) of which Canada and Japan received 96 percent.

Exports of iron and steel products totaled 4.4 million short tons, an increase of 44 percent over 1954. Imports of semifinished iron and steel products increased 53 percent, and finished iron and steel products increased 10 percent.

TABLE 17.—F. o. b. value of steel-mill products in the United States, 1954–55, in cents per pound [1]

Product	1954				1955			
	Carbon	Alloy	Stainless	Average	Carbon	Alloy	Stainless	Average
Ingots	[2] 3.408	11.013	18.702	[2] 8.379	3.308	9.382	25.366	[3] 4.431
Semifinished shapes and forms	4.463	7.571	22.988	5.226	4.668	7.575	22.967	5.272
Plates	4.993	12.015	46.408	5.484	5.135	13.424	55.044	5.475
Sheets and strips	5.830	11.864	45.953	6.654	5.992	12.245	46.874	6.837
Tin-mill products	7.699			7.699	7.824			7.824
Structural shapes and piling	4.835	6.097		4.843	5.117	7.250		5.148
Bars	5.940	10.802	52.971	7.204	6.188	11.325	51.515	7.516
Rails and railway track material	5.415			5.415	5.848			5.848
Pipes and tubes	8.165	14.883	148.687	8.918	8.472	14.858	162.519	9.243
Wire and wire products	[2] 9.690	30.478	61.577	[2] 10.273	10.077	29.124	66.312	10.810
Other rolled and drawn products	7.770	22.002	55.404	9.135	8.521	25.439	51.728	11.503
Average total steel	[2] 6.294	11.394	45.430	[2] 6.956	6.391	11.581	46.878	7.099

[1] Computed from figures supplied by the U. S. Department of Commerce, Bureau of the Census.
[2] Revised.
[3] The decrease in the value of all ingots was almost entirely due to an increase in the shipments of lower price carbon from 55 percent of the total in 1954 to 92 percent of the total in 1955. Shipments of carbon steel ingots accounted for 95 percent of total ingot shipments in 1953.

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

TABLE 18.—Pig iron imported for consumption in the United States, 1946–50 (average) and 1951–55, by countries, in short tons

[U. S. Department of Commerce]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	43,368	220,094	288,722	305,256	203,303	260,741
Mexico	2,450					
Total	45,818	220,094	288,722	305,256	203,303	260,741
South America:						
Argentina	(1)					
Brazil	110	33,936				
Chile	1,517	57,241	2,577			
Total	1,627	91,177	2,577			
Europe:						
Austria	16,241	82,628	11,071			
Belgium-Luxembourg	11,385	16,605	3,045			
Finland				168		
France	11,171	37,323	343			
Germany	50,415	331,244	[2] 16,203	[2] 3,539	[2] 31,854	
Italy	1,000	123	1			
Netherlands	62,339	99,189	12,735	18,475	7,914	1,232
Norway	7,782	15,352	6,369	2,692	3,482	224
Poland-Danzig	1,493					
Spain		34,048	25,224	4,665	11,704	3,000
Sweden	3,313	43,822	2,096	56,633	1,203	2,466
Turkey		36,587	622			
U. S. S. R.	271					
United Kingdom	2,623	3,957				
Total	168,033	700,878	77,709	86,172	56,157	6,922
Asia: India	9,269	34,158		12,659	7,470	11,217
Africa:						
Federation of Rhodesia and Nyasaland				[3] 6,606	[4] 1,944	241
Union of South Africa	67	20,206			5,517	1,425
Total	67	20,206		6,606	7,461	1,666
Oceania: Australia	9,300		11,192	179,132	16,325	3,013
Grand total: Short tons	234,114	1,066,513	380,200	589,825	290,716	283,559
Value	$8,974,259	$49,169,985	$19,846,695	$25,967,435	$13,315,255	$14,563,612

[1] Less than 1 ton.
[2] West Germany.
[3] Southern Rhodesia.
[4] Southern Rhodesia not separately classified after July 1, 1954; 1,562 net tons, January–June.

TABLE 19.—Major iron and steel products imported for consumption in the United States, 1953–55

[U. S. Department of Commerce]

Products	1953		1954		1955	
	Net tons	Value	Net tons	Value	Net tons	Value
Semimanufactures:						
Steel bars:						
Concrete reinforcement bars	108,913	$8,204,340	[1] 164,289	[1,2] $11,689,830	158,973	[2] $13,559,126
Solid and hollow, n. e. s.	98,115	10,170,334	[1] 40,873	[1,2] 3,858,537	33,005	[2] 3,642,584
Hollow and hollow drill steel	539	182,154	378	144,307	592	[2] 183,256
Iron slabs, blooms, or other forms	-------	-----------	219	49,554	79	17,909
Bar iron	174	42,614				
Wire rods, nail rods, and flat rods up to 6 inches in width	65,418	6,939,265	39,848	4,047,003	47,761	[2] 5,699,167
Boiler and other plate iron and steel, n. e. s.	133,221	15,943,332	2,242	240,682	4,026	477,653
Steel ingots, blooms, and slabs	48,536	4,167,762	[1] 8,783	[1,2] 1,216,009	146,103	[2] 10,635,444
Billets, solid or hollow	85,145	9,991,676				
Die blocks or blanks, shafting, etc.	421	118,851	310	[2] 80,743	285	46,464
Circular saw plates	17	16,362	13	[2] 21,904	24	18,688
Sheets of iron or steel, common or black and boiler or other plate iron or steel	325,658	43,798,269	789	107,121	2,903	392,171
Sheets and plates and steel, n. s. p. f.	1,005	151,436	197	262,272	298	90,287
Tinplate, terneplate, and taggers' tin	419	68,441	143	[2] 31,305	44	16,826
Total semimanufactures	867,581	99,794,836	[1] 258,084	[1,2] 21,749,267	394,093	[2] 34,779,575
Manufactures:						
Structural iron and steel	458,239	39,925,169	[1] 276,828	[1,2] 28,000,467	266,161	[2] 28,963,223
Rails for railways	2,005	137,393	3,511	191,847	6,278	362,469
Rail braces, bars, fishplates, or splice bars and tie plates	1,041	83,925	267	25,029	772	[2] 36,323
Pipes and tubes:						
Cast-iron pipe and fittings	3,818	454,307	6,868	[2] 876,427	9,219	[2] 1,383,590
Other pipes and tubes	237,804	53,305,392	[1] 66,250	[1,2] 10,810,489	77,105	[2] 10,990,257
Wire:						
Barbed	15,658	1,818,301	52,948	[2] 6,079,100	60,084	7,695,229
Round wire, n. e. s.	17,494	2,383,102	40,794	[2] 4,771,604	40,495	[2] 5,627,152
Telegraph, telephone, etc., except copper, covered with cotton jute, etc.	171	190,297	422	[2] 295,870	635	[2] 582,963
Flat wire and iron or steel strips	35,072	7,559,378	17,438	[1,2] 4,894,711	24,985	[2] 7,065,453
Rope and strand	4,333	1,602,936	3,939	[2] 1,619,444	5,537	[2] 2,933,517
Galvanized fencing wire and wire fencing	3,442	365,695	10,435	[2] 1,191,220	13,460	[2] 1,709,300
Iron and steel used in card clothing	(³)	356,590	(³)	308,945	(³)	409,196
Hoop and band iron and steel, for baling	13,703	1,452,575	17,500	1,819,972	6,261	726,812
Hoop, band and strips, or scroll iron or steel, n. s. p. f.	32,543	3,005,587	[1] 20,995	[1] 1,669,642	24,157	2,192,376
Nails	40,244	5,385,895	92,829	[2] 11,559,148	132,838	[2] 18,093,133
Castings and forgings, n. e. s.	6,325	1,835,340	5,459	1,855,545	7,998	[2] 2,242,451
Total manufactures	871,892	119,861,882	[1,2] 616,483	[1,2] 75,969,460	675,985	[2] 91,013,444
Advanced manufactures:						
Bolts, nuts, and rivets	12,017	3,436,911	15,568	[2] 3,964,850	21,643	[2] 5,402,242
Chains and parts	1,027	693,875	1,139	[2] 754,590	1,556	[2] 974,561
Hardware, builders'	-------	113,869	----------	[1,2] 249,626	-------	[2] 341,011
Hinges and hinge blanks	-------	531,351	----------	[2] 1,328,068	-------	[2] 1,363,490
Screws (wholly or chiefly of iron or steel)	-------	1,040,932	----------	[2] 708,291	-------	[2] 1,328,502
Tools	-------	5,308,867	----------	5,255,219	-------	[2] 8,198,468
Other advanced manufactures	-------	32,830	----------	27,297	-------	[2] 25,672
Total advanced manufactures	-------	11,158,635	----------	[1,2] 12,287,941	-------	17,633,946
Grand total	-------	230,815,353	----------	[2] 110,006,668	-------	[2] 143,426,965

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to years before 1954.
[3] Weight not recorded.

TABLE 20.—Major iron and steel products exported from the United States, 1953–55

[U. S. Department of Commerce]

Products	1953		1954		1955	
	Net tons	Value	Net tons	Value	Net tons	Value
Semimanufactures:						
Steel ingots, blooms, billets, slabs, and sheet bars	89,620	$8,140,371	29,465	$2,619,317	614,797	$50,826,763
Iron and steel bars and rods:						
Iron bars	519	166,770	1,142	333,021	408	89,559
Concrete reinforcement bars	53,354	5,574,688	29,856	3,078,997	73,969	8,018,949
Other steel bars	122,828	18,767,586	[1] 59,895	[1] 10,434,982	131,276	21,424,479
Wire rods	9,489	1,232,367	[1] 9,025	[1] 946,232	30,930	3,227,968
Iron and steel plates, sheets, skelp, and strips:						
Plates, including boiler plate, not fabricated	201,673	24,861,106	154,149	19,548,635	215,391	28,803,072
Skelp iron and steel	98,717	8,672,578	56,793	5,214,634	88,329	8,455,238
Iron and steel sheets, galvanized	110,590	20,423,943	[1] 142,945	[1] 25,444,070	157,036	28,102,680
Steel sheets, black, ungalvanized	517,893	79,872,271	[1] 616,266	[1] 97,976,710	1,067,085	164,614,295
Strip, hoop, bands, and scroll iron and steel:						
Cold-rolled	42,527	12,185,977	31,042	11,264,852	54,149	19,063,245
Hot-rolled	51,535	6,725,892	25,355	4,148,970	38,373	7,022,547
Tin plate and terneplate	514,797	94,720,263	[1] 712,284	[1] 122,895,046	837,268	143,169,614
Total semimanufactures	1,813,542	281,343,812	[1] 1,868,217	[1] 303,905,466	3,309,011	482,818,409
Manufactures—steel-mill products:						
Structural iron and steel:						
Water, oil, gas, and other storage tanks complete and knocked-down material	69,508	16,359,762	[1] 60,773	[1] 14,389,849	41,781	11,294,219
Structural shapes:						
Not fabricated	234,600	24,533,010	267,259	28,452,461	280,370	32,492,319
Fabricated	61,579	19,306,021	[1] 48,054	[1] 15,440,392	87,690	22,105,039
Plates, sheets, fabricated, punched or shaped	16,606	4,684,843	14,023	4,040,272	16,616	4,219,659
Metal lath	1,936	691,173	[1] 2,759	[1] 810,947	2,452	829,066
Frames, sashes, and sheet piling	12,241	2,362,973	23,013	3,444,699	11,035	2,116,256
Railway-track material:						
Rails for railways	190,867	18,987,548	96,914	9,778,837	57,869	4,583,524
Rail joints, splice bars, fishplates, and tieplates	51,557	6,945,446	18,006	3,194,633	11,279	2,316,702
Switches, frogs, and crossings	2,552	959,837	2,704	939,349	3,000	932,772
Railroad spikes	4,935	808,372	2,414	395,871	1,930	369,962
Railroad bolts, nuts, washers, and nut locks	1,741	481,086	917	342,513	818	317,480
Tubular products:						
Boiler tubes	40,695	10,248,268	19,899	7,364,461	26,708	7,683,990
Casing and line pipe	416,534	72,331,971	[1] 306,152	[1] 54,738,453	216,049	44,704,025
Seamless black and galvanized pipe and tubes, except casing, line and boiler, and other pipes and tubes	32,207	6,176,106	32,007	6,291,517	22,140	4,977,734
Welded black pipe and tubes	36,701	6,326,737	56,232	8,254,480	27,929	5,351,135
Welded galvanized pipe and tubes	38,861	7,287,613	11,273	2,252,681	12,125	2,449,004
Malleable-iron screwed pipe fittings	2,854	2,217,071	2,013	1,685,040	1,857	1,652,137
Cast-iron pressure pipe and fittings	26,554	3,913,996	21,489	3,360,190	21,021	3,077,033
Cast-iron soil pipe and fittings	8,458	1,479,446	10,770	1,830,344	9,243	1,695,536
Iron and steel pipe and fittings, n. e. c.	49,616	26,568,565	[1] 43,582	[1] 23,374,691	48,928	27,422,795
Wire and manufactures:						
Barbed wire	3,519	564,137	3,695	630,744	1,641	285,576
Galvanized wire	10,159	2,393,379	5,056	1,343,608	10,668	2,175,877
Iron and steel wire, uncoated	25,639	4,854,034	23,441	4,757,463	23,299	5,670,926
Spring wire	4,890	2,545,172	4,242	2,088,331	4,696	2,444,793
Wire rope and strand	13,224	6,208,285	13,228	6,755,653	14,166	7,263,801
Woven-wire fencing and screen cloth	4,006	[2] 2,096,509	3,244	[2] 1,831,168	4,174	[2] 2,265,921
All other	29,312	9,198,870	26,700	8,977,445	30,576	10,816,808

See footnotes at end of table.

TABLE 20.—Major iron and steel products exported from the United States, 1953–55—Continued

[U. S. Department of Commerce]

Products	1953		1954		1955	
	Net tons	Value	Net tons	Value	Net tons	Value
Manufactures—steel-mill products—Continued						
Nails and bolts, iron and steel, n. e. c.:						
Wire nails	3,960	1,641,394	3,235	1,705,901	3,090	2,022,481
All other nails, including tacks and staples	2,277	1,151,451	2,489	1,277,073	2,733	1,401,259
Bolts, machine screws, nuts, rivets, and washers, n. e. c.	17,326	13,499,554	13,752	11,254,985	19,874	15,446,646
Castings and forgings: Iron and steel, including car wheels, tires, and axles	100,793	22,800,403	[1] 66,121	[1] 16,650,107	109,534	25,323,043
Total manufactures	1,515,707	299,623,032	[1] 1,205,456	[1] 247,654,158	1,125,291	255,707,518
Advanced manufactures:						
Buildings (prefabricated and knockdown)	----------	9,377,647	----------	[1] 4,998,798	----------	6,983,005
Chains and parts	14,519	10,195,052	9,505	7,693,658	8,266	7,950,403
Construction material	6,371	3,346,785	6,762	4,000,865	8,012	4,727,559
Hardware and parts	----------	12,707,947	----------	14,342,712	----------	17,123,664
House-heating boilers and radiators	----------	5,614,357	----------	6,644,674	----------	7,896,943
Oil burners and parts	----------	8,252,306	----------	8,244,712	----------	10,134,831
Plumbing fixtures and fittings	----------	5,746,459	----------	6,203,291	----------	7,407,358
Tools	----------	41,916,336	----------	43,238,299	----------	48,183,073
Utensils and parts (cooking, kitchen, and hospital)	1,294	3,785,707	1,272	3,783,383	1,531	4,569,769
Other advanced manufactures	----------	22,138,247	----------	23,595,543	----------	29,411,837
Total advanced manufactures	----------	123,080,843	----------	[1] 122,745,935	----------	144,388,442

[1] Revised figure.
[2] Includes wire cloth as follows—1953: $1,060,693 (7,394,124 square feet); 1954: $952,431 (5,529,215 square feet); 1955: $1,163,185 (6,950,825 square feet).

TECHNOLOGY

Industry.—During 1955 there was an increased emphasis on the use of sinter in the Nation's blast furnaces. At least 12 new sintering lines were planned; some were under construction or had been completed. In Alabama high-grade foreign-ore fines were sintered with low-grade home ore to produce an ideal blast-furnace feed. At Bethlehem Steel Co., Bethlehem, Pa., the practice during the year was to use from 60 to 70 percent sinter in blast furnaces; and the Gary Works, United States Steel Corp., reported a 100-percent sinter burden in No. 12 blast furnace for a period of 9 months.

The results of the Gary test showed a definite increase in iron production with lower coke rates and lower flue-dust rates when the 100-percent sinter charge was used as compared with the normal burden. It was not necessary to provide a long period of adjustment when the burden is changed to higher sinter content. There was virtually no change in the temperature of the iron produced.[4]

The Duquesne works of United States Steel saved manganese by using open-hearth slag as part of its blast-furnace feed. Furnaces operated satisfactorily with 450 pounds of open-hearth slag per ton

[4] Sundquist, R. W., One-Hundred-Percent Sinter Burden at Gary Works: Pres. at AIME Blast-Furnace, Coke-Oven, and Raw Materials Conf., Philadelphia, Pa., Apr. 18–20, 1955.

of pig iron produced. The iron-ore equivalent of this quantity of slag is 280 pounds, and the flux content reduced the amount of limestone required from 1,150 pounds to 825 per ton of pig iron produced. The increase in the manganese content of the iron, plus a change in practice (that is, adding all ferromanganese to the steel ladle) resulted in a 19-percent decrease in the quantity of manganese required for steelmaking. Although the phosphorus content of pig iron doubled, it was easily lowered to normal in open-hearth furnaces with an early- and full-flushing slag practice. Sulfur was no problem in the open hearth; in fact, melt sulfur and ladle sulfur both decreased.[5]

The world's largest blast furnace, erected for Great Lakes Steel Corp. at Detroit, Mich., was blown in on June 5, 1955. Construction required 10 months, and 500 men were employed at one time at peak building stages. The furnace has a hearth diameter of 30 feet 3 inches and a rated capacity of 50,000 tons of iron per month. However, some engineers predict that, as operating experience develops, the furnace may average over 60,000 tons a month. Approximately 90 employees are needed to man the furnace and its auxiliary installations for 3 shifts. When operating at 100 percent of rated capacity, the furnace will use 3,200 short tons of iron ore, 1,300 tons of coke, 550 tons of limestone, 55,000 tons of cooling water, and 5,000 tons of air per day. Raw-material handling and charging are completely automatic, requiring only manipulation of a pushbutton at the loading pit when a charge is initiated. While the furnace was being constructed, every attention was given to preventing air and stream pollution.[6]

Since February 1951 the National Steel Corp. has used oxygen-enriched air in its four blast furnaces. Oxygen is supplied from an oxygen plant with a daily capacity of 450 tons. The average oxygen enrichment is 1.5 percent, which results in a 7-percent increase in equivalent wind volume and a 7-percent increase in pig-iron output. With 2-percent oxygen enrichment, the above equivalent wind volume and iron output would increase 9 percent. Velocities of gases up the stack with 2-percent oxygen enrichment or an 83,300-c. f. m.-equivalent blast are approximately the same as with 76,000 c. f. m. of normal air. The cost of oxygen, including amortization of the plant, is well under $5.00 per ton.[7]

Perhaps the most outstanding development in steelmaking for the year was that McLouth Steel Corp., United States, and Dominion Steel of Canada, demonstrated that the Linz-Donawitz process is practical for making high-grade steel. About 1.7 million tons of such steel was made in the 2 countries during 1955. At the end of the year several other companies in the United States announced plans for capacity increases of some 800,000 tons by this process. Studies also were being made on combining the process with the metallurgical-blast (hot) cupola instead of the blast furnace. It was reported that for a capacity of 500,000 tons per year the cost for building an oxygen-steelmaking plant would be about half that of an open-hearth shop.

[5] Speer, E. B., Use of Open-Hearth Slag in Blast Furnaces, and Effect on Open-Hearth Practices: Pres. at AIME Blast-Furnace, Coke-Oven, and Raw Materials Conf., Philadelphia, Pa., Apr. 18–20, 1955.
[6] Iron and Steel Engineer, vol. 32, No. 6, June 1955, p. 148.
[7] Strassburger, Julius H., Blast-Furnace Oxygen Operations: Pres. at 64th Ann. Meeting, Am. Iron and Steel Inst., New York, N. Y., May 23, 1956.

One advantage of oxygen steel is that its cold-working properties are superior to those of open-hearth steel, which makes it especially suitable for cold-drawn wire and cold-rolled strip and sheets.

Another technique that offers promise of increasing steel production at relatively low cost, is the use of desiliconized molten pig iron. With this procedure, hot metal from the blast furnace is desiliconized with oxygen, while, simultaneously, about one-fourth of the carbon is being removed. During this phase of the process, the metal temperature increases about 500° F. to 2,950° F. The partly refined metal then is charged into the open hearth to replace the molten pig iron. The extra heat in the metal, plus a reduction in refining time, results in savings in both fuel and furnace time. Estimated production increases with this practice range from 25 percent with 50 percent metal to 50 percent with 70 percent metal. Molten pig iron outside the steelmaking furnace is desiliconized in England and West Germany.

Weirton Steel Corp. was building the largest open hearth in the world (600 tons) as part of its expansion program. The furnace will be about 100 feet long.

The Nation's largest vacuum-melting induction furnace (capacity, 2,240 pounds) was put into operation at the end of the year by Vacuum Metals Corp. at Syracuse, N. Y. With a vacuum furnace of this size, vacuum melting is entering an era of commercial operation.

Substituting manganese stainless steels (AISI specifications 201 and 202) for the higher nickel-content (8 percent) stainless (300 series) received further attention during the year. Various sources indicate that manganese stainless steels could replace up to half the nickel-bearing grades. Substituting manganese for nickel, both stockpile items, would have little effect on our manganese supply, as the quantity of manganese required in the new stainless steels is very small compared with total consumption of manganese.

Recovering manganese from manganese stainless-steel scrap, however, would be a problem, because most of the manganese would find its way into the slag during remelting operations, whereas all the nickel remains in the melt.[8]

Bureau of Mines.—The Bureau of Mines made a number of significant contributions to iron and steel technology during 1955.

At Pittsburgh it was demonstrated in tests that anthracite could be used as a substitute for coke in the experimental blast furnace. Satisfactory operation was obtained with fuel burdens composed of 100-percent anthracite. In cooperation with industry, anthracite also was utilized as a partial substitute for coke in a metallurgical cupola with a daily capacity of 400 tons.

In a side-surface-blown basic converter the 3-percent phosphorus-iron byproduct of the manganese experiment on recovering manganese from open-hearth slag was successfully dephosphorized to less than 0.030 percent. This iron would be an ideal molten feed or melting stock, if cold, for steelmaking furnaces. Citrate-solubility fertilizer tests of the resulting slag indicated that nearly all of the phosphorus content was available.

Much progress was made in the relatively unexplored field of high-temperature reactions. Few facts are available on the values of

[8] Bennett, Edmund V., Low-Nickel Austenitic Stainless Steels: Nat. Acad. Sci. Rept. MAB-45-SM, June 10, 1955, 33 pp.

activity coefficients in liquid-metal solutions at high temperatures, and this information is needed frequently in applying thermodynamic data to steelmaking problems. The iron-copper system has been investigated, and the iron-silicon system was being studied.

In an effort to decrease the melting time and reduce the cost of steelmaking, experiments were continued with a portable, top-fired, scrap preheater for heating scrap before charging into the furnace. Results thus far indicate that oxidation losses are negligible below 1,800° F. and that heat recovery varies between 60 and 80 percent, depending on the velocity of the gaseous products of combustion and the depth of the scrap bed.

The Bureau of Mines was attempting to develop an economic method of recovering strategic metals from high-temperature alloy scrap. Studies on solidification, segregation, inclusions, and deoxidation procedures also were made to improve the quality of steel and abandon the wasteful practice of adding unnecessary critical alloys to steel. The project on utilizing the soft and fine iron ores of East Texas and low-grade fuels was continued. Electric-furnace smelting and duplex treatment were utilized.

WORLD PRODUCTION

World production of pig iron and steel in 1955 reached a new high of 211.5 and 297.6 million short tons, respectively, a 21-percent increase for both commodities. The United States, the European Coal and Steel Community, and the Soviet Union ranked first, second, and third in both pig-iron and steel production. The United States produced 37 percent of world pig iron and 39 percent of world steel, compared with 34 and 36 percent, respectively, in 1954.

Brazil.—The Brazilian Government authorized the Companhia Siderurgica Nacional, the largest steel producer in Brazil, to build a new steel mill in Piassaguera, Sao Paulo, in cooperation with Companhia Siderurgica Paulista. The plant will be similar to the Volta Redonda steel mill; it will have an annual capacity of 1 million tons and cost $60 million.[9]

India.—During 1955 expansion of the Indian iron and steel industry continued to meet the high demand for steel, which has far exceeded supply for many years. To meet the high requirements for steel products, imports increased 125 percent over 1954.

Satisfactory progress was made in the three Government-sponsored steel plants that are being constructed in Rourkela, Bhilai, and Durgapur with German, Soviet, and British assistance, respectively. The work at Rourkela included exploration of iron-ore and limestone deposits; construction of power stations, roads, and railroads; and leveling operations at the plant site for foundations. At Bhilai and Durgapur the work included acquisition of land, prospecting for iron ore, and preliminary work covering water-supply and powerplants.

The existing steel plants also were expanding. Tata Iron & Steel Co. at Jamshedpur proceeded with its scheme to produce 2 million tons annually. Mysore Iron & Steel Works at Bhadravati plans

[9] Mining World, vol. 17, No. 13, December 1955, p. 86.

TABLE 21.—World production of pig iron (including ferroalloys), by countries,[1] 1946–50 (average) and 1951–55, in thousand short tons [2]

[Compiled by Pearl J. Thompson]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	2,191	2,819	2,914	3,166	2,327	3,380
Mexico [3]	251	282	340	271	297	356
United States	57,934	72,472	63,391	77,201	59,752	79,263
Total	60,400	75,600	66,600	80,600	62,400	83,000
South America:						
Argentina	[4] 20	31	30	39	30	40
Brazil	574	[4] 875	906	984	1,222	[4] 1,200
Chile	36	265	298	315	336	282
Total	[4] 630	1,200	1,200	1,300	1,600	[4] 1,500
Europe:						
Austria	590	1,159	1,295	1,456	1,493	1,662
Belgium	3,605	5,366	5,280	4,648	5,092	5,872
Bulgaria	------	------	12	28	44	50
Czechoslovakia [4]	1,740	2,290	2,570	3,075	3,100	3,310
Denmark	32	36	40	40	44	60
Finland	88	112	119	88	83	127
France	6,894	9,753	10,894	9,678	9,855	12,220
Germany:						
East	223	375	718	1,177	1,436	1,653
West	5,757	11,791	14,194	12,846	13,792	18,168
Hungary	371	578	638	777	904	942
Italy [5]	493	1,200	1,425	1,536	1,484	1,911
Luxembourg	2,355	3,480	3,391	3,000	3,086	3,401
Netherlands	398	579	594	654	672	739
Norway	215	270	301	305	271	387
Poland	1,246	1,786	2,028	2,601	2,932	3,439
Rumania [4]	210	390	430	500	480	640
Saar	1,168	2,612	2,811	2,626	2,752	3,174
Spain	634	748	868	911	1,004	1,097
Sweden	870	999	1,228	1,165	1,103	1,373
Switzerland	28	44	44	45	39	60
U. S. S. R. [4] [6]	15,800	24,800	27,800	30,200	33,400	36,700
United Kingdom	9,852	10,868	12,015	12,516	13,309	13,966
Yugoslavia	192	289	317	310	406	585
Total [4] [6]	52,800	79,500	89,000	90,200	96,800	111,500
Asia:						
China	[4] 380	[4] 1,400	[4] 2,200	3,300	3,340	3,400
India	1,732	2,043	2,076	1,990	2,197	2,154
Japan	1,172	3,557	3,952	5,129	5,237	5,990
Korea, North [4]	30	22	22	110	220	220
Taiwan (Formosa)	4	6	7	8	10	11
Thailand	[7] 9	10	[4] 2	6	2	2
Turkey	112	183	216	239	216	223
Total [4] [6]	3,400	7,200	8,500	10,800	11,200	12,000
Africa:						
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	[8] 29	35	43	40	41	61
Union of South Africa	723	887	1,245	1,348	1,319	1,433
Total	800	900	1,300	1,400	1,400	1,500
Oceania: Australia	1,239	1,484	1,735	2,064	2,079	2,010
World total (estimate)	119,300	166,000	168,000	186,000	175,500	211,500

[1] Pig iron is also produced in Belgian Congo and Indonesia, but quantity produced is believed insufficient to affect world total.
[2] This table incorporates a number of revisions of data published in previous Iron and Steel chapters. Data do not add to totals shown owing to rounding where estimated figures are included in detail.
[3] Excluding ferroalloy production, for which data are not yet available; estimate included in total.
[4] Estimate.
[5] Trieste included with Italy.
[6] U. S. S. R. in Asia included with U. S. S. R. in Europe.
[7] Average for 1 year only; 1950 was first year of commercial production.
[8] Average for 1948–50.

TABLE 22.—World production of steel ingots and castings, by countries, 1946–50 (average) and 1951–55, in thousand short tons [1]

[Compiled by Pearl J. Thompson]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	3,009	3,569	3,703	4,116	3,195	4,529
Mexico	354	503	595	579	686	812
United States [2]	82,990	105,200	93,168	111,610	88,312	117,036
Total	86,353	109,272	97,466	116,305	92,193	122,377
South America:						
Argentina [3]	180	140	140	220	215	240
Brazil	577	929	984	1,120	1,265	1,376
Chile	37	196	271	345	354	320
Colombia [3]	8	11	11	------	------	385
Total [3]	802	1,276	1,406	1,685	1,834	2,321
Europe:						
Austria	656	1,133	1,166	1,415	1,822	2,010
Belgium	3,687	5,571	5,585	4,900	5,431	6,403
Bulgaria	------	------	------	------	55	60
Czechoslovakia [3]	2,770	3,870	4,180	4,880	5,070	5,400
Denmark	84	177	194	198	219	[3] 265
Finland	109	140	162	162	195	206
France	7,753	10,828	11,941	10,951	11,714	13,880
Germany:						
East	564	1,711	2,087	2,400	2,584	2,756
West	7,154	14,888	17,423	16,998	19,218	23,519
Greece [3]	17	33	37	45	62	73
Hungary	789	1,422	1,608	1,701	1,644	1,797
Ireland [3]	14	18	22	22	22	22
Italy [4]	2,081	3,376	3,897	3,858	4,637	5,947
Luxembourg	2,245	3,392	3,309	2,931	3,117	3,555
Netherlands	349	611	755	948	1,023	1,074
Norway	78	97	108	122	133	183
Poland	2,111	3,078	3,509	3,973	4,370	4,905
Rumania [3]	375	710	770	790	690	715
Saar	1,296	2,869	3,112	2,959	3,094	3,483
Spain	724	916	1,111	1,063	1,296	1,336
Sweden	1,423	1,658	1,836	1,939	2,028	2,344
Switzerland [5]	110	159	172	173	152	170
U. S. S. R. [3] [6]	21,400	34,600	38,000	42,000	45,600	50,000
United Kingdom	16,160	17,515	18,389	19,723	20,742	22,166
Yugoslavia	380	488	499	580	692	903
Total [3] [6]	72,300	109,300	119,900	124,700	135,600	153,200
Asia:						
China [3]	165	990	1,490	2,160	2,390	2,650
India	[7] 1,475	1,680	1,768	1,688	1,887	1,905
Japan	2,463	7,167	7,703	8,446	8,543	10,371
Korea:						
North [3]	} 43	44	33	33	55	140
Republic of		1	1	1	1	1
Pakistan	(7)	3	9	12	11	12
Taiwan (Formosa)	12	18	17	22	28	44
Thailand	[8] 9	10	[3] 4	1	2	2
Turkey	104	149	179	187	187	217
Total [3] [6]	4,270	10,060	11,205	12,550	13,105	15,340
Africa:						
Belgian Congo	------	(9)	1	4	3	2
Egypt [3]	10	11	11	22	78	95
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	13	31	40	28	36	55
Union of South Africa	681	1,045	1,326	1,368	1,577	1,742
Total	704	1,087	1,378	1,422	1,694	1,894
Oceania: Australia	1,414	1,606	1,839	2,288	2,476	2,460
World total (estimate)	165,800	232,600	233,200	259,000	246,900	297,600

[1] This table incorporates a number of revisions of data published in previous Iron and Steel chapters. Data do not add to totals shown owing to rounding where estimated figures are included in detail.
[2] Data from American Iron and Steel Institute. Excludes production of castings by companies that do not produce steel ingots.
[3] Estimate. [4] Trieste included with Italy. [5] Including secondary.
[6] U. S. S. R. in Asia included with U. S. S. R. in Europe. [7] Pakistan included with India.
[8] Average for 1 year only; 1950 was first year of commercial production. [9] Less than 500 tons.

to increase its 1955 annual capacity of 33,600 short tons to 112,000 tons. Three steel-fabricating plants, adjacent to 3 new steel plants and 2 steel foundries (1 at the Chittarnjan Locomotive Works), have been proposed. Other items of expansion include the installation of coal washers.

The export duty on iron and steel was abolished, and controls were again put into effect on distributing heavy structurals. A new Ministry of Iron and Steel was established. Other Government actions to aid the steel industry were appointment of an Iron and Steel Control Board, an organization for recruiting and training technical personnel to operate new steel plants, and a centralized group to coordinate rail transportation for steel imports.[10]

Japan.—The Japanese iron and steel industry enjoyed a year of unusual prosperity, and exports reached a record high. The 1955 production of iron and steel set new records, with 6.0 million short tons of pig iron, 10.4 million tons of crude steel, and 7.5 million tons of rolled ordinary steel, increases of 14, 21, and 24 percent, respectively, over 1954. Exports of iron and steel reached 2.3 million tons, an increase of 67 percent over the previous year.[11]

During the year a number of new techniques were introduced to improve iron and steelmaking. New sintering equipment was installed, and the use of sintered ores in the blast furnace increased. From using sized iron ores and sinter in the blast furnaces, output was increased and coke consumption decreased. Adopting automatic controls made striking improvements in open-hearth-furnace operation. In addition, the widespread application of oxygen in steelmaking, a changeover to heavy oil for fuel, and improvements in scrap-iron and charging equipment were important factors in saving materials and reducing fuel costs. Rolling mills attained greater efficiency and improved the quality of products by introducing modernized equipment, much of which was installed under United States technical guidance.

A number of companies announced expansion plans during the year: Yawata Iron & Steel Co. planned to install facilities for making heavy plate at a cost of about ¥5.5 billion [12] ($15.5 million). Nippon Steel Tube Co. applied for ¥900 million from the World Bank for its planned ¥3-billion medium-tube project to include a new strip mill. Fuji Iron & Steel Co. plans to improve its tinplate-making equipment. By far the largest expansion was that announced by the Kawasaki Steel Corp., to include a ¥4.9-billion strip mill and other construction at a total cost of ¥12.7 billion. Sumitomo Material Industries is planning a ¥980-million project at its Feltz-Moon Plant.[13]

United Kingdom.—Pig-iron and steel production in England in 1955 reached an alltime high of 14.0 million and 22.2 million short tons, respectively.

[10] U. S. American Consul, Calcutta, India, State Department Despatch 15, July 6, 1956.
[11] Japan Iron and Steel Federation, Statistical Yearbook for 1955, 1956: Summary, pp. i, ii.
[12] US$1=360 yen.
[13] U. S. Embassy, Tokyo, Japan, State Department Despatch 70, July 21, 1955.

The average output per blast furnace and open-hearth furnace in Britain has increased 75 percent from 1946 to 1954. During these years the industry spent an average of more than £1 million a week on modernization and development; expenditures in 1955 were about £80 million. As a result of modernizing, plants are operating more efficiently and economically; for example, fuel consumption per ton of steel has been reduced about 15 percent since World War II. The output of alloy steel has more than doubled since 1946; the estimated production was 1.4 million short tons in 1955, compared with 600,000 tons in 1946.[14]

Venezuela.—In September 1955 the Venezuelan Government announced that a contract for constructing the long-planned steel mill at Pureto Ordaz had been awarded to the Italian Fiat Group. The contract provides for a plant with an annual output of 395,000 to 465,000 short tons of finished products; the plant to be completed by the end of 1957. This project included an educational program in foreign countries to train Venezuelans to operate the plant.[15]

The European Coal and Steel Community.—Pig-iron and steel production in the European Coal and Steel Community topped all previous records in 1955, with 45.5 million short tons of pig iron and 57.9 million tons of steel. Pig iron was 24 percent above 1954 production, and steel 20 percent above.

The Community continued the program [16] for expanding its iron-ore, steelmaking, and finishing facilities. The problem in each country varied. For example, in West Germany the emphasis was on modernization and larger furnaces. During the year 5 new blast furnaces were put into operation, and the construction of 2 large, modern, continuous strip mills was underway. In addition, plans were made to increase annual steelmaking capacity from 23.6 million to 27.5 million tons. The modernization program in France is expected to raise the French and Saar steelmaking capacity to 18 million tons by 1960. Research in France was aimed at utilizing low-grade coals in producing coke. Italy was deficient in blast- and steel-furnace capacity and planned to build more of both. In Luxembourg and Belgium efforts were made to improve the efficiency of operations and scrap old mills and furnaces.

Community steel production increased. Basic Bessemer-steel production, 52.3 percent of total Community steel, was 22 percent more than in 1954. The open hearth, which supplied 39 percent of the total, increased 18 percent; and electric-furnace and other steels, representing slightly more than 8 percent, increased 23 percent.[17]

With respect to raw-material consumption in the steel industry: The salable iron-ore production of the Community in 1955 totaled 77.8 million short tons, compared with 66.8 million tons in 1954. The coking plants of the Community produced 75.6 million short tons of coke, compared with 65.9 million tons in 1954, an increase of nearly 15 percent. Of the 303.2 million tons of coal available, including 17.6 million tons from the United States, 100.8 million short tons was utilized in coking plants.

[14] Chemical Engineering and Mining Review, vol. 48, No. 6, Mar. 10, 1956, p. 188.
[15] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 3, March 1956, p. 12.
[16] Iron and Steel Engineer, vol. 33, No. 1, January 1956, pp. 119–166.
[17] European Iron and Steel Community, Fourth General Report on the Activities of the Community: Publications Department, Apr. 8, 1956, 277 pp.

Scrap still was in short supply within the Community in 1955. To alleviate the effect of high-priced, imported, American scrap, an equalizing fund was established. The various companies in the Community donated as much as $8 per ton to the fund for all purchased scrap consumed; the money was used to pay the difference in price between imported American scrap and domestic purchased scrap. The composite price of Community scrap per metric ton varied from $34 in May to $53 at the end of December. The price for imported American scrap was approximately $70, c. i. f., in December 1955. In addition to the fund a bonus was paid for increasing the pig iron: scrap ratio in steelmaking furnaces.

Investments in the Community iron and steel industry were estimated at $654 million in 1955, compared with $441 million in 1954. Over half was for rolling mills. The increased investments will result in enlarging coking capacity 1 million short tons, sintering plants 2.4 million tons, pig-iron capacity 0.9 million tons (excluding increases resulting from improved blast-furnace burden), steelmaking capacity 1.6 million tons, and rolling-mill capacity 4.6 million tons.

The $100 million loan by the United States was allocated for the following purposes: Collieries, power stations, coking plants, iron mining, and mineral-dressing facilities.

Iron and Steel Scrap

By James E. Larkin [1]

AN ALLTIME high in the use of ferrous materials (scrap and pig iron) was established during 1955, when domestic consumption totaled 159 million short tons, 32 percent greater than in 1954 and 4 per cent greater than in 1953, the previous record year. This increased consumption resulted from a year of full production and heavy demand for all steel products and a minimum of labor problems in the iron and steel industry.

Scrap consumption fluctuated during the year from a low of 6 million tons during February to a high of 7.3 million tons during December, the second highest month on record. The use of pig iron in May, September, October, November, and December was larger than in the previous record month, March 1953. The 6,937,000 short tons used in October established a new record. Total stocks of ferrous scrap held by consumers varied during the first 7 months of 1955 and reached a low for the year at the end of July. During the last 5 months stocks continued to fluctuate, the total rising to a record at the end of November. However, by the end of December it had decreased 2 percent from the end of November and December 31, 1954, and was equivalent to a 32-day supply at the average daily scrap consumption rate of 223,000 tons.

GOVERNMENT REGULATIONS

The record steel production in foreign countries, which was made possible to a large extent through use of the highest quantity of iron and steel scrap ever imported from the United States, resulted in the Bureau of Foreign Commerce imposing export restrictions to prevent an excessive drain on our supply. The export-licensing safeguards that had been in effect since December 8, 1954, were continued.

Effective March 7, additional conditions were announced under which iron and steel scrap exports would be licensed. An exporter holding a license could apply for additional licenses on a cargo-for-cargo basis against shipments to be made on or after February 21, 1955. An applicant not holding an export license could submit an application to export a quantity not to exceed a maximum cargo lot on a single carrier.

Quality controls on export licensing of scrap after March 31, 1955, were recommended on March 1, after an iron and steel scrap task committee met with officials of the Business and Defense Services Administration, Iron and Steel Division. It was recommended that shipments of iron and steel scrap be limited to include not less than 30 percent of No. 2 bundles and a maximum of 30 percent of No. 1 Heavy Melting grades.

[1] Commodity specialist.

The State Department opposed the suggested controls as well as quantitative controls, because it believed that the supply of scrap was ample at that time. The department also viewed with concern any curtailment of scrap exports to friendly nations as long as the domestic supply was not endangered and recommended that the export situation be studied further.

On April 4 the United States Department of Commerce announced that, at least pending further study, export-licensing procedures in effect for iron and steel scrap would continue unchanged for the second quarter.

Whether stricter curbs on shipments of iron and steel scrap should be imposed were discussed at meetings of the Inter-Government Committee during early April, which were held at the request of Joseph M. Dodge, Special Assistant to the President and head of the White House Council of Foreign Economic Policy. Of some concern was the possibility that restrictions on exports would harm the European security program. A request was made that the Department of Commerce review its findings with emphasis on how the Schuman Plan countries would be affected if controls in effect at that time were to be maintained.

During June the United States Department of Commerce recommended that strict controls be imposed on exports of iron and steel scrap; however, this was rejected by the White House Council on Economic Policy.

President Eisenhower on June 8 signed Public Law 66, H. R. 5223, extending to June 30, 1956, the suspension of import duties on all metal scrap except lead and zinc.

During the late months of the year discussions took place among representatives of the steel and scrap industries on a proposal to survey the supply of obsolete scrap iron in this country. The Bureau of Mines and Bureau of the Census were suggested as the agencies that might conduct such a survey.

CONSUMPTION

Of the 1955 consumption of ferrous scrap and pig iron for all purposes, 81.4 million short tons or 51 percent was scrap. Consumption was 33 percent greater than in 1954. The increased use of ferrous scrap was accompanied by a 32-percent increase in demand for pig iron. The annual consumption of pig iron was 77 million short tons, compared with 59 million tons in 1954.

A 33-percent increase over 1954 in the output of steel ingots and castings established an alltime high in steel production (117 million short tons) and required melting a record quantity of ferrous materials in steelmaking furnaces (open-hearth, Bessemer, and electric). The quantities used in these furnaces were 61,775,000 short tons of scrap and 67,957,000 short tons of pig iron, an increase of 34 and 32 percent, respectively, over the quantities of these materials consumed during 1954. December and October were the highest months for consumption of ferrous scrap and pig iron, respectively; however, December established a record in the total use of these materials in steelmaking furnaces.

The proportions of scrap and pig iron used in steel furnaces in 1955 were 48 and 52 percent, respectively, compared with 47 and 53 percent in 1954. The charge of scrap and pig iron used in iron foundries, mainly cupola furnaces, comprised 66 percent scrap and 34 percent pig iron, compared with 67 and 33 percent in 1954.

Total domestic consumption of scrap and pig iron increased 33 and 32 percent, respectively, in 1955, compared with 1954. Scrap use increased in all districts. As in 1954, a noticeably greater quantity of scrap than pig iron was consumed in the New England, West North Central, West South Central, and Pacific Coast districts. These districts together used 10 percent of the total scrap and 4 percent of the pig iron consumed in 1955, as compared with 11 and 4 percent, respectively, in 1954. The average ratio of scrap to pig iron in these 4 districts was 2.8:1, compared with 2.7:1 in 1954. The United States average was 1.05:1, the same as in 1954.

Open-hearth furnaces continued to consume the largest quantities of ferrous scrap and pig iron, using 63 percent of the total scrap in 1955, compared with 64 percent in 1954. Pig-iron consumption in open hearths was 83 percent of the total pig iron, the same as in 1954.

Scrap consumption in cupola furnaces was 15 percent of the total scrap used, compared with 16 percent in 1954; pig iron was 8 per cent, the same as in 1954.

TABLE 1.—Salient statistics of ferrous scrap and pig iron in the United States, 1954–55

	1954 (short tons)	1955 (short tons)	Change from 1954 (percent)
Stocks, December 31: Ferrous scrap and pig iron at consumers' plants:			
Total scrap	7,348,896	7,210,329	−2
Pig iron	2,536,220	2,289,200	−10
Total	9,885,116	9,499,529	−4
Consumption: Ferrous scrap and pig iron charged to:			
Steel furnaces:[1]			
Total scrap	46,064,651	61,774,897	+34
Pig iron	51,658,482	67,957,207	+32
Total	97,723,133	129,732,104	+33
Iron furnaces:[2]			
Total scrap	14,153,375	18,225,324	+29
Pig iron	7,003,567	9,259,128	+32
Total	21,156,942	27,484,452	+30
Miscellaneous uses[3] and ferro-alloy production: Total scrap	1,136,423	1,374,878	+21
All uses:			
Total ferrous scrap	61,354,449	81,375,099	+33
Pig iron	58,662,049	77,216,335	+32
Grand total	120,016,498	158,591,434	+32
Imports of scrap (including tinplate scrap)	[4] 239,035	228,561	−4
Exports of scrap:			
Iron and steel	[4] 1,681,553	[5] 5,129,779	+205
Tinplate, circles, strips, cobbles, etc.	[4] 14,308	17,649	+23
Average prices per gross ton:			
Scrap:			
No. 1 Heavy-Melting, Pittsburgh[6]	$29.90	$40.87	+37
No. 1 Cast Cupola, Chicago[6]	$39.74	$49.32	+24
For export	[4] $34.09	$38.63	+13
Pig iron, f. o. b. Valley furnaces[6]			
Basic	$56.00	$57.19	+2
No. 2 Foundry	$56.50	$57.69	+2

[1] Includes open-hearth, Bessemer, electric furnaces, and oxygen steel process in 1955.
[2] Includes cupola, air, crucible, and blast furnaces; also direct castings.
[3] Includes rerolling, reforging, copper precipitation, nonferrous, and chemical uses.
[4] Revised figure.
[5] Includes rerolling materials.
[6] Iron Age.

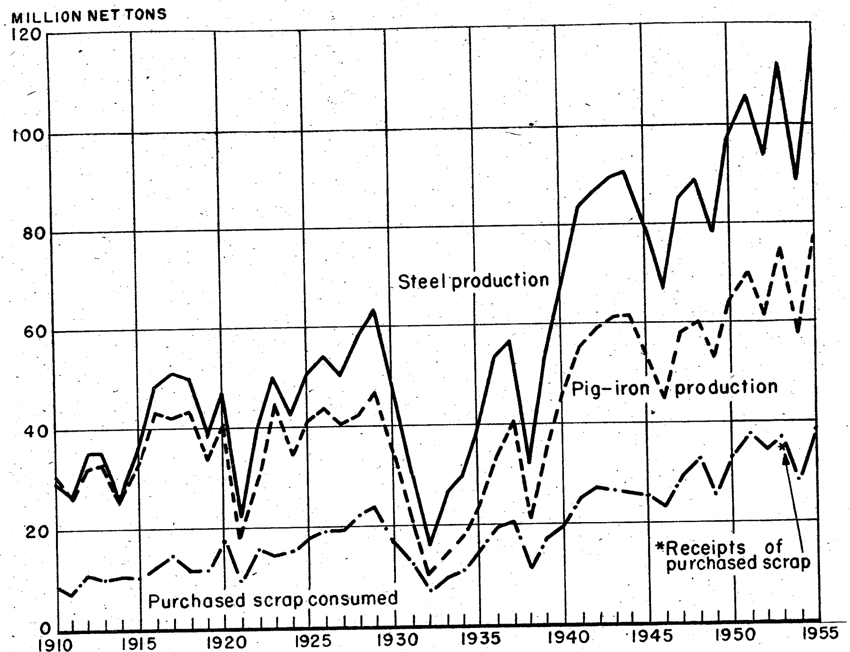

FIGURE 1.—Consumption of purchased scrap in the United States, 1910–52, and output of pig iron and steel, 1910–55. Figures on consumption of purchased scrap for 1910–32 are from State of Minnesota vs. Oliver Iron Mining Co., et al., Exhibits, vol. 5, 1935, p. 328; those for 1933–34 are estimated by authors; and those for 1935–52 are based on Bureau of Mines records. Data for 1953–55 represent receipts of purchased scrap by consumers, based on Bureau of Mines records. Data on steel output from American Iron and Steel Institute.

TABLE 2.—Ferrous scrap and pig iron consumed in the United States and percent of total derived from scrap and pig iron, 1954–55, by districts

District	1954			1955		
	Total consumed (short tons)	Percent of total consumed		Total consumed (short tons)	Percent of total consumed	
		Scrap	Pig iron		Scrap	Pig iron
New England	1,001,065	75.7	24.3	1,221,242	76.9	23.1
Middle Atlantic [1]	34,051,471	47.7	52.3	47,869,716	48.3	51.7
East North Central [1]	55,767,880	52.5	47.5	74,221,856	52.3	47.7
West North Central	2,420,643	75.2	24.8	2,978,887	74.9	25.1
South Atlantic [1]	9,861,381	42.8	57.2	11,495,115	44.8	55.2
East South Central [1]	7,642,209	43.5	56.5	9,689,497	43.7	56.3
West South Central	2,179,106	69.2	30.8	2,622,934	71.0	29.0
Rocky Mountain	3,373,275	44.0	56.0	3,917,579	42.3	57.7
Pacific Coast [1]	3,648,760	72.4	27.6	4,574,608	72.9	27.1
Undistributed [1]	70,708	100.0				
Total	120,016,498	51.1	48.9	158,591,434	51.3	48.7

[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."

Bessemer converters consumed 5 percent of the pig iron and 0.5 percent of the scrap.

Electric furnaces consumed 12 percent of the total scrap (1 percent more than in 1954) and 0.4 percent of the pig iron, compared with 0.3 percent in 1954.

TABLE 3.—Consumption of ferrous scrap and pig iron in the United States, 1954–55, by type of furnace, in short tons

Type of furnace or equipment	Total scrap	Pig iron	Total scrap and pig iron
1954			
Open-hearth	39,028,179	48,632,261	87,660,440
Bessemer	204,050	2,848,691	3,052,741
Electric	6,832,422	177,530	7,009,952
Cupola	9,563,863	4,896,703	14,460,566
Air	961,659	232,422	1,194,081
Crucible	75	42	117
Blast	3,627,778		3,627,778
Direct castings		1,874,400	1,874,400
Ferroalloy	305,607		305,607
Miscellaneous	830,816		830,816
Total	61,354,449	58,662,049	120,016,498
1955			
Open-hearth	51,555,356	63,750,490	115,305,846
Bessemer [1]	418,368	3,932,920	4,351,288
Electric	9,801,173	273,797	10,074,970
Cupola	12,057,789	5,961,861	18,019,650
Air	1,444,981	295,209	1,740,190
Crucible	74	38	112
Blast	4,722,480		4,722,480
Direct castings		3,002,020	3,002,020
Ferroalloy	343,563		343,563
Miscellaneous	1,031,315		1,031,315
Total	81,375,099	77,216,335	158,591,434

[1] Includes scrap and pig iron used in oxygen steel process.

TABLE 4.—Proportion of scrap and pig iron used in furnaces in the United States, 1954–55, in percent

Type of furnace	1954		1955	
	Scrap	Pig iron	Scrap	Pig iron
Open-hearth	44.5	55.5	44.7	55.3
Bessemer [1]	6.7	93.3	9.6	90.4
Electric	97.5	2.5	97.3	2.7
Cupola	66.1	33.9	66.9	33.1
Air	80.5	19.5	83.0	17.0
Crucible	64.1	35.9	66.1	33.9
Blast	100.0		100.0	

[1] Includes oxygen steel process during 1955.

CONSUMPTION BY DISTRICTS AND STATES

The use of iron and steel scrap and pig iron in all 48 States and the District of Columbia increased in all areas, as compared with decreases during 1954 in all but the West South Central district. As in previous years, the largest consuming areas were East North Central, Middle Atlantic, and South Atlantic. The States having the largest consumption of scrap, with the percentages consumed, were: Pennsylvania 22 (compared with 21 in 1954), Ohio 17 (the same percentage for 3 consecutive years), and Indiana 11 and Illinois 10 (the same, respectively, as in 1954).

TABLE 5.—Consumption of ferrous scrap and pig iron in the United States in 1955, by types of consumer and types of furnace, in short tons

Type of furnace or equipment	Type of consumer: Manufacturers of steel ingots and castings [1]			Manufacturers of steel castings [2]			Iron foundries and miscellaneous users			Total		
	Scrap	Pig iron	Total scrap and pig iron	Scrap	Pig iron	Total scrap and pig iron	Scrap	Pig iron	Total scrap and pig iron	Scrap	Pig iron	Total scrap and pig iron
Open-hearth	50,789,067	63,630,784	114,419,851	766,289	119,706	885,995				51,555,356	63,750,490	115,305,846
Bessemer [3]	390,601	3,931,707	4,322,308	21,547	868	22,415	6,220	345	6,565	418,368	3,932,920	4,351,288
Electric	8,086,652	228,146	8,314,798	1,567,970	28,893	1,596,863	146,551	16,758	163,309	9,801,173	273,797	10,074,970
Total steelmaking furnaces	59,266,320	67,790,637	127,056,957	2,355,806	149,467	2,505,273	152,771	17,103	169,874	61,774,897	67,957,207	129,732,104
Cupola	945,298	797,767	1,743,065	512,952	29,655	542,607	10,599,539	5,134,439	15,733,978	12,057,789	5,961,861	18,019,650
Air	36,731	15,045	51,776	412,214	66,774	478,988	996,036	213,390	1,209,426	1,444,981	295,209	1,740,190
Crucible	20		20				54	38	92	74	38	112
Blast [4]	4,722,480		4,722,480							4,722,480		4,722,480
Direct castings		1,722,221	1,722,221					1,279,799	1,279,799		3,002,020	3,002,020
Ferroalloy							343,563		343,563	343,563		343,563
Miscellaneous	370,441		370,441				660,874		660,874	1,031,315		1,031,315
Total: 1955	65,341,290	70,325,670	135,666,960	3,280,972	245,896	3,526,868	12,752,837	6,644,769	19,397,606	81,375,099	77,216,335	158,591,434
Total: 1954	48,778,327	53,314,130	102,092,457	2,543,955	336,514	2,880,469	10,032,167	5,011,405	15,043,572	61,354,449	58,662,049	120,016,498

[1] Includes only those castings made by companies producing steel ingots.
[2] Excludes companies that produce both steel ingots and steel castings.
[3] Includes scrap and pig iron used in oxygen steel process.
[4] Includes consumption in blast furnaces by both integrated and nonintegrated mills.

TABLE 6.—Consumption of ferrous scrap and pig iron in the United States, 1951–55, by districts

District and year	Total scrap (short tons)	Change from previous year (percent)	Pig iron (short tons)	Change from previous year (percent)
New England:				
1951	1,179,980	+21.8	404,530	+12.8
1952	940,579	−20.3	296,086	−26.8
1953	942,226	+ .2	305,786	+ 3.3
1954	757,486	−19.6	243,579	−20.3
1955	939,422	+24.0	281,820	+15.7
Middle Atlantic:				
1951 [1]	23,049,676	+13.2	24,025,918	+11.0
1952 [1]	20,642,588	−10.4	20,398,739	−15.1
1953 [1]	23,270,654	+12.7	24,499,189	+20.1
1954 [1]	16,257,629	−30.1	17,793,842	−27.4
1955	23,143,420	+42.4	24,726,296	+39.0
East North Central:				
1951 [1]	34,801,707	+ 8.6	31,465,063	+10.0
1952 [1]	31,258,860	−10.2	27,162,411	−13.7
1953 [1]	35,465,748	+13.5	33,695,462	+24.1
1954 [1]	29,269,021	−17.5	26,498,859	−21.4
1955	38,827,041	+32.7	35,394,815	+33.6
West North Central:				
1951	2,645,897	+25.3	885,951	+18.5
1952	2,319,763	−12.3	695,594	−21.5
1953 [1]	2,187,526	− 5.7	697,850	+ .3
1954 [1]	1,819,496	−16.8	601,147	−13.9
1955	2,230,430	+22.6	748,457	+24.5
South Atlantic:				
1951 [1]	4,587,561	+ 4.5	5,932,711	+ 3.2
1952 [1]	4,588,962	(2)	5,108,186	−13.9
1953 [1]	5,078,804	+10.7	5,951,217	+14.2
1954 [1]	4,221,583	−16.9	5,639,798	− 5.2
1955	5,145,031	+21.9	6,350,084	+12.6
East South Central:				
1951 [1]	4,098,689	+ 7.9	4,944,109	+ 4.1
1952 [1]	3,488,798	−14.9	4,373,527	−11.5
1953 [1]	3,959,665	+13.5	5,219,535	+19.3
1954 [1]	3,323,212	−16.1	4,318,997	−17.3
1955	4,232,268	+27.4	5,457,229	+26.4
West South Central:				
1951	1,301,441	+29.7	592,574	+62.8
1952	1,193,583	− 8.3	430,925	−27.3
1953	1,377,747	+15.4	580,625	+34.7
1954	1,508,612	+ 9.5	670,494	+15.5
1955	1,863,407	+23.5	759,527	+13.3
Rocky Mountain:				
1951	1,690,133	+ 9.7	1,866,679	+ 5.5
1952	1,453,402	−14.0	1,777,226	− 4.8
1953	1,595,976	+ 9.8	2,507,558	+41.1
1954	1,483,596	− 7.0	1,889,679	−24.6
1955	1,657,623	+11.7	2,259,956	+19.6
Pacific Coast:				
1951 [1]	3,291,618	+23.2	1,296,782	+35.2
1952 [1]	3,061,178	− 7.0	1,308,267	+ .9
1953 [1]	3,167,946	+ 3.5	1,249,255	− 4.5
1954 [1]	2,643,106	−16.6	1,005,654	−19.5
1955	3,336,457	+26.2	1,238,151	+23.1
Undistributed:				
1951 [1]	81,397			
1952 [1]	75,411			
1953 [1]	84,210		1,267	
1954 [1]	70,708			
1955				
United States 1946–50 (average)	59,710,369		56,355,734	
1951 [1]	76,728,099	+11.4	71,414,317	+10.0
1952 [1]	69,023,124	−10.0	61,550,961	−13.8
1953 [1]	77,130,502	+11.7	74,707,744	+21.4
1954 [1]	61,354,449	−20.5	58,662,049	−21.5
1955	81,375,099	+32.6	77,216,335	+31.6

[1] Some scrap consumed in East North Central, West North Central, East South Central, Middle Atlantic, Pacific Coast, and South Atlantic districts, and some pig iron consumed in the East North Central district—not separable—are included with "Undistributed."
[2] Less than 0.05 percent.

TABLE 7.—Consumption of ferrous scrap and pig iron in the United States in 1955, by districts and States, in short tons

District and State	Total scrap (short tons)	Percent of total	Pig iron (short tons)	Percent of total	Total scrap and pig iron (short tons)	Percent of total
New England:						
Connecticut	316, 782	0. 5	50, 126	0. 1	366, 908	0. 2
Maine	7, 577	(1)	3, 357	(1)	10, 934	(1)
Massachusetts	466, 418	. 6	160, 664	. 2	627, 082	. 4
New Hampshire	18, 097	(1)	3, 731	(1)	21, 828	(1)
Rhode Island	102, 406	. 1	53, 316	. 1	155, 722	. 2
Vermont	28, 142	(1)	10, 626	(1)	38, 768	(1)
Total	939, 422	1. 2	281, 820	. 4	1, 221, 242	. 8
Middle Atlantic:						
New Jersey	714, 814	1. 0	234, 153	. 3	948, 967	. 6
New York	4, 179, 217	5. 1	3, 891, 870	5. 0	8, 071, 087	5. 1
Pennsylvania	18, 249, 389	22. 4	20, 600, 273	26. 7	38, 849, 662	24. 5
Total	23, 143, 420	28. 5	24, 726, 296	32. 0	47, 869, 716	30. 2
East North Central:						
Illinois	7, 972, 498	9. 8	5, 877, 830	7. 6	13, 850, 328	8. 7
Indiana	8, 669, 391	10. 7	9, 411, 067	12. 2	18, 080, 458	11. 4
Michigan	7, 064, 331	8. 7	4, 642, 449	6. 0	11, 706, 780	7. 4
Ohio	14, 193, 946	17. 4	15, 203, 917	19. 7	29, 397, 863	18. 5
Wisconsin	926, 875	1. 1	259, 552	. 3	1, 186, 427	. 8
Total	38, 827, 041	47. 7	35, 394, 815	45. 8	74, 221, 856	46. 8
West North Central:						
Iowa	458, 991	. 6	88, 072	. 1	547, 063	. 3
Kansas and Nebraska	84, 291	. 1	7, 322	(1)	91, 613	. 1
Minnesota, North Dakota, and South Dakota	669, 675	. 8	601, 199	. 8	1, 270, 874	. 8
Missouri	1, 017, 473	1. 2	51, 864	. 1	1, 069, 337	. 7
Total	2, 230, 430	2. 7	748, 457	1. 0	2, 978, 887	1. 9
South Atlantic:						
Delaware, District of Columbia, and Maryland	3, 081, 173	3. 8	4, 260, 786	5. 5	7, 341, 959	4. 6
Florida and Georgia	286, 882	. 3	45, 371	. 1	332, 253	. 2
North Carolina	62, 163	. 1	23, 456	(1)	85, 619	. 1
South Carolina	28, 348	(1)	14, 165	(1)	42, 513	(1)
Virginia and West Virginia	1, 686, 465	2. 1	2, 006, 306	2. 6	3, 692, 771	2. 3
Total	5, 145, 031	6. 3	6, 350, 084	8. 2	11, 495, 115	7. 2
East South Central:						
Alabama	2, 643, 750	3. 2	4, 319, 869	5. 6	6, 963, 619	4. 4
Kentucky, Mississippi, and Tennessee	1, 588, 518	2. 0	1, 137, 360	1. 5	2, 725, 878	1. 7
Total	4, 232, 268	5. 2	5, 457, 229	7. 1	9, 689, 497	6. 1
West South Central:						
Arkansas, Louisiana, and Oklahoma	192, 371	. 2	10, 229	(1)	202, 600	. 1
Texas	1, 671, 036	2. 1	749, 298	1. 0	2, 420, 334	1. 5
Total	1, 863, 407	2. 3	759, 527	1. 0	2, 622, 934	1. 6
Rocky Mountain:						
Arizona, Nevada, and New Mexico	58, 122	. 1	82	(1)	58, 204	(1)
Colorado and Utah	1, 569, 550	1. 9	2, 259, 694	2. 9	3, 829, 244	2. 5
Montana	19, 458	(1)	150	(1)	19, 608	(1)
Idaho and Wyoming	10, 493	(1)	30	(1)	10, 523	(1)
Total	1, 657, 623	2. 0	2, 259, 956	2. 9	3, 917, 579	2. 5
Pacific Coast:						
California	2, 777, 589	3. 4	1, 223, 264	1. 6	4, 000, 853	2. 4
Oregon and Washington	558, 868	. 7	14, 887	(1)	573, 755	. 5
Total	3, 336, 457	4. 1	1, 238, 151	1. 6	4, 574, 608	2. 9
Total United States: 1955	81, 375, 099	100. 0	77, 216, 335	100. 0	158, 591, 434	100. 0
1954	61, 354, 449	100. 0	58, 662, 049	100. 0	120, 016, 498	100. 0

1 Less than 0.05 percent.

TABLE 8.—Iron and steel scrap, net available supply [1] for consumption in 1955, by districts and States, in short tons

District and State	Home production	Receipts from dealers and all others	Total available supply	Shipments [2]	Net available supply for consumption
New England:					
Connecticut	113,889	210,967	324,856	5,956	318,900
Maine	3,801	7,012	10,813	3,743	7,070
Massachusetts	210,230	294,573	504,803	23,586	481,217
New Hampshire	8,735	10,798	19,533	664	18,869
Rhode Island	50,351	57,882	108,233	2,116	106,117
Vermont	13,826	13,769	27,595	43	27,552
Total	400,832	595,001	995,833	36,108	959,725
Middle Atlantic:					
New Jersey	210,315	528,832	739,147	26,939	712,208
New York	2,117,597	1,998,352	4,115,949	40,395	4,075,554
Pennsylvania	11,352,147	7,814,684	19,166,831	877,237	18,289,594
Total	13,680,059	10,341,868	24,021,927	944,571	23,077,356
East North Central:					
Illinois	3,967,056	4,187,731	8,154,787	265,097	7,889,690
Indiana	5,458,283	3,442,504	8,900,787	191,167	8,709,620
Michigan	3,566,206	3,645,496	7,211,702	165,645	7,046,057
Ohio	8,598,563	5,860,469	14,459,032	470,594	13,988,438
Wisconsin	528,246	500,293	1,028,539	101,631	926,908
Total	22,118,354	17,636,493	39,754,847	1,194,134	38,560,713
West North Central:					
Iowa	187,808	294,270	482,078	21,682	460,396
Kansas and Nebraska	21,917	64,631	86,548	1,334	85,214
Minnesota, North and South Dakota	312,852	374,992	687,844	7,601	680,243
Missouri	205,417	830,175	1,035,592	14,233	1,021,359
Total	727,994	1,564,068	2,292,062	44,850	2,247,212
South Atlantic:					
Delaware, District of Columbia, and Maryland	2,188,196	879,570	3,067,766	13,392	3,054,374
Florida and Georgia	67,617	217,095	284,712	2,439	282,273
North Carolina	41,033	35,975	77,008	16,344	60,664
South Carolina	12,378	10,368	22,746	1,010	21,736
Virginia and West Virginia	825,139	970,546	1,795,685	61,567	1,734,118
Total	3,134,363	2,113,554	5,247,917	94,752	5,153,165
East South Central:					
Alabama	1,624,855	1,299,205	2,924,060	257,720	2,666,340
Kentucky, Mississippi, and Tennessee	706,220	902,140	1,608,360	43,914	1,564,446
Total	2,331,075	2,201,345	4,532,420	301,634	4,230,786
West South Central:					
Arkansa, Louisiana, and Oklahoma	48,972	160,336	209,308	2,275	207,033
Texas	692,743	1,143,222	1,835,965	44,352	1,791,613
Total	741,715	1,303,558	2,045,273	46,627	1,998,646
Rocky Mountain:					
Arizona, Nevada, and New Mexico	7,997	55,125	63,122	13,735	49,387
Colorado and Utah	1,100,809	510,336	1,611,145	55,930	1,555,215
Idaho, Montana, and Wyoming	6,319	21,856	28,175	30	28,145
Total	1,115,125	587,317	1,702,442	69,695	1,632,747
Pacific Coast:					
California	1,123,188	1,801,073	2,924,261	105,093	2,819,168
Oregon	38,774	174,409	213,183	7,202	205,981
Washington	89,702	273,268	362,970	11,937	351,033
Total	1,251,664	2,248,750	3,500,414	124,232	3,376,182
Total United States	45,501,181	38,591,954	84,093,135	2,856,603	81,236,532

[1] Net available supply for consumption is a net figure computed by adding home production to receipts from dealers and all others and deducting consumers scrap shipped, transferred or otherwise disposed of during the year.
[2] Includes scrap shipped, transferred, or otherwise disposed of during the year.

CONSUMPTION BY TYPES OF FURNACE

Open-Hearth Furnaces.—Record production of ingots and castings during 1955 (105.4 million tons) in open-hearth furnaces, an increase of 31 percent over 1954 and 5 percent higher than 1953, resulted in a record total charge of 115.3 million short tons of ferrous materials, scrap and pig iron, 32 percent greater than 1954. The use of scrap and pig iron, the largest quantities of each of these materials ever used in these furnaces, increased 32 and 31 percent, respectively, over 1954 and 4 percent each over 1953. The open-hearth melt in 1955 consisted of 45 percent scrap and 55 percent pig iron, unchanged from the previous year.

Monthly high rates of consumption were established for scrap during December (4,640,000 short tons) and for pig iron during October (5,687,000 short tons).

TABLE 9.—Consumption of ferrous scrap and pig iron in open-hearth furnaces in the United States in 1955, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
New England: Connecticut, Massachusetts, and Rhode Island	413, 750	100, 856	514, 606
Total: 1955	413, 750	100, 856	514, 606
1954	278, 780	81, 565	360, 345
Middle Atlantic:			
New Jersey and New York	3, 247, 342	3, 730, 422	6, 977, 764
Pennsylvania	13, 929, 937	18, 071, 822	32, 001, 759
Total: 1955	17, 177, 279	21, 802, 244	38, 979, 523
1954	11, 652, 259	15, 737, 454	27, 389, 713
East North Central:			
Illinois	4, 394, 852	4, 542, 224	8, 937, 076
Indiana	7, 612, 348	9, 057, 807	16, 670, 155
Michigan and Wisconsin	2, 135, 931	2, 996, 848	5, 132, 779
Ohio	8, 699, 694	11, 427, 613	20, 127, 307
Total: 1955	22, 842, 825	28, 024, 492	50, 867, 317
1954	17, 935, 075	21, 141, 514	39, 076, 589
West North Central: Minnesota and Missouri	958, 418	556, 660	1, 515, 078
Total: 1955	958, 418	556, 660	1, 515, 078
1954	770, 343	454, 421	1, 224, 764
South Atlantic:			
Delaware and Maryland	2, 691, 752	3, 797, 339	6, 489, 091
Georgia and West Virginia	1, 253, 301	1, 893, 455	3, 146, 756
Total: 1955	3, 945, 053	5, 690, 794	9, 635, 847
1954	3, 281, 879	5, 129, 679	8, 411, 558
East South Central: Alabama, Kentucky, and Tennessee	1, 943, 504	3, 917, 487	5, 860, 991
Total: 1955	1, 943, 504	3, 917, 487	5, 860, 991
1954 [1]	1, 516, 845	3, 014, 264	4, 531, 109
West South Central: Oklahoma and Texas	1, 099, 362	552, 918	1, 652, 280
Total: 1955	1, 099, 362	552, 918	1, 652, 280
1954	900, 383	504, 138	1, 404, 521
Rocky Mountain: Colorado and Utah	1, 339, 005	2, 070, 365	3, 409, 370
Total: 1955	1, 339, 005	2, 070, 365	3, 409, 370
1954	1, 218, 127	1, 723, 578	2, 941, 705
Pacific Coast: California and Washington	1, 836, 160	1, 034, 674	2, 870, 834
Total: 1955	1, 836, 160	1, 034, 674	2, 870, 834
1954	1, 474, 488	845, 648	2, 320, 136
Total United States: 1955	51, 555, 356	63, 750, 490	115, 305, 846
1954	39, 028, 179	48, 632, 261	87, 660, 440

[1] Tennessee not included in 1954.

Pennsylvania continued to be the leading State in the use of scrap in open-hearth furnaces, followed by Ohio, Indiana, and Illinois, maintaining the same order since 1936.

Bessemer Converters.—The inclusion during 1955 of scrap and pig iron used in the oxygen steel process with Bessemer converters resulted in these data not being comparable with 1954, when this process was in operation for only 1 month. Ingots produced in Bessemer furnaces during 1955 were 30 percent higher than during the previous year. The ratio of scrap to total charge was 1:10 compared with 1:15 during 1954. Ohio followed the pattern set in the past few years by remaining as the principal consumer of converter scrap and the largest consumer of pig iron in this type of furnace.

TABLE 10.—Consumption of ferrous scrap and pig iron in Bessemer [1] converters in the United States in 1955, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
New England and Middle Atlantic:			
Connecticut and New Jersey	1,655	37	1,692
Pennsylvania	125,837	671,189	797,026
Total: 1955	127,492	671,226	798,718
1954	86,344	529,936	616,280
East North Central and West North Central:			
Illinois	96	145,442	145,538
Michigan and Minnesota	130,568	264,888	395,456
Ohio	150,223	2,465,503	2,615,726
Total: 1955	280,887	2,875,833	3,156,720
1954	109,827	2,032,590	2,142,417
South Atlantic and East South Central: Delaware, Maryland, and Louisiana	9,534	385,848	395,382
Total: 1955	9,534	385,848	395,382
1954	7,612	286,152	293,764
Rocky Mountain and Pacific Coast: Colorado and Washington	455	13	468
Total: 1955	455	13	468
1954	267	13	280
Total United States: 1955	418,368	3,932,920	4,351,288
1954	204,050	2,848,691	3,052,741

[1] Includes scrap and pig iron used in oxygen steel process.

Electric Steel Furnaces.—The melt of ferrous scrap and pig iron used in electric furnaces in 1955 totaled 10 million short tons, an increase of 44 percent over 1954. Production of ingots and castings during 1955, in electric furnaces, is not comparable with 1954 because of the inclusion by the American Iron and Steel Institute of the ingots and castings produced in the oxygen steel process. The ratio of scrap to pig iron used in electric furnaces was 36:1, compared with 38:1 in 1954. Consumption of scrap in electric furnaces increased in all 9 districts, with the largest increase occurring in the East North Central district. The Middle Atlantic and East North Central areas continued to melt the largest quantity of scrap in electric furnaces, consuming 73 percent of the total.

Cupolas.—Consumption of scrap and pig iron for cupolas increased 25 percent over 1954; scrap increased 26 percent and pig iron 22 percent. The charge to cupolas consisted of 67 percent scrap and 33

TABLE 11.—Consumption of ferrous scrap and pig iron in electric steel furnaces in the United States in 1955, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
New England:			
Connecticut and New Hampshire	28,728	436	29,164
Massachusetts	23,608	1,370	24,978
Total: 1955	52,336	1,806	54,142
1954	41,962	3,351	45,313
Middle Atlantic:			
New Jersey	28,583	2,215	30,798
New York	200,089	3,091	203,180
Pennsylvania	1,752,251	20,503	1,772,754
Total: 1955	1,980,923	25,809	2,006,732
1954	1,402,008	16,842	1,418,850
East North Central:			
Illinois	1,598,949	98,646	1,697,595
Indiana	124,265	1,461	125,726
Michigan	1,192,336	88,609	1,280,945
Ohio	2,110,204	30,823	2,141,027
Wisconsin	189,808	4,017	193,825
Total: 1955	5,215,562	223,556	5,439,118
1954	3,427,339	134,680	3,562,019
West North Central:			
Iowa, Kansas, and Nebraska	80,854	1,007	81,861
Minnesota	12,245	242	12,487
Missouri	215,478	356	215,834
Total: 1955	308,577	1,605	310,182
1954	254,840	1,077	255,917
South Atlantic:			
Delaware, District of Columbia, and Maryland	115,023	1,643	116,666
Florida and Georgia	164,924	273	165,197
North Carolina, Virginia, and West Virginia	97,882	1,043	98,925
Total: 1955	377,829	2,959	380,788
1954	293,082	5,786	298,868
East South Central:			
Alabama	126,108	74	126,182
Kentucky	448,521	9,896	458,417
Tennessee	27,723	545	28,268
Total: 1955	602,352	10,515	612,867
1954	430,211	485	430,696
West South Central:			
Arkansas, Louisiana, and Oklahoma	57,356	1,072	58,428
Texas	258,493	3,970	262,463
Total: 1955	315,849	5,042	320,891
1954	274,634	12,694	287,328
Rocky Mountain: Arizona, Colorado, Nevada, and Utah	42,373	233	42,606
Total: 1955	42,373	233	42,606
1954	29,042	343	29,385
Pacific Coast:			
California	659,269	1,762	661,031
Oregon	163,823	193	164,016
Washington	82,280	317	82,597
Total: 1955	905,372	2,272	907,644
1954	679,304	2,272	681,576
Total United States: 1955	9,801,173	273,797	10,074,970
1954	6,832,422	177,530	7,009,952

percent pig iron, compared with 66 and 34 percent, respectively, in 1954.

Michigan continued to be the leading State in consumption of scrap in cupola furnaces, using 26 percent of the total.

TABLE 12.—Consumption of ferrous scrap and pig iron in cupola furnaces in the United States in 1955, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
New England:			
Connecticut	74,514	40,188	114,702
Maine	7,577	3,356	10,933
Massachusetts	238,750	87,203	325,953
New Hampshire	11,749	2,258	14,007
Rhode Island	38,055	24,088	62,143
Vermont	28,142	10,627	38,769
Total: 1955	398,787	167,720	566,507
1954	368,570	149,351	517,921
Middle Atlantic:			
New Jersey	327,218	187,916	515,134
New York	340,895	179,259	520,154
Pennsylvania	754,079	328,134	1,082,213
Total: 1955	1,422,192	695,309	2,117,501
1954	1,308,562	627,329	1,935,891
East North Central:			
Illinois	1,094,223	316,724	1,410,947
Indiana	599,078	309,135	908,213
Michigan	3,131,449	1,281,097	4,412,546
Ohio	1,494,086	616,908	2,110,994
Wisconsin	556,996	219,527	776,523
Total: 1955	6,875,832	2,743,391	9,619,223
1954	5,142,861	2,156,339	7,299,200
West North Central:			
Iowa	242,006	83,391	325,397
Kansas	34,424	6,718	41,142
Nebraska	18,425	394	18,819
Minnesota, North Dakota, and South Dakota	186,455	55,204	241,659
Missouri	180,716	34,845	215,561
Total: 1955	662,026	180,552	842,578
1954	529,623	138,125	667,748
South Atlantic:			
Delaware and Maryland	84,708	72,449	157,157
Florida	5,719	3,154	8,873
Georgia	30,270	12,949	43,219
North Carolina	56,476	22,532	79,008
South Carolina	24,803	14,165	38,968
Virginia	276,274	72,309	348,583
West Virginia	21,092	62,914	84,006
Total: 1955	499,342	260,472	759,814
1954	386,797	211,446	598,243
East South Central:			
Alabama	782,081	1,104,711	1,886,792
Kentucky and Mississippi	152,667	185,595	338,262
Tennessee	289,018	237,850	526,868
Total: 1955	1,223,766	1,528,156	2,751,922
1954	1,029,136	1,303,619	2,332,755
West South Central:			
Arkansas and Louisiana	8,612	517	9,129
Oklahoma	41,465	8,640	50,105
Texas	247,906	165,756	413,662
Total: 1955	297,983	174,913	472,896
1954	219,309	130,616	349,925
Rocky Mountain:			
Arizona and New Mexico	7,225		7,225
Colorado	76,707	30,797	107,504
Utah	66,295	49,720	116,015
Idaho and Wyoming	9,008	30	9,038
Montana	11,981	150	12,131
Total: 1955	171,216	80,697	251,913
1954	166,864	73,271	240,135
Pacific Coast:			
California	433,696	126,507	560,203
Oregon	34,906	1,879	36,785
Washington	38,043	2,265	40,308
Total: 1955	506,645	130,651	637,296
1954	412,141	106,607	518,748
Total United States: 1955	12,057,789	5,961,861	18,019,650
1954	9,563,863	4,896,703	14,460,566

Air Furnaces.—The total charge of scrap and pig iron in air furnaces in 1955 was 46 percent greater than in 1954; total scrap consumed in these furnaces increased 50 percent over the previous year, with pig iron increasing 27 percent. No Brackelsberg furnaces were used in the United States during the year. Owing to the large consumption of scrap in air furnaces in Ohio, the East North Central district used 75 percent of the total scrap consumed, to repeat as the largest consuming area for these furnaces.

TABLE 13.—Consumption of ferrous scrap and pig iron in air furnaces in the United States in 1955, by districts and States, in short tons

District and State	Total scrap	Pig iron	Total scrap and pig iron
New England:			
Connecticut	34,656	7,390	42,046
Massachusetts and New Hampshire	12,453	4,012	16,465
Total: 1955	47,109	11,402	58,511
1954	37,493	9,262	46,755
Middle Atlantic:			
New Jersey	3,429	2,660	6,089
New York	49,267	13,200	62,467
Pennsylvania	151,105	52,402	203,507
Total: 1955	203,801	68,262	272,063
1954	147,146	53,977	201,123
East North Central:			
Illinois	219,294	40,070	259,364
Indiana	211,163	42,157	253,320
Michigan	145,757	18,040	163,797
Ohio	403,868	61,902	465,770
Wisconsin	105,974	28,976	134,950
Total: 1955	1,086,056	191,145	1,277,201
1954	718,349	150,474	868,823
West North Central: Iowa, Minnesota, and Missouri	14,819	9,628	24,447
Total: 1955	14,819	9,628	24,447
1954	11,636	7,508	19,144
South Atlantic: Delaware, North Carolina, and West Virginia	20,173	9,872	30,045
Total: 1955	20,173	9,872	30,045
1954 [1]	14,296	6,762	21,058
East South Central and West South Central: Alabama and Texas	55,289	3,305	58,594
Total: 1955	55,289	3,305	58,594
1954 [2]	18,135	1,735	19,870
Pacific Coast: California	17,734	1,595	19,329
Total: 1955	17,734	1,595	19,329
1954	14,604	2,704	17,308
Total United States: 1955	1,444,981	295,209	1,740,190
1954	961,659	232,422	1,194,081

[1] The figures for 1954 exclude Texas. The figures for Texas are included in East South Central and West South Central regions for 1954 and 1955.
[2] The figures for 1954 are for Texas only.

Crucible and Puddling Furnaces.—The consumption of scrap and pig iron in crucible furnaces was negligible in 1955, and no iron and steel scrap was reported melted in puddling furnaces.

Blast Furnaces.—Materials other than scrap constitute by far the largest proportion of blast-furnace charge. The proportion of scrap used to pig iron produced was 6.1 percent, compared with 6.3 percent in 1954, and total scrap consumption was 30 percent higher in 1955.

Other materials consisted of 133,379,000 short tons of iron ore, sinter, and manganiferous ore; 4,065,000 tons of mill cinder and roll scale; 5,539,000 tons of open-hearth and Bessemer slag; and 22,000 tons of miscellaneous materials.

TABLE 14.—Consumption of ferrous scrap in blast furnaces in the United States in 1955, by districts and States, in short tons

District and State	Total scrap	District and State	Total scrap
New England and Middle Atlantic:		South Atlantic, East and West South Central:	
Massachusetts and New York	415, 218	Alabama	259, 885
Pennsylvania	1, 450, 662	Kentucky, Maryland, Tennessee, Texas, and West Virginia	389, 295
Total: 1955	1, 865, 880	Total: 1955	649, 180
1954	1, 417, 422	1954	536, 441
East North Central and West North Central:		Rocky Mountain and Pacific Coast:	
Illinois	415, 285	California, Colorado, and Utah	66, 031
Indiana	114, 019	Total: 1955	66, 031
Michigan and Minnesota	407, 776	1954	38, 187
Ohio	1, 204, 309	Total United States: 1955	4, 722, 480
Total: 1955	2, 141, 389	1954	3, 627, 778
1954	1, 635, 728		

USE OF SCRAP IN FERROALLOY PRODUCTION

The ferroalloy plants operating electric furnaces or aluminothermic units during 1955 used 12 percent more scrap than in 1954.

Scrap used in blast furnaces in the manufacture of ferroalloys is included with blast furnaces in this chapter.

TABLE 15.—Consumption of ferrous scrap by ferroalloy producers in the United States in 1955, by districts, in short tons

District	Total scrap	District	Total scrap
Middle Atlantic: Total: 1955	41, 961	East South Central: Total: 1955	66, 154
1954[1]	29, 436	1954	38, 261
East North Central: Total: 1955	47, 684	Pacific Coast: Total: 1955	7, 714
1954[1]	13, 003	1954	2, 979
West North Central: Total: 1955	163, 681	Undistributed: Total: 1955	
1954	149, 071	1954[1]	70, 708
South Atlantic: Total: 1955	16, 369	Total United States: 1955	343, 563
1954	2, 149	1954	305, 607

[1] Some scrap consumption in the Middle Atlantic and East North Central districts during 1954—not separable—is included with "Undistributed."

MISCELLANEOUS USES

Scrap consumed in 1955 for miscellaneous purposes, such as rerolling, nonferrous metallurgy, and as a chemical agent, was 1.3 percent of the total consumption, compared with 1.4 percent during the previous year. The quantity so used increased 24 percent over that used for similar purposes in 1954.

STOCKS

Complete iron-and-steel-scrap figures covering 1955 year-end stocks are not available; producers (railroads and manufacturers) were not canvassed, and dealers, automobile wreckers, and shipbreakers were canvassed on a sample basis.

TABLE 16.—Consumption of ferrous scrap in miscellaneous uses in the United States in 1955, by districts and States, in short tons

District and State	Total scrap	District and State	Total scrap
New England: Connecticut and Massachusetts	16,915	South Atlantic:	
		Georgia	859
		Virginia and West Virginia	50,091
Total: 1955	16,915	Total: 1955	50,950
1954	15,882	1954	47,048
Middle Atlantic:		East South Central and West South Central: Alabama and Texas	68,019
New Jersey	158,095		
New York	91,080	Total: 1955	68,019
Pennsylvania	85,222	1954	57,185
Total: 1955	334,397	Rocky Mountain:	
1954	229,242	Arizona	28,093
East North Central:		Colorado, Idaho, and Montana	10,435
Illinois	249,799	Utah	6,169
Indiana	8,518		
Michigan and Wisconsin	23,760	Total: 1955	44,697
Ohio	83,824	1954	41,360
Total: 1955	365,901	Pacific Coast:	
1954	306,777	California	55,734
		Washington	942
West North Central:		Total: 1955	56,676
Minnesota	572	1954	49,344
Missouri	93,188		
Total: 1955	93,760	Total United States: 1955	1,031,315
1954	83,978	1954	830,816

Consumers' Stocks.—Total iron-and-steel-scrap stocks held by consumers on December 31, 1955, were 2 percent lower than at the beginning of the year. Despite this decrease in total stocks, there were increases in the following districts: New England, West North Central, South Atlantic, East South Central, West South Central, and Pacific Coast. Stocks of pig iron on December 31, 1955, decreased 10 percent from the stocks on hand December 31, 1954.

Suppliers' Stocks.—Stocks of iron and steel scrap in the hands of a combined total of 591 dealers, automobile wreckers, and shipbreakers, as reported voluntarily to the Bureau of Mines, totaled 877,000 short tons on December 31, 1955.

TABLE 17.—Consumers' stocks of ferrous scrap and pig iron on hand in the United States on December 31, 1954, and December 31, 1955, by districts and States, in short tons

District and State	December 31, 1954		December 31, 1955	
	Total scrap	Pig iron	Total scrap	Pig iron
New England:				
Connecticut	19,099	8,356	21,248	5,893
Maine	1,576	651	1,043	932
Massachusetts	65,873	82,448	80,763	89,266
New Hampshire	1,193	304	1,964	201
Rhode Island	8,948	5,253	8,905	8,997
Vermont	3,177	1,214	2,588	1,668
Total	99,866	98,226	116,511	106,957
Middle Atlantic:				
New Jersey [1]	75,795	39,641	79,617	37,884
New York [1]	532,797	289,014	429,482	212,483
Pennsylvania	1,478,802	528,845	1,513,491	398,845
Total	2,087,394	857,500	2,022,590	649,212

See footnote at end of table.

TABLE 17.—Consumers' stocks of ferrous scrap and pig iron on hand in the United States on December 31, 1954, and December 31, 1955, by districts and States, in short tons—Continued

District and State	December 31, 1954		December 31, 1955	
	Total scrap	Pig iron	Total scrap	Pig iron
East North Central:				
Illinois	914,415	129,339	826,531	170,332
Indiana [1]	708,418	116,563	751,556	92,697
Michigan	407,780	237,537	387,950	303,830
Ohio [1]	1,198,178	367,463	1,012,508	323,690
Wisconsin	70,586	27,308	72,287	29,229
Total	3,299,377	878,210	3,050,832	919,778
West North Central:				
Iowa	32,295	37,694	33,701	15,126
Kansas and Nebraska	12,132	753	12,803	532
Minnesota, North Dakota, and South Dakota	137,788	59,426	154,188	15,441
Missouri [1]	176,766	14,218	180,996	17,270
Total	358,981	112,091	381,688	48,369
South Atlantic:				
Delaware, District of Columbia, and Maryland	171,338	34,538	145,940	27,544
Florida and Georgia	16,352	3,062	11,830	3,947
North Carolina	6,834	3,364	5,328	2,718
South Carolina	1,940	2,659	1,779	2,509
Virginia and West Virginia [1]	166,640	16,470	217,696	20,567
Total	363,104	60,093	382,573	57,285
East South Central:				
Alabama [1]	159,778	269,413	190,038	260,939
Kentucky, Mississippi, and Tennessee	139,335	113,857	113,025	99,840
Total	299,113	383,270	303,063	360,779
West South Central:				
Arkansas, Louisiana, and Oklahoma	17,983	1,792	27,000	1,424
Texas	191,227	61,193	305,751	51,411
Total	209,210	62,985	332,751	52,835
Rocky Mountain:				
Arizona, Nevada, and New Mexico	23,460	152	13,974	110
Colorado and Utah	145,940	51,484	131,624	41,519
Montana	6,325	66	4,832	91
Idaho and Wyoming	2,540	81	2,092	50
Total	178,265	51,783	152,522	41,770
Pacific Coast:				
Alaska, Washington, and Oregon [1]	108,026	3,476	113,944	6,003
California	313,544	28,586	353,855	46,212
Total	421,570	32,062	467,799	52,215
Undistributed [1]	32,016			
Total United States	7,348,896	2,536,220	7,210,329	2,289,200

[1] Some scrap stocks in 1954 in Alabama, New Jersey, New York, Missouri, Ohio, Oregon, and West Virginia—not separable—are included with "Undistributed."

TABLE 18.—Iron and steel scrap: Consumers' stocks, production, receipts, consumption, and shipments by grades, in 1955, in short tons

Grades of scrap	Total stocks on hand Jan. 1, 1955	Scrap produced	Receipts from dealers and all others	Total consumption	Shipments	Total stocks on hand Dec. 31, 1955
No. 1 Heavy-Melting steel	1,890,436	18,064,558	6,846,610	25,016,872	16,623	1,768,109
No. 2 Heavy-Melting steel	923,961	2,387,076	5,180,583	7,414,195	33,599	1,043,826
Bundles	1,180,380	1,349,150	9,165,342	10,670,770	138,079 (Bundles and Low-phosphorus scrap combined)	1,085,913
Low-phosphorus scrap	490,583	1,613,534	3,497,195	4,881,836		519,586
Cast-iron scrap other than borings	974,998	7,559,366	5,153,529	12,329,122	392,656	966,115
All others	1,888,538	14,527,497	8,748,695	21,062,304	2,275,646	1,826,780
Total, all grades	7,348,896	45,501,181	38,591,954	81,375,099	2,856,603	7,210,329

TABLE 19.—Consumption, and stocks December 31, 1955, of iron and steel scrap, by grades, by districts and States, in 1955, in short tons

District and State	No. 1 Heavy-Melting steel		No. 2 Heavy-Melting steel		Bundles		Low-phosphorus scrap		Cast-iron scrap other than borings		All others		Total all grades	
	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks	Consumption	Stocks
New England:														
Connecticut	47,723	660	22,836	1,213	41,343	1,905	11,325	655	92,515	7,949	101,040	8,866	316,782	21,248
Maine	1,004	137							6,573	836		70	7,577	1,043
Massachusetts	81,589	28,263	2,661	630	42,496	7,505	47,404	6,357	205,640	21,185	86,628	16,823	466,418	80,763
New Hampshire	2,499	202	213	4			767	3	11,205	1,448	3,413	307	18,097	1,964
Rhode Island	634	50	36,110	2,468	4,882	162	11,779	2,476	21,570	1,274	27,431	2,475	102,406	8,905
Vermont	4,725	364	217						23,200	2,224			28,142	2,588
Total	138,174	29,676	62,037	4,315	88,721	9,572	71,275	9,491	360,703	34,916	218,512	28,541	939,422	116,511
Middle Atlantic:														
New Jersey	28,036	2,451	21,839	2,200	73,815	11,747	54,218	11,092	302,340	30,879	234,566	21,248	714,814	79,617
New York	1,549,435	130,722	75,080	17,848	587,029	99,408	111,691	14,878	403,246	43,155	1,452,736	123,471	4,179,217	429,482
Pennsylvania	6,832,137	412,964	1,401,997	126,631	2,266,239	252,414	1,101,646	157,576	2,046,599	119,117	4,600,771	444,789	18,249,389	1,513,491
Total	8,409,608	546,137	1,498,916	146,679	2,927,083	363,569	1,267,555	183,546	2,752,185	193,151	6,288,073	589,508	23,143,420	2,022,590
East North Central:														
Illinois	2,230,679	151,73	928,217	119,122	1,234,146	141,088	599,049	77,079	908,974	99,075	2,071,433	238,435	7,972,498	826,531
Indiana	4,371,886	388,424	330,869	96,835	1,258,387	72,673	213,239	30,853	761,669	71,173	1,733,341	91,598	8,669,391	751,556
Michigan	302,607	2,321	453,764	8,668	1,504,104	110,244	820,051	64,309	1,909,630	53,902	2,074,175	148,506	7,064,331	387,950
Ohio	4,191,253	252,173	897,759	100,906	1,678,942	180,722	1,096,031	77,762	1,621,836	107,473	4,708,125	293,472	14,193,946	1,012,508
Wisconsin	63,719	4,899	8,792	290	11,603	752	247,896	23,419	336,236	20,619	258,629	22,308	926,875	72,287
Total	11,160,144	799,549	2,619,401	325,821	5,687,182	505,479	2,976,266	273,422	5,538,345	352,242	10,845,703	794,319	38,827,041	3,050,832
West North Central:														
Iowa	11,182	1,373	11,327	983	2,147	4	49,105	1,610	188,925	16,177	196,305	13,554	458,991	33,701
Kansas and Nebraska	3,619	18					24,618	2,151	47,929	10,285	8,125	349	84,291	12,803
Minnesota, North and South Dakota	181,415	47,962	82,347	68,431	63,729	10,728	20,451	1,186	183,202	19,021	138,531	6,860	669,675	154,188
Missouri	30,266	12,517	567,888	42,078	11,656	1,415	22,759	2,234	247,913	54,386	136,991	68,366	1,017,473	180,996
Total	226,482	61,870	661,562	111,492	77,532	12,147	116,933	7,181	667,969	99,869	479,952	89,129	2,230,430	381,688

South Atlantic:														
Delaware, District of Columbia, and Maryland	1,369,613	44,165	162,937	40,280	452,847	17,981	32,791	4,381	308,186	21,550	754,799	17,583	3,081,173	145,940
Florida and Georgia	74,312	3,933	127,363	1,387			1,571	2	24,800	1,295	58,836	5,214	286,882	11,831
North Carolina	1,153	577					507	17	56,856	4,323	3,647	411	62,163	5,328
South Carolina									20,557	925	7,791	854	28,348	1,779
Virginia and West Virginia	61,274	11,096	202,431	20,439	332,095	32,433	70,158	17,449	277,736	29,539	742,771	106,739	1,686,465	217,695
Total	1,506,352	59,771	492,731	62,106	784,942	50,414	105,027	21,849	688,135	57,632	1,567,844	130,801	5,145,031	382,573
East South Central:														
Alabama	836,916	29,302	145,323	26,831	313,228	22,537	32,277	5,106	775,430	55,047	540,576	51,215	2,643,750	190,038
Kentucky, Mississippi, and Tennessee	565,763	47,983	280,755	11,942	210,441	14,672	74,856	749	325,359	20,023	131,344	17,656	1,588,518	113,025
Total	1,402,679	77,285	426,078	38,773	523,669	37,209	107,133	5,855	1,100,789	75,070	671,920	68,871	4,232,268	303,063
West South Central:														
Arkansas, Louisiana, and Oklahoma	4,032	67	73,397	15,641	682		55,731	6,985	44,002	2,921	14,527	1,386	192,371	27,000
Texas	24,088	11,298	1,038,856	186,186	90,310	30,737	71,695	3,726	333,333	59,958	112,754	13,846	1,671,036	305,751
Total	28,120	11,365	1,112,253	201,827	90,992	30,737	127,426	10,711	377,335	62,879	127,281	15,232	1,863,407	332,751
Rocky Mountain:														
Arizona, Nevada, and New Mexico			22,714	7,396					1,889	1,826	33,519	4,752	58,122	13,974
Colorado and Utah	942,992	61,997	61,341	17,547	54,449	10,422	3,550	607	217,006	23,199	290,212	17,852	1,569,550	131,624
Idaho, Montana, and Wyoming									16,560	2,423	13,391	4,501	29,951	6,924
Total	942,992	61,997	84,055	24,943	54,449	10,422	3,550	607	235,455	27,448	337,122	27,105	1,657,623	152,522
Pacific Coast:														
Washington	125,847	22,785	55,245	15,977	15,174	7,909	18,696	1,859	76,465	13,621	65,551	14,064	356,978	76,215
Oregon	71,200	11,080	49,277	6,604	16,823	38	2,420	439	30,205	1,622	31,965	17,946	201,890	37,729
California	1,005,274	86,594	352,640	105,289	404,203	58,417	85,555	4,626	501,536	47,665	428,381	51,264	2,777,589	353,855
Total	1,202,321	120,459	457,162	127,870	436,200	66,364	106,671	6,924	608,206	62,908	525,897	83,274	3,336,457	467,799
Total United States	25,016,872	1,768,109	7,414,195	1,043,826	10,670,770	1,085,913	4,881,836	519,586	12,329,122	966,115	21,062,304	1,826,780	81,375,099	7,210,329

TABLE 20.—Stocks of iron and steel scrap and pig iron on hand at plants of major consuming industries, in short tons

	Manufacturers of steel ingots and castings	Manufacturers of steel castings	Iron foundries and miscellaneous users	Total
	Scrap stocks			
December 31, 1954	5,937,373	393,010	1,018,513	7,348,896
December 31, 1955	5,815,310	416,901	978,118	7,210,329
	Pig-iron stocks			
December 31, 1954	1,965,929	49,751	520,540	2,536,220
December 31, 1955	1,562,917	64,324	661,959	2,289,200

PRICES

Record iron-and-steel-scrap prices during 1955 were caused by continued high domestic mill demands, increased exports, and higher operating rate in electric furnaces, which use virtually 100 percent scrap.

The price of No. 1 Heavy-Melting scrap at Pittsburgh, as reported in the Iron Age Annual Review, January 5, 1956, was $36.50 per gross ton in January, $6.25 higher than in January 1954. Prices for this grade of scrap fluctuated from a low of $34.70 per ton in May to an alltime record high of $51.13 per ton in December.

Cast-iron scrap at Cincinnati averaged $42.25 per gross ton for the year. The highest price during 1954, $39.50 per ton, which was firm during the last 3 months of the year, was the lowest during 1955 and remained steady through April; the highest price, $46.50 per ton, was in effect during October.

The average composite price of iron and steel scrap, as reported by Iron Age, was $34.62 per gross ton in January, $5.95 higher than in January 1954; the price fluctuated at a higher level during the next 3 months but dropped to a low for the year of $34.40 per ton during May; the next 7 months witnessed a continuous rise to a high for the year of $50.42 per ton during December. The average composite price for the year was $40.19 per ton. The price of No. 1 Cast scrap at Chicago varied from month to month with a low of $44.75 per gross ton during January and a high of $55.50 per ton during December, an increase of $11.87 over December 1954. The average for the year was $49.32 per ton. No. 1 Heavy Melting at Chicago was quoted at $34.50 per ton in January, ranging from a low of $32.90 per ton during May to a high of $49.13 per ton in December. The average price for this grade of scrap for the year was $38.48 per ton.

FOREIGN TRADE [2]

Imports.—Imports of iron and steel scrap, including tinplate, decreased 4 percent in quantity from the previous year; however, the value increased 18 percent. Of the scrap imported, the largest quantity was received from Canada-Newfoundland-Labrador (91 percent of the total imports), followed by Peru (5 percent) and Cuba (1 per-

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

cent); 3 percent was imported from other countries. Of the total imports, 14 percent was tinplate scrap, mostly from Canada, the same percentage as during the previous year.

TABLE 21.—Ferrous scrap imported for consumption in the United States, by countries, 1946–50 (average) and 1951–55, in short tons

[U. S. Department of Commerce]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Bahamas	356	1,737	234	198	28	190
Canada-Newfoundland-Labrador	53,405	69,799	55,101	131,371	[1] 223,030	207,640
Canal Zone	2,256	10,525	1,141	2,180	511	
Cuba	18,268	43,870	22,800	3,012	2,893	3,685
French West Indies	939		1,596	1,381	1,215	57
Guatemala	349	522	146			1,363
Netherlands Antilles	4,438	4,328	951	7,104	3,360	
Panama	184	65	1,913	1,410		
Other North America	3,969	9,547	6,495	2,809	483	432
Total	84,164	140,393	90,377	149,465	[1] 231,520	213,367
South America:						
Peru	24		2,722			10,554
Venezuela	1,647	554	8,385	2,240	2,912	674
Other South America	313	4,796	2,695			
Total	1,984	5,350	13,802	2,240	2,912	11,228
Europe:						
Belgium-Luxembourg	10,580	1,676	328			
Denmark	2,193	475	128			13
France	32,683	27,844	258	373	46	
Germany	189,299	63,912		[2] 253	[2] 1	[2] 78
Netherlands	56,071	19,402	12	77	13	
Norway	88	35	2,576	3		
Switzerland	6	6,709				
United Kingdom	2,895	6,225	23	5,686	591	2,062
Other Europe	1,814	2,965	545	247	177	100
Total	295,629	129,243	3,870	6,639	828	2,253
Asia:						
India	1,041	21,519	13,251			
Japan	77,762	31,648	1,259	1,751	400	575
Korea, Republic of	179	8,516	5,741			
Philippines	23,122	26,336		51		
Other Asia	4,759	217				
Total	106,863	88,236	20,251	1,802	400	575
Africa:						
Algeria	3,286	22,863	799	790	688	195
French Morocco	2,330	3,042	2,187	3,778	906	
Union of South Africa	2,998	6,930	5,617	2,167	1,399	802
Other Africa	124	364	820	316	224	122
Total	8,738	33,199	9,423	7,051	3,217	1,119
Oceania:						
Australia	10,147	12,512	8,755	6,145	56	
New Zealand	495	7,477	431	318	102	9
Western Pacific Islands	20		6,720			
Other Oceania	1,086	448	45			10
Total	11,748	20,437	15,951	6,463	158	19
Grand total: Short tons	509,126	416,858	153,674	173,660	[1] 239,035	228,561
Value	$12,490,821	$15,013,148	$5,398,570	$5,870,215	[3] $5,947,731	$7,038,266

[1] Revised figure.
[2] West Germany.
[3] Owing to changes in tabulating procedures by U. S. Department of Commerce data known to be not comparable with other years.

Exports.—Record demand by friendly nations and member countries of the European Steel and Coal Community resulted in the highest quantity of ferrous scrap ever to be exported from the United States. Exports during 1955 increased 12 percent over the previous high year 1937 and were 56 percent greater than the 5-year prewar average (1935–39) of 3,298,000 tons a year. Total ferrous scrap excluding rerolling rails, exported during 1955 increased 204 percent in quantity and 246 percent in value over 1954.

TABLE 22.—Ferrous scrap exported from the United States, 1946–50 (average) and 1951–55, by countries of destination, in short tons [1]

[U. S. Department of Commerce]

Destination	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada-Newfoundland-Labrador	122,615	89,632	195,370	76,762	48,544	429,751
Mexico	73,633	130,491	135,054	156,394	[2] 224,409	258,492
Other North America	135	49	26			87
Total	196,383	220,172	330,450	233,156	[2] 272,953	688,330
South America:						
Argentina	1,915	2,597	741		75,425	103,932
Brazil	993	1,018	296		928	141
Chile	1,343	6				54
Other South America	212	279	3	9	191	22
Total	4,463	3,900	1,040	9	76,544	104,149
Europe:						
Belgium-Luxembourg	13	316	55	15	[2] 20,330	185,331
France	80	1			31,427	256,631
Germany	5		[3] 131		[2] [3] 350,212	[3] 672,385
Italy	75	473	1,300	171	252,026	1,152,752
Netherlands	142	1,212	34	27	20,906	42,487
Turkey	144	420	846	624	459	
United Kingdom	123		9,634	9,055	181,342	1,044,635
Other Europe	1,339	1,375	398	126	142,036	163,273
Total	1,921	3,797	12,398	10,018	998,738	3,517,494
Asia:						
Hong Kong	1,513	14		121	939	541
India	378	797	1,763	3,205	1,929	1,366
Japan	322	3,105	4,362	62,471	[2] 316,691	782,686
Malaya	173	2,487	1,044	361	73	345
Philippines	43	81		287	439	722
Taiwan	20					8,000
Other Asia	2,133	465	306	84	10,741	1,818
Total	4,582	6,949	7,475	66,529	[2] 330,812	795,478
Africa:						
Union of South Africa	238	709	28	91		50
Other Africa	106		33	11	130	104
Total	344	709	61	102	130	154
Grand total: Short tons	207,693	235,527	351,424	309,814	[2] 1,679,177	5,105,605
Value	$5,654,140	$8,736,327	$12,423,002	$10,827,452	[2]$50,746,951	$175,627,328

[1] In addition to data shown, rerolling materials exported as follows: 1949, Canada, 37 tons; Mexico, 1,095 tons; Honduras, 30 tons; Bolivia, 44 tons; total, 1,206 tons ($50,086): 1951, Mexico, 9,813 tons ($358,146): 1952, Canada, 69 tons; Mexico, 1,217 tons; total, 1,286 tons ($77,287): 1953, Belgium-Luxembourg, 163 tons; Japan, 5,873 tons; Mexico, 692 tons; total, 6,728 tons ($391,464): 1954, Canada, 110 tons; Mexico, 3,062 tons; India, 2,824 tons; Japan, 10,688 tons; total, 16,684 tons ($865,413): 1955, Canada, 454 tons; Mexico, 19,504 tons; El Salvador, 76 tons; United Kingdom, 24 tons; Belgium-Luxembourg, 793 tons; Japan, 19,304 tons; India, 1,107 tons; Hong Kong, 561 tons; total, 41,823 tons ($1,898,357).
[2] Revised figure.
[3] West Germany.

TECHNOLOGY

During 1955 the Bureau of Mines was engaged in two projects pertaining to iron and steel scrap: (1) Experimental operation of a portable top-fired preheater for heating scrap before charging into the furnaces was continued in an effort to determine if equipment of this type would shorten the time for melting scrap and reduce the cost of steelmaking; (2) a project, "Metallurgical Problems of Steel and

TABLE 23.—Ferrous scrap imported into and exported from the United States, 1946–50 (average) and 1951–55, by classes [1]

[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				
1946–50 (average)	468,844	40,282	509,126	202,179	169	5,066	279	207,693
1951	359,099	57,759	416,858	219,905	907	14,554	161	235,527
1952	105,896	47,778	153,674	336,287	3,998	11,139	----------	351,424
1953	131,568	42,092	173,660	291,177	5,818	12,819	----------	309,814
1954	206,316	[2] 32,719	[2] 239,035	[2] 1,664,869	1,057	[2] 13,251	----------	[2] 1,679,177
1955	196,394	32,167	228,561	5,087,956	1,075	16,574	----------	5,105,605
				VALUE				
1946–50 (average)	$11,761,930	$728,891	$12,490,821	$5,100,448	$19,211	$511,317	$23,164	$5,654,140
1951	13,181,093	1,832,055	15,013,148	6,457,069	33,498	2,227,549	18,211	8,736,327
1952	4,053,529	1,345,041	5,398,570	11,035,285	85,828	1,301,889	----------	12,423,002
1953	4,754,939	1,115,276	5,870,215	9,574,911	99,041	1,153,500	----------	10,827,452
1954	[3] 5,115,808	[3] 831,923	[3] 5,947,731	[2] 49,625,759	22,651	[2] 1,098,541	----------	[2] 50,746,951
1955	[3] 6,199,282	838,984	[3] 7,038,266	174,222,920	33,489	1,370,919	----------	175,627,328

[1] In addition to data shown rerolling materials exported as follows: 1949, 1,206 tons ($50,086); 1951, 9,813 tons ($358,146); 1952, 1,286 tons ($77,287); 1953, 6,728 tons ($391,464); 1954, 16,684 tons ($865,413); 1955, 41,823 tons ($1,898,357). Not separately classified prior to 1949.

[2] Revised figure.

[3] Owing to changes in tabulating procedures by U. S. Department of Commerce, data known to be not comparable with years before 1954.

Steel Scrap," was prompted by The Minerals and Metals Advisory Board of the National Academy of Sciences in its report, dated December 28, 1953, on The Recovery of Critical and Strategic Metals From High-Alloy Scrap. No definite conclusions were reached on this long-range project, but a number of techniques were tested in the search for economic methods for recovering strategic metals from alloy scrap.

Advancement during 1955 in the production of briquets from scrap with a specific chemical analysis may alleviate future open-hearth scrap shortages by use of briquets converted from blast-furnace-scrap grades. These briquets are reported to be equal in quality and price to No. 1 Heavy-Melting scrap, and future production may range up to 100,000 tons per month.[3]

The outstanding topic of discussion on April 4, 1955, at a meeting of the board of directors of the Institue of Scrap Iron and Steel, was various methods for improving the quality of No. 2 bundles to broaden the market for this grade. The board adopted a program proposed by the Balers Committee, which included a review of specifications on bundles by dealers and consumers and methods for more uniform acceptance and enforcement of such specifications and also authorized funds for the Battelle Memorial Institute to begin research on bundles, including an evaluation of their yield in comparison with other grades of scrap. This research is expected to develop into a

[3] Iron Age, vol. 175, No. 9, Mar. 3, 1955, p. 73.

study of the entire bundle problem and also possible new areas for utilizing scrap.[4]

Increased steel production and exports of metallics during the past decade have caused a heavy drain upon the conventional source of supplies of iron and steel scrap.[5] Industrial plants, railroads, dealers' yards, automobile wrecking yards, ships, worn-out and obsolete machinery, demolished buildings, and other demolition projects have been basically the sources of iron and steel scrap. Dealers and consumers looking for new sources from which to replenish stocks found a potential supply, that had not been exploited, in the slag dumps of steel mills and foundries. These dumps contain slag mixed with iron and steel from open-hearth, Bessemer, blast, and electric furnaces and foundry operations. Dump sites fall into two categories: (1) Active dumps near steel mills and foundries and (2) abandoned areas. Scrap recovered from these dumps falls into two sizes—blast furnace and open hearth—and several types known as pit scrap, necks, monkey scrap, buttons, cinder scrap, and salamander scrap.

For many years individuals collected scrap from the surface of these dumps, selling it in small quantities. However, the increased demand for scrap invited investmant in equipment and crews to exploit the dumps. A process similar to surface mining has been developed. The equipment used includes shovels, cranes, bulldozers, magnets, earth-moving pans, magnetic separators, oxygen-acetylene torches, breaking balls, conveyors, conveyor belt systems, screening units, and trucks, Operation procedures generally include removal of slag from dumps, crushing, screening, and recovery of iron by use of magnetic separators.

Greater utilization of steel scrap has been realized in the ability of metallurgical blast cupola furnaces to use a charge of nearly 100 percent steel scrap in producing hot metal of blast-furnace quality.[6] The metallurgical blast cupola resembles a blast furnace in appearance, but differs in operation, in that it retains the low-pressure blast and continuous tapping features of a conventional cupola. This furnace has been so designed to permit rigid control of combustion and melting while retaining the operating characteristics of a blast furnace.

Operating efficiencies and economic advantages are of particular interest to steel mills and foundries. Advantageous to steelmakers is the use of hot metal from these furnaces, which decreases the melting time for open hearths, normally utilizing a 100-percent cold charge. For foundry use the metallurgical blast cupola greatly reduces the requirements for pig iron or cast-iron scrap, and the higher temperature metal reduces foundry rejects.

These cupolas were operated in the United States, 11 European countries, and Japan. The 480-ton daily capacity unit installed at Phoenix Iron & Steel Co., Harrisburg, Pa., was the largest in operation. When the cupola is operating to supply molten iron, the average daily output of steel from the open-hearth furnaces at this location is increased 25 percent, with a resulting decrease in the operating cost per ton of steel ingots produced.

The iron and steel scrap dealers' industry collects and prepares scrap for use in steel mills and iron foundries. This industry deals in

4 Institute of Scrap Iron and Steel, Inc., Special Letter 1285: Apr. 5, 1955.
5 Waste Trade Journal, vol. 100, No. 4, Oct. 15, 1955, pp. 7–10.
6 Jaswinski, S. T., Metallurgical Blast Cupola Offers Improved Melting Efficiency: Iron Age, vol. 175, No. 16, Apr. 21, 1955, pp. 87–91.

purchased or open-market scrap, which can be classified as scrap that is produced by industrial plants and that which occurs by obsolescence or failure. Fewer wasted man-hours and higher profits through better scrap segregation are benefits gained through efficient removal and handling of scrap.[7] For use in improving efficiency within industrial plants, dealers have provided or offered to provide self-dumping hoppers or tote boxes, for scrap flow within the plant, that can be moved easily to a central collection area by standard fork or platform-type lift trucks; some can also be moved by overhead cranes. Equipment of this type has virtually replaced drums and wheelbarrows and has improved segregation of scrap into various grades.

Firms that have large quantities of scrap and adequate storage space either loaded directly into railroad cars or trucks, using cranes, lift trucks, or mobile-type cranes furnished and operated by the dealer. Conveyor equipment has also been devised to transport scrap from production lines to collection points or processing areas.

One relatively new low-cost method used by dealers is to supply firms that are not equipped to remove their scrap with large, detachable, self-dumping boxes, which are picked up by specially designed hydraulic hoist trucks. These boxes are placed at strategic collecting points and tagged as to grade. This provides better segregation and identification. One other advantage of this equipment is that it can be placed in ground-level concrete pits, enabling firms that still use wheelbarrows to easily dump and segregate their scrap.

The crane is the most important piece of equipment in handling scrap. Among those used are the locomotive, overhead electric, crawler, and truck cranes. The overhead electric crane is considered one of the most efficient, and its advantage over other cranes is low cost of maintenance.

Locomotive cranes serve a dual purpose in loading and unloading scrap and switching cars within a plant that has multiple railroad track layouts, which eliminates a switch engine or like equipment.

The cranes most commonly found in scrap yards are the crawler and mobile types. These types are more desirable to a dealer because of their low initial cost and maneuverability.

Two innovations to enter scrap yards have been conveyor systems and television sets. Conveyors, along with cranes, are doing a good job in feeding the steel turning crushers. Electronically controlled conveyors were used by some hydraulic balers to carry unprepared scrap to the presses and the finished bales to the railroad cars. Television sets have also been installed by some baler installations and are so situated that an operator can see the entire operation from his control room.

A new combination grapple and magnet for handling baling material, small loose material, and prepared scrap, which is equipped with four keenly pointed tines to achieve improved penetration into all types of scrap metals, has been developed by M. P. McCaffrey, Inc.[8]

The weight of the grapples used is lighter than others, but the sharp prongs bite deeply into the scrap, holding it firmly. This new grapple-magnet combination provides several times as much pickup capacity as a grapple, magnet, or clamshell bucket alone.

---

[7] Pinkert, Norman L., Modern Handling Methods as Applied to the Scrap Iron and Steel Industry: Am. Met. Market, vol. 62, No. 99, May 21, 1955, pp. 11, 13.

[8] Iron and Steel Engineer, vol. 32, No. 12, December 1955, p. 216.

A publication prepared through the combined efforts of the Departments of the Army, Navy, and Air Force points out practical methods in recovery and disposal of ferrous and nonferrous scrap and waste materials at military services.[9] Although this handbook was written primarily to instruct the military establishments in efficient recovery and disposal of scrap and waste materials, it includes information of interest to the civilian dealer. Various methods of identification, such as surface appearance, chemical spot tests, and spot-test procedures, are described and discussed.

During 1955 the American Iron and Steel Institute conducted a survey on scrap preparation for open-hearth-furnace plants. Questionnaires were sent out requesting the following information: Scrap-preparation equipment, size of scrap-preparation area, loading methods, scrap portion of furnace metallic charge, inspection of scrap, incentive system for preparation, and preparation of coated scrap. Fifty-six steel mills, representing 75 plants producing open-hearth steel, completed and returned the form. Their information was published in a booklet.[10]

WORLD REVIEW

Austria.—Because imported-scrap prices were approximately four times higher than the same grades of domestic scrap, Austrian steel mills hesitated to import foreign scrap. However, owing to record activity in steel mills and rolling plants, it was believed that about 110,000 short tons of scrap would have to be imported, which was to be covered by purchases in the United States.[11]

Germany, West.—The High Authority of the European Coal and Steel Community ordered the West German Association for the Purchase of Scrap to discontinue its activities, because they were considered to be contrary to the rules of the Schuman Treaty.[12] Several functions entrusted to the Brussels Scrap Bureau had been performed by the association since late 1954, and in addition it had used a bonus system similar to the one formed by the High Authority for consuming pig iron instead of scrap.

According to the Government's Office of Statistics, scrap stocks held by the steel industry totaled 1,336,000 short tons at the end of October, which was the first time since 1948 that the industry held adequate stocks for 3 months' consumption at the beginning of a winter period.[13]

Italy.—The Italian Ministry for Foreign Affairs estimated the total scrap consumption for 1955 at about 4,211,000 short tons, which was based on an estimated production of 5,291,000 tons of crude steel, and on this basis asked the ECSC for an allocation of 1,653,000 tons of third country scrap, of which an estimated 1,323,000 tons would come from the United States.[14] According to final export data, Italy received 1,153,000 short tons of scrap from the United States, compared with 252,000 short tons during the previous year.

Japan.—During September and October, 38,000 short tons of scrap salvaged from vessels in the South Pacific arrived in Japan.

[9] U. S. Department of Commerce, Office of Technical Services, Scrap Yard Handbook: October 1955, pp. 1–127.
[10] American Iron and Steel Institute, Survey of Scrap Preparation in Steel Plants: Contributions to the Metallurgy of Steel, No. 48, 350 Fifth Ave., New York 1, N. Y., June 1955, pp. 1–44.
[11] American Metal Market, vol. 62, No. 166, Aug. 26, 1955, p. 12.
[12] American Metal Market, vol. 62, No. 149, Aug. 3, 1955, p. 12.
[13] American Metal Market, vol. 62, No. 224, Nov. 22, 1955, p. 15.
[14] U. S. Embassy, Rome, State Department Dispatch 1714, Feb. 18, 1955.

This was the first return of a joint United States-Japan venture which began last March and is expected to produce better than 331,000 tons over a period of the next 2 years. Thirty-eight sunken World War II vessels, consisting mostly of small and medium cargo ships and small naval craft, were being salvaged.[15]

Difficulties in obtaining raw materials required for the stepped-up steel-production program were acute in Japan during 1955, particularly the shortage of iron and steel scrap.[16]

On October 13 representatives of the Japanese steel industry met and discussed the disruption in the united front on scrap purchases which the Scrap Iron Cartel had endeavored to maintain. The steelmakers decided at this meeting to reinstitute the Scrap Iron Cartel, effective in December, and recommended that, because of raw-material shortages, steel production for the last quarter of 1955 be reduced by 165,000 short tons below the scheduled 1.9 million tons.

The United States has been Japan's primary source of scrap, with exports of 783,000 short tons in 1955. Japan's reluctance to use scrap instead of pig iron in steelmaking is explained in the scarce supply of suitable domestic coal and iron ore. However, if scrap is not available, more pig iron will have to be used, and will have to be obtained from local production or imported.

To meet its raw materials requirements for the steel industry, Japan placed its reliance on continued access to the United States scrap market, increased imports of iron ore from the Philippines, India, Malaya, Goa, Canada, and the United States, and purchases of scrap wherever obtainable, to be supplemented by pig-iron imports. With no immediate increase expected in domestic supplies of iron ore or scrap iron, one alternative was to seek improvements in the ratio of scrap to pig iron and in general plant efficiency.

United Kingdom.—Although the British Iron and Steel Federation noted increased pressure to ban exports of iron and steel scrap from the United States, it concluded, in a review of the world situation, that there was little chance of a revival in the world scrap trade unless recent increases in exports from the United States, which before World War II supplied approximately two-thirds of all scrap exports, was maintained.[17]

If a scrap shortage occurred in the near future the federation did not believe Great Britain's steel industry would be greatly affected, even though it has been, in the past, a major scrap importer.

Anticipating decreased exports from the United States, the British steel industry plans to produce adequate scrap and pig iron for future needs. If by 1958 steel production has risen to 22 million net tons, requirements will call for approximately 24 million tons of steelmaking scrap and pig iron, which will be met by producing more pig iron and larger quantities of circulating scrap made available from increased steel production.

A further prediction in the review of the British Iron and Steel Federation was that, even though the European Coal Community has a long-term program of blast-furnace expansion which may make the community self-sufficient, it would remain a large scrap importer indefinitely. Meanwhile, a new scrap-levy-pig-iron bonus scheme

[15] U. S. Embassy, Tokyo, State Department Dispatch 369, Oct. 21, 1955.
[16] U. S. Embassy, Tokyo, State Department Dispatch 370, Oct. 21, 1955.
[17] American Metal Market, vol. 62, No. 217, Nov. 10, 1955, pp. 1, 3.

has been formed to conserve scrap by encouraging increased consumption of pig iron in open-hearth furnaces.

The situation in Japan was considered different; it is believed that, until Japan can locate sources for suitable imports of ore and coking coal at low transport costs, its imports of scrap would continue to rise.

Jewel Bearings

By Henry P. Chandler[1] and Eleanor V. Blankenbaker[2]

INCREASES in the production, importation, and consumption of jewel bearings during 1955 accompanied a general increase in industrial activity in the United States. The statistics are based on an expanded survey of the jewel-bearings industry conducted by the Federal Bureau of Mines in cooperation with the Business and Defense Services Administration, United States Department of Commerce. Data were obtained from 96 respondents in 16 States and Puerto Rico in 1955, compared with 78 respondents in 16 States in 1954 and 41 respondents in 12 States in 1953.

DOMESTIC PRODUCTION

Production of finished jewel bearings during 1955 increased 46 percent over 1954 and was 19 percent greater than the average annual production for the years 1951–55, inclusive. Production of blanks in 1955 exceeded by 13 percent the average annual production for the 5 years cited. Firms in Waltham and West Lynn, Mass.; Newark, Perth Amboy, and Trenton, N. J.; Rochester, N. Y.; Rolla, N. Dak.; and Morrisville, Pa., reported production of finished jewel bearings.

TABLE 1.—Salient statistics of the jewel-bearings industry in the United States, 1946–50 (average) and 1951–55

(Millions of jewel bearings)

	1946–50 (average)	1951	1952	1953	1954	1955
Production:						
Blanks	0.5	1.2	1.9	6.0	0.8	2.9
Finished jewels [1]	2.6	9.9	10.6	15.7	10.5	[2] 15.3
Consumption:						
Blanks	6.7	11.4	9.1	7.9	2.8	4.9
Semifabricated jewels	2.2	7.9	1.9	1.9	(3)	(3)
Finished jewels [1]	64.3	85.0	77.3	70.9	66.2	74.8
Shipments: [4]						
Blanks	.1	.1	(5)	8.2	(5)	2.2
Finished jewels [1]	16.5	14.0	28.8	36.8	29.4	40.1
Stocks on hand Dec. 31:						
Blanks	5.5	2.6	4.3	1.4	.7	1.5
Semifabricated jewels	.5	.7	1.0	2.1	(3)	(3)
Finished jewels [1]	74.8	97.4	104.2	97.5	95.4	103.6

[1] Includes finished jewels made from glass.
[2] Includes phonograph needles.
[3] Canvass discontinued.
[4] Semifabricated-jewels canvass discontinued in 1954; in prior years number insignificant.
[5] Less than 0.1 million.

[1] Commodity-specialist.
[2] Literature-research clerk.

457676—58——41

CONSUMPTION AND USES

Consumption of finished jewels and blanks in the United States increased 13 percent over 1954, reversed the downward trend in progress since 1954, and matched the average annual consumption for 1951–55, inclusive.

Although the consumption of blanks increased 76 percent over 1954, it was only 68 percent of the annual average for 1951–55, inclusive. Consumption and sales of finished jewels, by uses, appear in table 2. Synthetic sapphire and ruby bearings constituted 90 percent of the total consumption; glass bearings, nearly 10 percent; and bearings of other materials, a negligible quantity.

A diagram illustrating the more widely used types of jewel bearings is shown in figure 1.

TABLE 2.—Consumption and sales of finished jewels in the United States, 1955, by uses

Use	Consumption (number of jewels)	Sales (number of jewels)
Synthetic sapphire and ruby:		
Watch holes:		
Olive	15,878,246	1,021,449
Straight	15,452,810	1,588
Pallet stones	3,757,685	3,026
Roller (jewel) pins	2,158,799	40,656
End stones or caps:		
Watch	12,806,306	2,513,669
Instrument	394,973	5,123,633
Vees	7,557,826	6,708,739
Instrument rings	1,020,823	8,118,037
Cups or double cups	7,479,874	5,171,959
Orifice jewel	377,331	314,075
Dies (wire drawing)		(1)
Other	555,780	4,270,043
Total number of finished synthetic sapphire and ruby jewel bearings	67,440,453	33,286,874
Glass:		
Vees	6,874,281	6,871,448
Instrument rings (including hole jewels)	493,886	620
Total number of glass bearings	7,368,167	6,872,068
Other jewel bearings	31,830	30
Total finished jewel bearings	74,840,450	40,158,972

1 Included with "Other."

In 1955, 13 firms in New York consumed 24 percent of the national total, while in Illinois only 10 firms consumed 37 percent.

The following 13 firms used 87 percent of the jewel bearings consumed in the United States during 1955:

The George W. Borg Corp., Delavan, Wis.
Bulova Watch Co., Flushing, N. Y.
Duncan Electric Mfg. Co., Lafayette, Ind.
Elgin National Watch Co., Elgin, Ill.
General Electric Co., Somersworth, N. H.
General Electric Co., West Lynn, Mass.
General Time Corp., La Salle, Ill.
Hamilton Watch Co., Lancaster, Pa.
Jaeger Watch Co., New York, N. Y.
New Haven Clock & Watch Co., New Haven, Conn.
Sangamo Electric Co., Springfield, Ill.
Westinghouse Electric Corp., Newark, N. J.
Weston Electrical Instrument Corp., Newark, N. J.

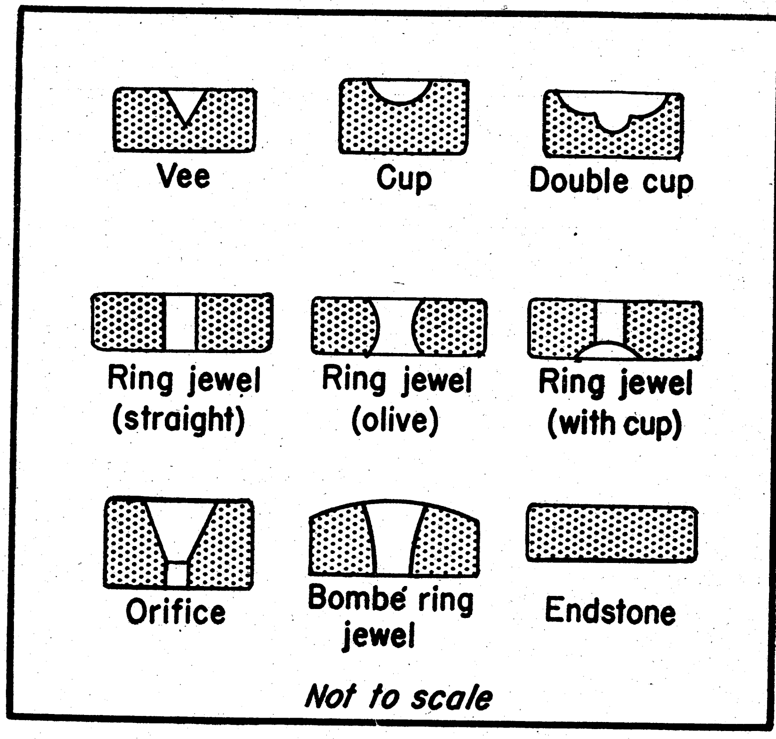

FIGURE 1.—Typical shapes of jewel bearings.

TABLE 3.—Consumption of finished jewel bearings in the United States, 1955, by States

State	Number of consumers	Quantity (number of jewels)	State	Number of consumers	Quantity (number of jewels)
California	5	159, 595	New Jersey	8	4, 926, 199
Connecticut	7	3, 275, 129	New York	13	17, 602, 879
Illinois	10	27, 762, 964	Ohio	4	957, 545
Indiana	2	1, 493, 113	Pennsylvania	5	6, 220, 070
Massachusetts	9	2, 304, 095	Wisconsin	2	5, 493, 765
Michigan	3	167, 408	Other States [1]	4	1, 172, 584
Missouri	2	931			
New Hampshire	4	3, 304, 173	Total	78	74, 840, 450

[1] Includes Maryland, Minnesota, Puerto Rico, and Rhode Island.

FOREIGN TRADE [3]

Imports of jewel bearings into the United States in 1955 increased 34 percent in quantity and 30 percent in value compared with 1954. Jewel bearings in loose form (not assembled in units) were dutiable at 10 percent ad valorem.

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

TABLE 4.—Jewel bearings imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Number	Value	Year	Number	Value
1946–50 (average)	107,979,493	$4,112,414	1953	86,892,637	$3,708,027
1951	92,396,053	3,965,983	1954	49,262,027	[1] 2,219,001
1952	98,021,914	4,226,948	1955	66,067,549	[1] 2,874,796

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable with that of years before 1954.

TABLE 5.—Imports [1] of jewel bearings in 1955, by uses

Use	Quantity (number of jewels)	Use	Quantity (number of jewels)
Watch holes:		Vees	10,376,345
Olive	12,271,149	Instrument rings	6,442,956
Straight	13,497,426	Cups or double cups	5,026,571
Pallet stones	2,872,230	Orifice jewel	305,100
Roller (jewel) pins	1,240,135	Other [2]	560,184
End stones or caps:			
Watch	9,563,955	Total	66,093,103
Instrument	3,937,052		

[1] As reported to the Bureau of Mines.
[2] Includes glass vees, stylii, pivot for compasses, rough and finished pins, phonograph points and blanks, jewel tip, and guide jewels.

TECHNOLOGY

During 1955 patents were issued covering the manufacture of rutile boules, both white and colored, for jewel bearings.[4]

Articles were published on synthetic corundum and its manufacture from the boule to the finished jewels.[5]

[4] Moore, C. H., Jr. (assigned to National Lead Co.), Manufacture of Rutile Boules: U. S. Patent 2,715,070, Aug. 9, 1955.
Merker, Leon (assigned to National Lead Co.), Manufacture of Colored Rutile Boules: U. S. Patent 2,715,071, Aug. 9, 1955.

[5] Vogt-Schild, Ltd., (Soleure, Switzerland), The Swiss Watch (special issue on gemstones and jewel bearings): March 1955, 4 pp., in English.
Industrial Diamond Review, vol. 15, No. 174, May 1955, p. B143.

Kyanite and Related Minerals

By Brooke L. Gunsallus[1] and Gertrude E. Tucker[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. These minerals are aluminum silicates that may be used to produce mullite-containing refractories.

Domestic production of crude kyanite increased 31 percent from 1954 in 1955. For several years no domestic production of other minerals in this group was reported. Kyanite imported for consumption in 1955 increased 57 percent compared with 1954. The increase was caused partly by the availability of good-quality Indian kyanite at a price comparable with synthetic mullite and partly by the increased demand for mullite refractories in 1955 compared with 1954.

DOMESTIC PRODUCTION

Kyanite was the only natural mullite-forming mineral produced in the United States in 1955. All kyanite produced was recovered as flotation concentrate. Demand for kyanite concentrate was limited, largely because mullite produced from it is of such small grain size and low strength that it is not suitable for the highest grades of refractories.

For many years only two companies have been producing kyanite in the United States: Commercialores, Inc., 39 Cortlandt Street, New York, N. Y., from deposits near Clover, S. C.; and Kyanite Mining Corp., Cullen, Va., from a property near Farmville, Prince Edward County, Va.

CONSUMPTION AND USES

Domestic consumption of foreign and domestic kyanite and synthetic mullite during 1951–55 ranged from about 38,000 to 46,000 tons.

Mullite was produced in 1955 either by calcining natural ores or by synthesis. The output was used almost entirely in manufacturing superduty refractories. Mullite refractories represented only a small percentage of the total tonnage of refractories used in the United States; but they occupied an important position in that field, because

[1] Commodity specialist.
[2] Statistical assistant.

of their relatively high softening points, low coefficients of expansion, and resistance to loads at high temperatures, thermal shock, and corrosive action of certain fluxing agents. Although mullite refractories are relatively expensive, industry has found it profitable to use them for certain superduty refractories applications.

Mullite refractories have been used in the form of brick and shapes or in the form of cements, mortars, plastics, and ramming mixtures. In some instances the relatively fine grained domestic mullite has been blended with the coarse-grained mullite obtained from imported kyanite or synthetic mullite in the production of refractory brick and shapes. Domestic kyanite has been satisfactory for use in refractory cement and for other uses that do not require a coarse-grained material; such uses account for the major part of the United States consumption of domestic kyanite in 1955.

For a number of years about 90 percent of all mullite refractories have been used to line furnaces operated by the metallurgical and glass industries. About 50 percent of the mullite refractories were used by the metallurgical industry and 40 percent by the glass industry. The remaining 10 percent have been used for miscellaneous applications, chiefly in the ceramic industry.

In the metallurgical industry the principal use of mullite refractories in 1955 was in electric furnaces, largely the induction type, for melting brass, bronze, copper-nickel alloys, certain steels, and ferrous alloys. Other metallurgical applications were in zinc-smelting and gold-refining furnaces.

In the glass industry mullite refractories were used mainly in constructing continuous tanks, especially in the superstructure, and in plungers, rings, and tubes for feeding molten glass to the forming machines.

In the ceramic industry small quantities of mullite refractories were used for manufacturing kiln furniture (for placing ceramic ware in kilns), in saggers (open-topped refractory boxes for protecting ware during firing), and in kiln construction. Small quantities of kyanite without calcination were used as a source of alumina in glass and as an ingredient of electrical and chemical porcelain and pyrometer tubes.

Purchase specifications for crude kyanite or related minerals or prepared mullite grain include limits of chemical composition, a minimum pyrometric-cone equivalent, and a specified grain-size distribution. In addition, most purchasers of new sources of supply require hot and cold load tests and spall tests on brick made by commercial processes.

PRICES

As reported by industry in December 1955, quotations on kyanite were as follows: Per short ton, f. o. b. point of shipment, Virginia and South Carolina, 35-mesh, carlots, in bulk $29, in bags $32; 200-mesh, in bags, carlots, $40. Quotations on imported kyanite (55- to 59-percent grade) in bags were $75 to $80 per short ton, c. i. f. Atlantic ports. One company in the eastern United States quoted sintered synthetic mullite, f. o. b. Philadelphia, as follows: Rough-shaped dobies, in bulk, $138 per short ton; ground, in bags, minus 4- or minus 7-mesh, $158 per short ton.

FOREIGN TRADE [3]

Data on imports and exports of kyanite and related minerals are shown in table 1. India continued as the principal supplier in 1955, with 91 percent of the total compared with 69 percent in 1954, 63 percent in 1953, and 53 percent in 1952. Union of South Africa supplied 7 percent in 1955 compared with 20 percent in 1954, 24 percent in 1953, and 16 percent in 1952. Total imports for 1955 increased 57 percent compared with 1954. The increase was caused partly by the availability of good-quality Indian kyanite at a price comparable to synthetic mullite and partly by the increased demand for mullite refractories in 1955 compared with 1954.

TABLE 1.—Kyanite and allied minerals imported for consumption in and exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Imports

Year and origin	Short tons	Value
1946–50 (average)	14,037	$290,549
1951	19,570	812,434
1952	9,057	390,557
1953	6,620	287,689
1954		
North America: Canada	7	360
Asia: India	3,322	151,271
Africa:		
British East Africa	97	3,527
Southern British Africa	442	13,163
Union of South Africa	958	28,188
Total	1,497	44,878
Grand total 1954	4,826	[1] 196,609
1955		
Europe: United Kingdom	2	349
Asia: India	6,931	319,740
Africa:		
Southern British Africa	116	3,393
Union of South Africa	532	15,511
Total	648	18,904
Grand total 1955	7,581	338,993

Exports

Year and destination	Short tons	Value
1946–50 (average)	611	$28,545
1951	990	43,762
1952	1,129	44,497
1953	1,032	41,401
1954		
North America:		
Canada	534	23,530
Mexico	502	19,684
Total	1,036	43,214
Europe:		
France	101	13,393
United Kingdom	10	1,345
Total	111	14,738
Grand total 1954	1,147	57,952
1955		
North America:		
Canada	996	41,931
Mexico	483	19,890
Total	1,479	61,821
Europe:		
Italy	76	5,271
Portugal	10	661
United Kingdom	119	15,301
Total	205	21,233
Asia: Japan	32	4,261
Grand total 1955	1,716	87,315

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to other years.

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

TECHNOLOGY

The Federal Geological Survey discovered a deposit of pale-blue dumortierite in Jefferson County, Mont., on the Great Northern Railroad.[4] The deposit is poorly exposed in talus and float along a probable shear zone 30 to 100 feet wide and about 1,000 feet long.

Dumortierite (steel-gray with a dark bluish-lavender tint), was found in veins on the west slope of La Madera Mountain, Petaca District, Rio Arriba County, N. Mex.[5]

An improved synthetic mullite refractory for high-temperature applications in nonferrous foundries, primary steel production, ceramic kilns and furniture, and power plants was developed. Several grades of the refractory are available in the form of brick, special shapes, and ramming mixes.[6]

Refractory mineral wool compositions were made by fusing kyanite and silica to a fluid consistency and fiberizing the mixture. The product is said to be a good high-temperature insulator.[7]

WORLD REVIEW

Africa.—In December 1955 the New Consolidated Gold Fields, Ltd., New York, purchased the Murka mine and other claims of the Kenya Kyanite, Ltd., of Kenya for a reported price of $450,000. A new company, the G. F. K. Refractories, was formed to operate the Kenya properties. Production was expected to begin in late 1956.[8]

Canada.—The Hoyle Mining Co., Ltd., continued its diamond-drilling program on its kyanite property in Dryden township, about 12 miles east of Sudbury, Ontario.[9] Investigations of kyanite ores at the Industrial Minerals Division of the Mines Branch, Ottawa, gave encouraging results on a pilot-plant flotation scale and also on the utilization of kyanite concentrate for the production of mullite. Transportation and power facilities were available for developing this deposit, which is said to contain 20 to 30 percent kyanite.

Nyasaland.—Output of kyanite in Nyasaland totaled 1,624 short tons valued at £14,950 in 1954 (£1 approximates US$2.81). This production was all exported to the United Kingdom.[10]

---

4 Geological Survey, Deposit of Dumortierite Discovered in Jefferson County, Mont.: Press release, Feb. 8, 1955, 1 p.
Skillings' Mining Review, vol. 43, No. 48, Mar. 5, 1955, p. 11.

5 Rocks and Minerals, vol. 30, No. 1112–, November-December 1955, p. 589.

6 Iron Age, vol. 175, No. 24, June 16, 1955, p. 126.

7 Hahn, W. P. (assigned to Johns-Manville Corp.), Refractory Mineral Fiber· U. S. Patent 2,699,397, Jan. 11, 1955.

8 Letter to the Bureau of Mines by the Gold Fields American Development Co., Apr. 13, 1956.

9 Canadian Mining and Metallurgical Bulletin, Montreal, vol. 48, No. 519, July 1955, p. 456.

10 Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, p. 41.

Lead

By O. M. Bishop,[1] A. J. Martin,[1] and Edith E. den Hartog [2]

ECONOMIC conditions affecting the lead industry in the United States in 1955 improved as the year progressed. The lead price at the end of the year was the highest since October 1952. Consumption of lead increased substantially, keeping pace with the general expansion of industrial activity. The quantity of lead used in the last half of the year, excluding purchases for the national strategic stockpile, was 9 percent larger than in the first half, and the full year consumption increased 11 percent over 1954. With the increase in consumption, offerings in response to requests for tender to the National Stockpile decreased considerably. Consumption also increased in nearly all other countries of the world.

The quoted price of common lead in New York remained 15 cents a pound from January to September 23, when it began to advance fractionally and settled at 15.50 cents on September 26. Another advance on December 29 raised the price to 16.00 cents a pound. The average weighted sales price was 14.90 cents a pound.

Total supplies of lead in the United States increased 3 percent over 1954 and exceeded consumption for the fourth successive year, but the excess (69,100 tons) was the smallest in the 4 years. There were increases of 4 percent each in domestic mine production and in the quantity of secondary lead recovered and 1 percent in total imports of pig lead and lead contained in ores and concentrates. Of the total lead supply—1,281,700 tons—39 percent was recovered from scrap as secondary lead; nearly 35 percent was obtained from imports (excluding imported scrap, which normally goes to secondary smelters and is thus included in the secondary output); and more than 26 percent was produced by domestic mines. The output of refined primary lead at domestic primary lead refineries declined 2 percent from 1954, but that of antimonial lead increased 7 percent. Stocks of refined lead at the end of 1955 totaled 21,900 tons—72 percent less than at the beginning of the year and the lowest since 1951. Year-end smelter stocks of antimonial lead declined 31 percent from 1954. A strike lasting from July 1 to August 10, 1955, interrupted operations of lead smelters at East Helena, Mont.; El Paso, Tex.; Leadville, Colo.; and Selby, Calif. (smelter and refinery) and refineries at Omaha, Nebr., and Perth Amboy, N. J.

Domestic mine production of lead, although larger than in 1954, was 10 percent less than the average for the 5 years 1950–54 and well below imports and secondary metal as a source of supply. Because

[1] Commodity specialist.
[2] Statistical assistant.

of the more favorable economic conditions of improved demand and average prices for lead and zinc, mine operations were resumed at several important producing lead-zinc mines. However, due mainly to a prolonged labor strike affecting a number of mines in the Coeur d'Alene region of Idaho and one mine in Montana lead production in the last half of 1955 was 5 percent less than in the first half. Missouri was the principal lead-producing State in the United States for the 48th consecutive year, contributing 37 percent of the total domestic output; Idaho ranked second, with 19 percent, and Utah third, with 15 percent. Of the remaining 29 percent, Montana, Colorado, Oklahoma, Washington, Arizona, and California together produced 22 percent and other States 7 percent.

Domestic lead consumption (including the lead content of ore used in pigments and salts) was 1,212,600 tons, or 117,700 tons more than in 1954. The three largest lead-consuming products—batteries, tetraethyl lead, and cable covering—took 31, 14, and 10 percent, respectively, or a total of 55 percent of all lead consumed. The quantity of lead used in batteries and tetraethyl lead increased 13 and 3 percent, respectively, from 1954, but that used in cable covering decreased 5 percent.

Imports of pig lead and lead contained in ores and concentrates totaled 441,600 tons, a yearly increase of only 1 percent, but imports of lead contained in scrap (20,600 tons) was nearly four times that in 1954. The 264,100 tons imported in the form of pigs and bars in 1955 came largely from Mexico, Australia, Yugoslavia, Canada, and Peru, and most of the 177,500 tons contained in ores and concentrates was obtained from Peru, South Africa, Canada, and Australia. Of the scrap lead imported, about three-fourths was supplied by Canada, Mexico, and Australia.

Exports of primary lead were less than 600 tons in both 1954 and 1955.

World mine production of lead in 1955 was estimated to be 2,370,000 short tons, a 7-percent increase over 1954. World smelter production, estimated at 2,220,000 tons, increased 1 percent. Canada and Mexico were the only large producing countries in which mine production decreased. These two countries, the United States, Argentina, West Germany, and Australia were the only important producers that reported decreases in refined-lead production.

LEGISLATION AND GOVERNMENT REGULATIONS

The Reciprocal Trade Bill passed by the Congress and signed by the President June 21, 1955, extended the Reciprocal Trade Agreements Act for another 3 years and empowered the President to cut tariffs up to 5 percent a year in each of the 3 years. No cut was made in the tariff on lead in 1955.

The Defense Production Act of 1950, with amendments, was extended to June 30, 1956.

The Export Control Act of 1949, still in effect in 1955, required export licenses for exports to all countries except Canada.

Defense Mobilization Order OD–LS 416, dated August 11, 1955, closed the issuance of Certificates of Necessity for a number of minerals, including lead and zinc.

TABLE 1.—Salient statistics of the lead industry in the United States, 1946–50 (average) and 1951–55, in short tons

	1946–50 (average)	1951	1952	1953	1954	1955
Production of refined primary lead:						
From domestic ores and base bullion	367,418	342,644	383,358	328,012	322,271	321,132
From foreign ores and base bullion	66,893	75,049	89,494	139,879	164,441	158,025
Total	434,311	417,693	472,852	467,891	486,712	479,157
Recovery of secondary lead	459,857	518,110	471,294	486,737	480,925	502,051
Imports (general):						
Lead in pigs, bars, and old	264,262	188,175	523,059	390,510	281,941	284,729
Lead in base bullion	2,950	2,281	389	869	41	
Lead in ores and matte	68,549	67,484	104,661	160,899	[2] 161,261	177,479
Exports of refined pig lead	1,247	1,281	1,762	803	596	403
Consumption of primary and secondary lead	1,091,605	1,184,793	1,130,795	1,201,604	1,094,871	1,212,644
Prices (cents per pound):						
New York:						
Average for period	13.90	17.49	16.47	13.48	14.05	15.14
Quotation at end of period	15.61	19.00	14.12	13.50	15.00	15.54
London average for period	14.26	20.25	16.82	11.48	12.08	13.19
Mine production of recoverable lead [1]	390,182	388,164	390,162	342,644	325,419	338,025
World smelter production of lead	1,550,000	[2] 1,810,000	[2] 1,990,000	[2] 2,060,000	[2] 2,190,000	2,220,000

[1] Includes Alaska.
[2] Revised figure.

DEFENSE MINERALS EXPLORATION ADMINISTRATION

The DMEA program to encourage exploration and increase domestic reserves of strategic and critical minerals and metals was continued throughout 1955. On exploration contracts for lead and zinc the Government provided 50 percent of the approved cost of the project. Twenty-three such contracts were made in 1955, authorizing a maximum Government participation of $691,972, which was matched by an equal amount of private capital for an anticipated total expenditure of $1,383,944, or an average of $60,172 per project. From the beginning of the program in 1951 through December 1955, 220 contracts involving lead and zinc were executed, which authorized Government participation of $9,719,243 [3] and total expenditures (combined Government and private capital) of $19,445,191. Additional information, including a list of DMEA contracts for lead and zinc exploration executed in 1955, is given in the Zinc chapter of this volume.

GENERAL SERVICES ADMINISTRATION

The General Services Administration (GSA) continued to be responsible for stockpile procurement and administration, procurement under foreign aid programs as agent of the former Foreign Operations Administration and the new International Cooperation Administration, and administration of Defense Production Act programs (including domestic purchase programs). GSA also reviewed applications by producers of metals and minerals for accelerated tax amortization. Purchases of lead produced from domestically mined ores were made againt the long-term stockpile objective for this metal. The program for the barter of surplus agricultural commodities in exchange for strategic and critical materials pursuant to the provisions of the Agricultural Trade Development and Assistance Act enacted in July 1954,

[3] Includes sums provided through amendments to contracts and also funds for participation in exploration contracts that were subsequently canceled or terminated upon completion.

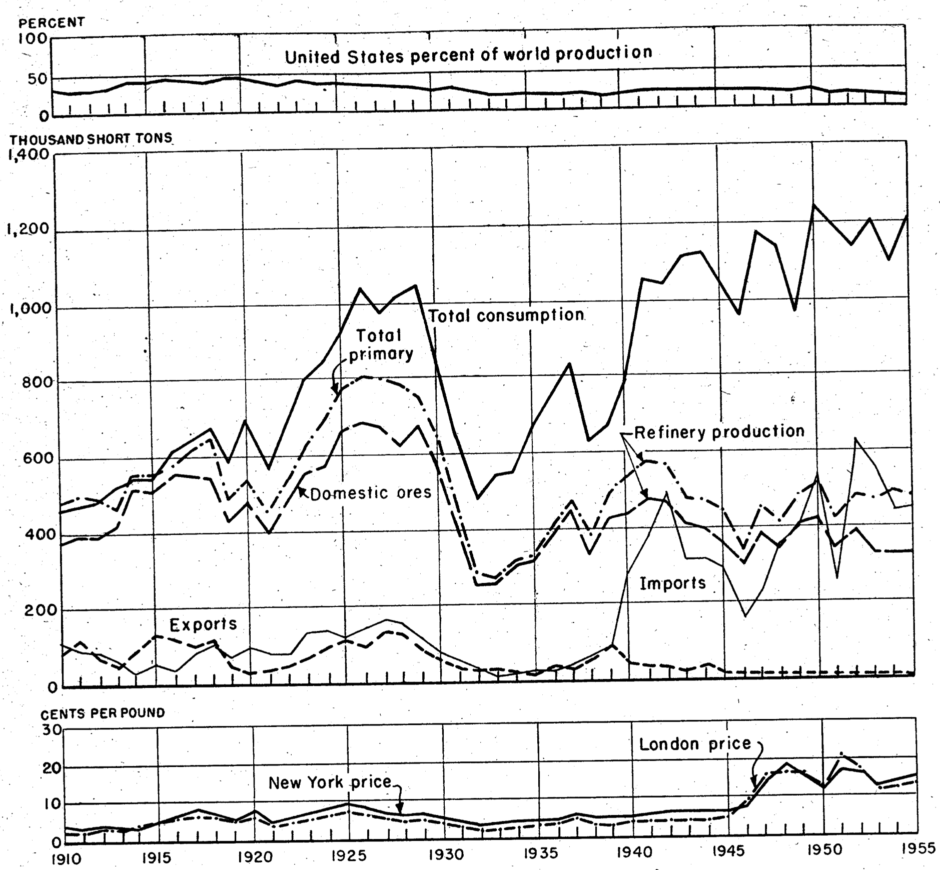

FIGURE 1.—Trends in the lead industry in the United States, 1910–55. Consumption includes primary refined, antimonial, and secondary lead and lead in pigments made directly from ore. Imports are factored to include 95 percent of lead content of ores, mattes, and concentrates and 100 percent of pigs, bars, base bullion, and scrap. Exports include lead that entered the United States under bond.

was carried on with respect to a number of materials, but no lead was acquired under the program during 1955. No new contracts with foreign producers for obtaining lead under the Defense Production Act of 1950 were executed in 1955; some lead produced under contracts negotiated in preceding years was delivered.

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 ore and concentrate, 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-production figure owing to the lag between mine shipments and smelter treatment of ore and concentrate.

Lead-production data for 1954 were collected jointly with the Bureau of the Census (United States Department of Commerce). Comparison of final data reported by each agency shows only minor differences. The Bureau of Mines figure (325,419 short tons), representing recoverable domestic mine production of lead in 1954, was slightly larger than the Census figure (321,765 tons). The difference is due to slightly broader coverage by the Bureau of Mines through inclusion of output of metal contained in old slag and mill cleanup material and by mines with production valued at less than $500. Some State totals reported by the two agencies also differ because the metal derived from ores transported across State lines for milling was credited by the Bureau of Mines to the production of the State in which the ore was mined, while the Bureau of the Census credited such production to the State in which the ore was milled.

MINE PRODUCTION

The output of recoverable lead from domestic mines totaled 338,000 short tons in 1955, a 4-percent increase over 1954 but 10 percent less than the 5-year average from 1950–54. Owing mainly to a prolonged strike that affected a number of mines in the Coeur d'Alene region of Idaho and one mine in Montana, lead production in the latter half of 1955 was 5 percent less than that in the first half. Because of improved demand, along with higher average prices of lead and zinc, operations were resumed by several important mines that had been shut down for periods ranging from less than 1 year to nearly 3 years because of unfavorable economic conditions for lead-zinc-mining. Missouri, with 125,400 tons, Idaho, with 64,200 tons, and Utah, with 50,500 tons, together contributed 71 percent of the total domestic mine output of lead in 1955. Missouri production varied little from 1954; Idaho decreased 7 percent, and Utah increased 12 percent. Output increased in Montana, Washington, Arizona, and California and decreased in Colorado and Oklahoma.

The Southeastern Missouri lead belt was the major lead-producing district in the United States for the 48th consecutive year; its output of recoverable lead in 1955 was 125,400 tons, twice that of the second ranking producing district and 37 percent of the total domestic output. St. Joseph Lead Co., largest producer of lead in the United States, operated its Bonne Terre, Desloge, Federal, and Leadwood mine-mill units, its Doe Run and Hayden Creek mines in St. Francois County (ore milled at the Federal and Leadwood mills), and its new Indian Creek mine-mill unit in Washington County. The combined daily capacity of the 5 mills in St. Francois and Washington Counties was about 28,000 tons of ore. The company also operated the Mine La Motte mine and a 2,000-ton mill in Madison County. National Lead Co. continued to operate its Madison mine-mill unit at Fredericktown, Madison County.

TABLE 2.—Mine production of recoverable lead in the United States, 1946–50 (average) and 1951–55, by States, in short tons

State	1946–50 (average)	1951	1952	1953	1954	1955
Western States and Alaska:						
Alaska	182	21	1	9	----------	1
Arizona	28,469	17,394	16,520	9,428	8,385	9,817
California	11,052	13,967	11,199	8,664	2,671	8,265
Colorado	22,947	30,336	30,066	21,754	17,823	15,805
Idaho	81,360	76,713	73,719	74,610	69,302	64,163
Montana	16,082	21,302	21,279	19,949	14,820	17,028
Nevada	8,829	7,148	6,790	4,371	3,041	3,291
New Mexico	5,548	5,846	7,021	2,943	887	3,296
Oregon	10	2	1	5	5	3
South Dakota	6	2	2	10	----------	----------
Texas	111	43	56	----------	----------	----------
Utah	46,837	50,451	50,210	41,522	44,972	50,452
Washington	6,449	8,002	11,744	11,064	9,938	10,340
Wyoming	----------	----------	----------	----------	----------	----------
Total	227,882	231,227	228,608	194,329	171,844	182,461
West Central States:						
Arkansas	10	33	4	----------	----------	----------
Kansas	8,275	8,947	5,916	3,347	4,033	5,498
Missouri	127,159	123,702	129,245	125,895	125,250	125,412
Oklahoma	17,097	16,575	15,137	9,304	14,204	14,126
Total	152,541	149,257	150,302	138,546	143,487	145,036
States east of the Mississippi River:						
Illinois	3,288	3,160	4,262	3,391	3,232	4,544
Kentucky	156	107	60	52	80	----------
New York	1,320	1,500	1,120	1,435	1,187	1,037
Tennessee	103	14	18	9	----------	----------
Virginia	3,891	1,508	3,792	2,788	[1] 4,324	[2] 2,999
Wisconsin	1,001	1,391	2,000	2,094	[3] 1,265	1,948
Total	9,759	7,680	11,252	9,769	10,088	10,528
Grand total	390,182	388,164	390,162	342,644	325,419	338,025

[1] Includes 4 tons from North Carolina.
[2] Includes 2 tons from North Carolina.
[3] Includes 4 tons from Iowa.

In the Tri-State district the 4,140,300 tons of crude zinc-lead ore milled was only 1 percent more than in 1954, but owing to the higher average lead and zinc content of the ore milled, the quantity of lead recovered increased 8 percent to 19,700 tons, and zinc rose 6 percent to 68,300 tons. An additional 1,400 tons of zinc and 27 tons of lead were recovered from old tailings remilled. The mines and the Central and Bird Dog mills of Eagle-Picher Co., leading producer in the district, operated continuously, except for a few days in July, when union workers were on strike. In addition to ore from company mines in the Oklahoma and Kansas parts of the district, the Central mill treated custom ore from a number of mines in both States. The Barbara J and Lawyers mines and mills of the Nellie B Division, American Zinc, Lead & Smelting Co. operated steadily until December 22, when they were shut down; the mines resumed operations at a materially reduced production rate on January 3, 1956; and the Barbara J mill reopened. The Ballard mill, National Lead Co., operated a full year in 1955 compared with only 8 months in 1954.

In the Western States, improved economic conditions for lead-zinc mining resulted in the reopening of several important producing mines, but most of the gain was offset by losses caused by strikes, particularly in Idaho, the Western States' leading producer.

Idaho output, 7 percent under 1954 and the smallest since 1946, was due partly to the prolonged strike in the mining district. The Bunker Hill mine was the largest lead producer by a wide margin, followed by the Star mine. The Morning (salvage operation on ore pillars) and the Sunshine mines were substantial producers. Operations by Spokane-Idaho Mining Co. at its Constitution and Douglas lead-zinc mines in the Pine Creek area of the Coeur d'Alene region were terminated in June; the mine had been worked for 2 years under a block-leasing system. Shoshone County produced 93 percent of the Idaho lead output in 1955. Among the other counties the Triumph mine in Blaine County was the leading producer.

The output of recoverable lead in Utah increased 12 percent over 1954. Most of the gain came from the Park City group of the United Park City Mines Co., which operated throughout 1955 but only 4 months in 1954. Production from the United States & Lark mine of the United States Smelting, Refining, & Mining Co. (the leading producer in the State) increased moderately, but the total of the other mines was less than in 1954.

In Montana increased mine production of lead at Butte more than offset a decline in other producing areas and brought about a 15-percent gain in the State output. Silver Bow County production, derived largely from The Anaconda Co. operation at the Anselmo, Lexington, and Orphan Girl mines (lead-zinc ore) and the Emma mine (manganese ore) increased nearly 25 percent over 1954 and supplied 84 percent of the Montana total. The output of lead in other counties dropped 18 percent. In Sanders County the Jack Waite mine of the American Smelting & Refining Co. was closed from August 23 through December by a strike. Other producing mines included the Hand in Beaverhead County and the Trout (Algonquin), and Scratch Awl in Granite County. Lead was also recovered from smelter slag at the East Helena fuming plant.

Mine production of lead in Colorado decreased 11 percent from 1954 and was the smallest since 1942. Destruction of the Emperius Mining Co. mill at Creede by fire in August and a full year of idleness of the Smuggler Union group of Telluride Mines, Inc., at Telluride caused production losses, which were not offset by new production from the 6-month operation of the Keystone mine of American Smelting & Refining Co. at Crested Butte. The Treasury Tunnel-Black Bear group (Idarado Mining Co.) continued to be the largest Colorado producer of lead; other important producers included the Eagle mine (New Jersey Zinc Co.), Eagle County; Rico-Argentine (Rico Argentine Mining Co.), Dolores County; Camp Bird (King Lease), Ouray County; and Resurrection in Lake County.

In Washington the output of lead showed a 4 percent gain over 1954. Four mines continuing to yield nearly all the State output in order of production were: The Pend Oreille mine (Pend Oreille Mines & Metals Co.) and the Grandview (American Zinc, Lead & Smelting Co.), Pend Oreille County; and the Van Stone (American Smelting &

Refining Co.) and Deep Creek (Goldfield Consolidated Mines Co.) in Stevens County. Fires at the surface plant of the Grandview mine and in the underground workings of the Deep Creek mine interrupted operations for about 3 weeks at each property.

Arizona lead production increased 17 percent in 1955 to 9,800 tons. The Iron King mine in Yavapai County was again the largest lead and zinc producer; other important producers included the Flux mine in Santa Cruz County, Athletic in Graham County, San Xavier in Pima County, and Shannon in Cochise County.

In California the large increase in lead production was due to the reopening by The Anaconda Co. of its Darwin mines, Inyo County, idle from March 1954 to January 1955.

Lead production in New Mexico increased to 3,300 tons from 900 tons in 1954. Zinc and zinc-lead mining, which ceased altogether in the State at the end of September 1953, was revived in March 1955 with reopening of the Ground Hog mine of the American Smelting & Refining Co. in the Central district, Grant County. The Hanover mine (New Jersey Zinc Co.) and Kearney (Peru Mining Co.) were reopened in September and November, respectively.

Output of lead in Nevada increased 8 percent over 1954. The principal producers were the Three Kids mine of Manganese, Inc., Clark County (lead recovered as a byproduct from manganese ore); Consolidated Eureka, Eureka County; and Combined Metals Reduction Co. group at Pioche, Lincoln County.

Nearly all the lead produced in the States east of the Mississippi was recovered from ores that yielded chiefly zinc or zinc and fluorspar. Illinois ranked first among the States of this group in lead production; most of the output was recovered from fluorspar-zinc-lead ore mined in the southern part of the State by the Ozark Mahoning Co. and the Minerva Oil Co. and zinc-lead ore from the mines of the Eagle-Picher Co. and Tri-State Zinc, Inc., in northern Illinois. In the Wisconsin zinc-lead area adjoining northern Illinois, most of the lead production

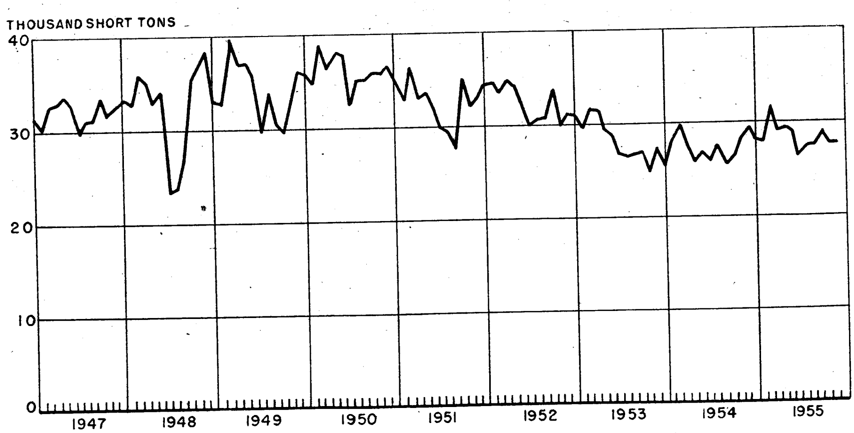

FIGURE 2.—Mine production of recoverable lead in the United States, 1947–55, by months.

came from zinc and zinc-lead ores mined from Vinegar Hill Zinc Co. properties (sold in August to the American Zinc, Lead & Smelting Co.) and the Eagle-Picher Co. mines. In the Kentucky fluorspar area adjoining southern Illinois some lead was recovered as a byproduct of fluorspar mining.

The lead output in New York came from the Balmat zinc-lead mine of the St. Joseph Lead Co. in St. Lawrence County and that in Virginia from the Austinville zinc-lead mine of the New Jersey Zinc Co. in Wythe County.

TABLE 3.—Mine production of recoverable lead in the United States, 1946–50 (average) and 1951–55, by districts that produced 1,000 tons or more during any year, 1951–55, in short tons

District	State	1946–50 (average)	1951	1952	1953	1954	1955
Southeastern Missouri region.	Missouri	125,183	122,318	122,942	125,273	125,173	125,357
Coeur d'Alene region	Idaho	76,209	70,570	67,330	69,885	64,812	59,820
West Mountain (Bingham)	Utah	25,850	29,120	34,328	29,311	29,671	31,712
Tri-State (Joplin region)	Kansas, southwestern Missouri, Oklahoma.	27,309	26,906	27,356	13,273	18,314	19,679
Summit Valley (Butte)	Montana	10,675	16,630	16,153	16,767	11,516	14,331
Park City region	Utah	9,630	11,719	7,494	4,735	5,432	9,954
Metaline	Washington	4,289	5,234	(1)	8,694	(1)	(1)
Coso (Darwin)	California	6,749	7,191	(1)	8,269	(1)	(1)
Upper San Miguel	Colorado	4,361	8,008	7,657	7,440	5,574	5,098
Tintic	Utah	5,914	5,553	4,279	3,590	5,926	5,017
Big Bug	Arizona	2,968	4,035	4,135	4,339	4,336	4,612
Upper Mississippi Valley	Iowa, northern Illinois, Wisconsin.	1,866	1,923	3,532	3,688	3,229	3,809
Red Cliff	Colorado	1,289	4,274	3,980	2,500	2,588	3,171
Austinville	Virginia	3,891	1,508	3,792	2,788	4,320	2,997
Kentucky-Southern Illinois	Kentucky-southern Illinois.	2,578	2,516	2,790	1,849	1,348	2,683
Central	New Mexico	3,037	3,133	4,486	1,460	5	2,604
Harshaw	Arizona	1,512	1,668	1,921	2,104	2,135	(1)
Warm Springs	Idaho	1,964	3,086	3,455	2,583	2,415	2,388
Northport (Aladdin)	Washington	510	937	(1)	2,165	1,275	2,212
Pioneer (Rico)	Colorado	1,835	2,231	2,230	1,871	2,177	(1)
Rush Valley & Smelter (Tooele County).	Utah	3,170	2,674	2,595	2,753	2,454	1,607
California (Leadville)	Colorado	4,991	5,996	5,624	3,072	1,935	1,404
Bayhorse	Idaho	1,445	1,732	1,091	1,484	1,372	1,367
Creede	Colorado	722	1,167	1,513	1,696	2,178	1,192
Ophir	Utah	791	712	999	1,157	1,159	(1)
Pima (Sierritas, Papago, Twin Buttes).	Arizona	3,270	2,834	1,864	-------	1	1,105
St. Lawrence County	New York	1,320	1,497	1,120	1,435	1,187	1,037
Eagle	Montana	700	(1)	733	1,179	-------	706
Aravaipa	Arizona	1,034	1,294	865	-------	812	682
Sneffels	Colorado	(1)	1,094	1,044	1,307	1,113	634
Pioche	Nevada	5,197	4,751	4,632	3,306	(1)	(1)
Hansonberg	New Mexico	140	753	847	1,031	800	517
Breckenridge	Colorado	192	246	499	1,056	1,000	474
Magdalena	do	1,635	1,004	1,046	-------	47	95
Heddleston	Montana	1,989	1,398	1,251	-------	-------	78
Resting Springs	California	(1)	(1)	(1)	-------	-------	22
Warren (Bisbee)	Arizona	11,444	1,606	1,828	-------	4	-------
Old Hat	do	5,513	4,241	3,913	-------	3	-------
Animas	Colorado	2,668	3,963	3,464	1,212	-------	-------
Bossburg	Washington	1,497	1,768	(1)	168	-------	-------

(1) Figure not shown to avoid disclosure of individual company operations.

TABLE 4.—Twenty-five leading lead-producing mines in the United States in 1955, in order of output

Rank	Mine	District	State	Operator	Type of ore
1	Federal	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
2	Bunker Hill	Yreka	Idaho	The Bunker Hill Co	Lead-zinc.
3	United States & Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co	Do.
4	Leadwood	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
5	Butte Hill mines and dumps	Summit Valley (Butte)	Montana	The Anaconda Co	Lead-zinc.
6	Desloge	Southeastern Missouri	Missouri	St. Joseph Lead Co	Lead.
7	Mine La Motte	do	do	do	Do.
8	Bonne Terre	do	do	do	Do.
9	Indian Creek	do	do	do	Do.
10	Star	Hunter	Idaho	Sullivan Mining Co	Lead-zinc.
11	Darwin group	Coso	California	The Anaconda Co	Do.
12	Pend Oreille	Metaline	Washington	Pend Oreille Mines & Metals Co	Do.
13	Ontario-Park Utah	Blue Ledge	Utah	United Park City Mines Co	Do.
14	Madison	Southeastern Missouri	Missouri	National Lead Co	Lead-copper.
15	Treasury Tunnel-Black Bear	Upper San Miguel	Colorado	Idarado Mining Co	Lead-zinc.
16	Iron King	Big Bug	Arizona	Shattuck-Denn Mining Co	Do.
17	Chief	Tintic	Utah	Chief Consolidated Mining Co	Do.
18	Mayflower, Galena & Star Units	Blue Ledge	do	New Park Mining Co	Do.
19	Page	Yreka	Idaho	American Smelting & Refining Co	Do.
20	Eagle	Redcliff (Battle Mountain)	Colorado	The New Jersey Zinc Co	Copper, zinc.
21	Austinville	Austinville	Virginia	do	Zinc-lead.
22	Ground Hog	Central	New Mexico	American Smelting & Refining Co	Lead-zinc.
23	Bunker Hill Smelter	Yreka	Idaho	The Bunker Hill Co	Zinc slag.
24	Flux Group	Harshaw	Arizona	American Smelting & Refining Co	Lead-zinc.
25	Triumph	Warm Springs	Idaho	Triumph Mining Co	Do.

TABLE 5.—Mine production of recoverable lead in the United States,[1] 1954–55, by months, in short tons

Month	1954	1955	Month	1954	1955
January	25,289	27,936	August	27,480	27,390
February	28,002	27,600	September	25,370	27,390
March	29,908	31,535	October	26,135	28,649
April	27,259	28,916	November	28,314	27,379
May	25,793	29,136	December	29,449	27,443
June	26,658	28,625			
July	25,762	26,026	Total	325,419	338,025

[1] Includes Alaska.

SMELTER AND REFINERY PRODUCTION

Pig (refined) lead produced in the United States was derived from three principal sources—domestic mine production, imports of foreign ore and base bullion, and scrap material (treated largely at secondary smelters)—and was recovered at primary refineries that treat ore, base bullion, and small quantities of scrap and at secondary plants that process scrap exclusively. Refined lead and antimonial or "hard" lead was 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 was 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.

In 1955 the 11 primary smelters consumed 487,900 short tons (lead content) of primary materials in the form of ores and concentrates. Of this total, 66 percent was of domestic and 34 percent of foreign origin—the same division as in 1954. The total consumption of raw materials was less than 1 percent above that in 1954.

ACTIVE LEAD SMELTERS AND REFINERIES

Primary lead smelters and refineries operating in the United States in 1955 follow:

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 483,200 tons of refined lead in 1955 or 2 percent less than the output in 1954.

Of the total production of refined lead, 479,200 tons was from primary sources, 66 percent domestic and 34 percent foreign, and 4,000 tons from secondary sources. 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, 1946–50 (average) and 1951–55, by source material, in short tons

Source	1946–50 (average)	1951	1952	1953	1954	1955
Refined lead:						
From domestic ores and base bullion	367,418	342,644	383,358	328,012	322,271	321,132
From foreign ores	64,622	71,984	89,092	139,711	164,353	157,863
From foreign base bullion	2,271	3,065	402	168	88	162
Total from primary sources	434,311	417,693	472,852	467,891	486,712	479,157
From scrap	11,462	3,893	3,070	4,211	5,066	4,079
Total refined lead	445,773	421,586	475,922	472,102	491,778	483,236
Average sales price per pound	$0.140	$0.173	$0.161	$0.131	$0.137	$0.149
Total calculated value of primary refined lead [1]	$123,325,200	$144,522,000	$153,247,000	$122,587,000	$133,359,000	$142,789,000

[1] Excludes value of refined lead produced from scrap at primary refineries.

TABLE 7.—Refined primary lead produced in the United States, 1946–50 (average) and 1951–55, by source material and country of origin, in short tons

Source	1946–50 (average)	1951	1952	1953	1954	1955
Domestic ore and base bullion	367,418	342,644	383,358	328,012	322,271	321,132
Foreign ore:						
Australia	6,733	9,056	5,888	19,886	17,311	26,701
Canada	4,678	7,986	7,113	26,673	47,150	39,919
Europe	15	17	454	199	865	109
Mexico	5,295	3,620	2,344	5,876	16,790	10,123
South America	24,192	36,849	48,625	50,828	58,341	44,855
Other foreign	23,709	14,456	24,668	36,249	23,896	36,156
Total	64,622	71,984	89,092	139,711	164,353	157,863
Foreign base bullion:						
Australia	855	2,815				
Mexico	1,230	27	70	42		
South America	127	75	177	126	88	162
Other foreign	59	148	155			
Total	2,271	3,065	402	168	88	162
Total foreign	66,893	75,049	89,494	139,879	164,441	158,025
Grand total	434,311	417,693	472,852	467,891	486,712	479,157

ANTIMONIAL LEAD

Primary lead refineries produced 64,000 tons of antimonial lead in 1955, a 7-percent increase over output in 1954. Four of the 5 producing plants increased output. Distribution of antimonial lead production at primary refineries in 1951–55, by source material, is shown in table 8, as is, also, the average antimony content.

Antimonial lead was an important byproduct of the refining of base bullion, although the quantity derived was only a small part of the total domestic output. The major production was recovered from smelting 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, 1946–50 (average) and 1951–55

Year	Production (short tons)	Antimony content		Lead content by difference (short tons)			
		Short tons	Percent	From domestic ore	From foreign ore	From scrap	Total
1946–50 (average)	67, 336	4, 373	6. 8	13, 403	7, 376	42, 184	62, 963
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
1953	62, 373	4, 537	7. 3	10, 366	10, 721	36, 749	57, 836
1954	59, 873	3, 521	5. 9	5, 136	7, 661	43, 555	56, 352
1955	64, 044	3, 555	5. 6	5, 259	9, 327	45, 903	60, 489

SECONDARY LEAD

Some scrap lead was treated at primary smelters, but the greater part was processed at many plants that specialize in treating secondary materials. Secondary lead was recovered in the form of refined lead, antimonial lead, and other alloys.

Recovery of lead in 1955 totaled 502,000 tons, or 4 percent more than than the 480,900 tons reclaimed in 1954. Lead recovered as metal and in alloys exceeded domestic mine production for the 10th successive year and furnished 39 percent of the total supply. Detailed information on secondary lead appears in the Secondary Metals—Nonferrous chapter of this volume.

TABLE 9.—Secondary lead recovered in the United States, 1946–50 (average) and 1951–55, in short tons

	1946–50 (average)	1951	1952	1953	1954	1955
As refined metal:						
At primary plants	11, 462	3, 893	3, 070	4, 211	5, 066	4, 079
At other plants	108, 348	165, 023	137, 032	122, 363	114, 941	124, 241
Total	119, 810	168, 916	140, 102	126, 574	120, 007	128, 320
In antimonial lead:						
At primary plants	42, 184	34, 303	35, 145	36, 749	43, 555	45, 903
At other plants	178, 127	195, 660	187, 806	199, 806	195, 284	201, 800
Total	220, 311	229, 963	222, 951	236, 555	238, 839	247, 703
In other alloys	119, 736	119, 231	108, 241	123, 608	122, 079	126, 028
Grand total:						
Short tons	459, 857	518, 110	471, 294	486, 737	480, 925	502, 051
Value	$130,380,226	$179,266,060	$151,756,668	$127,525,094	$131,773,450	$149,611,198

LEAD PIGMENTS

The principal lead pigments marketed were litharge. white lead, red lead, basic lead sulfate, and leaded zinc oxide. These products were manufactured chiefly from metal, but some ore and concentrates were converted directly into pigments. Details of lead-pigments production are given in the Lead and Zinc Pigments and Zinc Salts chapter of this volume.

CONSUMPTION AND USES

Domestic lead consumption (including lead in lead ore consumed directly in manufacturing lead pigments and salts) totaled 1,212,600 tons in 1955, an 11-percent increase over that in 1954. Of the total consumed, 758,400 tons was soft lead (including both primary and secondary soft lead); 307,000 tons was contained in antimonial lead (the greater part of which was secondary), 29,500 tons in unmelted white scrap, 57,100 tons in percentage metals, 24,700 tons in copper-base scrap, and 26,100 tons in drosses and residues; and 9,800 tons was recovered from ore in producing leaded zinc oxide and other nonspecified pigments. Of all lead consumed during the year, about 41 percent went to metal products, 31 percent to storage batteries, 11 percent to pigments, 14 percent to chemicals, including tetraethyl fluid, and 3 percent to miscellaneous uses. Production of the 3 principal lead-consuming items—batteries, tetraethyl lead, and cable covering—took 31 percent (31 percent in 1954), 14 percent (15 percent in 1954), and 10 percent (12 percent in 1954), respectively, for a total of 55 percent or 666,300 tons.

Shipments of automotive replacement batteries in 1955 rose from 23,149,000 units (revised figure) in 1954 to 25,409,000 units, the largest quantity reported since 1947 according to the Association of American Battery Manufacturers, Inc.[4] Notable was the more widespread use of the 12-volt battery, estimated to consume about 30 percent more lead than the 6-volt unit.

Of the total lead consumption (excluding lead contained in leaded zinc oxide and some other pigments), New Jersey consumed 17 percent; Illinois, 12 percent; Indiana, 9 percent; California, 7 percent; Pennsylvania, 6 percent; and New York, 5 percent—a total of 56 percent in 6 of the leading lead-consuming States.

[4] American Metal Market, vol. 63, No. 20, Jan. 31, 1956, p. 6.

TABLE 10.—Consumption of lead in the United States, 1954–55, by products, in short tons

	1954	1955		1954	1955
Metal products:			Pigments:		
Ammunition	40,206	46,816	White lead	17,704	18,549
Bearing metals	27,166	34,567	Red lead and litharge	76,472	87,503
Brass and bronze	20,147	24,043	Pigment colors	14,062	15,000
Cable covering	127,939	121,165	Other [1]	8,171	10,383
Calking lead	49,854	59,406			
Casting metals	10,969	15,141	Total	116,409	131,435
Collapsible tubes	10,736	11,136			
Foil	4,448	5,185	Chemicals:		
Pipes, traps, and bends	26,832	29,757	Tetraethyl lead	160,436	165,133
Sheet lead	26,014	30,466	Miscellaneous chemicals	6,748	5,492
Solder	71,122	88,749			
Terne metal	1,286	2,382	Total	167,184	170,625
Type metal	25,665	26,507			
			Miscellaneous uses:		
Total	442,384	495,320	Annealing	4,653	6,059
			Galvanizing	2,732	2,313
Storage batteries:			Lead plating	872	848
Antimonial lead	174,447	195,787	Weights and ballast	7,393	7,673
Lead oxides	162,825	184,246			
			Total	15,650	16,893
Total	337,272	380,033	Other, unclassified uses	15,972	18,338
			Grand total	1,094,871	1,212,644

[1] Includes lead content of leaded zinc oxide and other nonspecified pigments.

TABLE 11.—Consumption of lead in the United States, 1954–55, by months, in short tons [1]

Month	1954	1955	Month	1954	1955
January	90,815	93,301	August	96,763	107,158
February	83,345	86,290	September	95,348	112,091
March	93,323	99,677	October	91,002	115,289
April	93,844	96,700	November	90,433	108,649
May	91,804	101,029	December	90,222	104,615
June	96,027	103,451			
July	81,945	84,394	Total	1,094,871	1,212,644

[1] Includes lead content of leaded zinc oxide and other nonspecified pigments.

TABLE 12.—Consumption of lead in the United States in 1955, by classes of product and types of material, in short tons

	Soft and antimonial lead	Scrap, percentage metal, drosses, etc.	Total
Metal products	360,289	135,031	495,320
Storage batteries	379,839	194	380,033
Pigments	121,356	219	121,575
Chemicals	170,625	----------	170,625
Miscellaneous	16,615	278	16,893
Unclassified	16,684	1,654	18,338
Total	1,065,408	137,376	[1] 1,202,784

[1] Excludes 9,860 tons of lead contained in leaded zinc oxide and other nonspecified pigments

TABLE 13.—Lead consumption by States in 1955, in short tons [1]

State	Refined soft lead	Antimonial lead	Unmelted white scrap	Percentage metals	Copper-base scrap	Drosses, residues, etc.	Total
Alabama	337	3	-	-	356	-	696
California	50,459	30,374	3,152	690	1,433	1,160	87,268
Colorado	1,584	697	368	276	253	247	3,425
Connecticut	17,353	11,329	92	19	1,077	-	29,870
District of Columbia	85	96	-	-	-	-	181
Florida	802	1,239	-	-	-	-	2,041
Georgia	15,564	6,875	2	876	126	3,696	27,139
Illinois	84,150	33,632	1,792	20,134	3,434	3,540	146,682
Indiana	53,697	41,404	2,658	2,872	874	3,160	104,665
Iowa	38	203	-	-	-	-	241
Kansas	210	5,180	7	290	538	-	6,225
Kentucky	157	70	4	-	-	-	231
Maryland	22,896	11,132	362	2,637	142	174	37,343
Massachusetts	7,795	4,367	948	1,939	738	4	15,791
Michigan	13,106	13,124	13	2,401	681	48	29,373
Minnesota	1,079	6,643	-	2,193	369	2,802	13,086
Missouri	46,943	1,709	743	2,462	1,908	31	53,796
Nebraska	11,114	1,386	-	-	77	-	12,577
New Jersey	139,160	50,803	5,197	4,306	657	3,836	203,959
New York	51,156	9,738	3,006	2,537	1,399	[2] −55	67,781
Ohio	24,195	19,931	3,305	3,828	2,473	374	54,106
Pennsylvania	39,286	22,979	3,672	3,224	4,393	3,336	76,890
Rhode Island	4,977	307	-	190	-	-	5,474
Tennessee	786	6,009	67	416	460	-	7,738
Virginia	1,253	1,623	15	1,514	1,662	-	6,067
Washington	10,370	898	-	26	2	[2] −2	11,294
West Virginia	17,057	2,541	-	620	-	-	20,218
Wisconsin	1,152	3,231	8	419	548	4	5,362
Louisiana and Texas [3]	128,084	10,749	554	1,804	506	43	141,740
Montana and Idaho	7,530	94	-	-	-	-	7,624
Oregon and Hawaii	1,489	2,790	5	290	316	-	4,890
Utah, Nevada and Arizona	107	341	-	-	-	-	448
Arkansas and Oklahoma	2,322	2,482	-	-	-	-	4,804
North and South Carolina	128	1,925	-	-	-	2	2,055
New Hampshire, Maine and Delaware	1,408	184	3,486	1,080	293	113	6,564
Undistributed	543	948	-	59	46	3,544	5,140
Total	758,372	307,036	29,456	57,102	24,761	26,057	1,202,784

[1] Excludes lead content of leaded zinc oxide and other nonspecified pigments.
[2] Negative consumption represents an increase in stocks of home scrap.
[3] The following States are grouped to avoid disclosure of individual figures.

STOCKS

National Stockpile.—The General Services Administration continued to purchase lead, in accordance with purchase directives from the Office of Defense Mobilization (ODM). According to an ODM report [5] on the status of the stockpile for the 6 months ended December 31, 1955, the minimum objectives had been completed for lead and zinc, as well as for many other minerals. However, newly mined domestic lead and zinc were purchased in 1955 for the long-term stockpile to support the domestic mining industry as a component of the mobilization base.

Producers' Stocks.—Lead stocks, as reported by the American Bureau of Metal Statistics, are shown in table 14. Stocks of refined and antimonial lead include metal held by all primary refiners and by some refiners of secondary metal producing soft lead. The supply of lead (1,281,700 tons) continued to exceed consumption (1,212,600 tons). Producers' stocks in process and in transit increased but finished metal stocks decreased substantially; the total dropped from 201,900 tons to 150,800.

[5] Stockpile Report to the Congress, July-December 1955, Executive Office of the President, Office of Defense Mobilization, p. 2.

TABLE 14.—Stocks of lead at smelters and refineries in the United States at end of year, 1946–50 (average) and 1951–55, in short tons

[American Bureau of Metal Statistics]

	1946–50 (average)	1951	1952	1953	1954	1955
Refined pig lead	34,755	18,518	31,405	65,036	77,930	21,196
Antimonial lead	7,965	6,821	12,155	16,116	14,789	9,893
Total	42,720	25,339	43,560	81,152	92,719	31,089
Lead in base bullion:						
At smelters and refineries	10,832	11,315	17,583	17,920	18,170	16,532
In transit to refineries	4,623	3,909	3,105	2,867	1,723	3,764
In process at refineries	16,242	15,700	19,759	26,713	27,164	27,625
Total	31,697	30,924	40,447	47,500	47,057	47,921
Lead in ore and matte and in process at smelters	86,129	67,817	65,771	67,688	62,074	71,812
Grand total	160,546	124,080	149,778	196,340	201,850	150,822

Bureau reports indicated 21,900 tons of refined-lead stocks at the end of 1955 compared with 78,900 tons on January 1. Stocks of antimonial lead at primary refineries dropped from 13,300 tons to 9,100 during the year. Stocks of lead in ore and concentrate increased from 29,900 tons to 42,900; and stocks of base bullion at refineries that receive bullion, and smelters that produce bullion for shipment to refineries, increased from 14,900 tons to 15,600. These data represent physical inventory at the plants, irrespective of ownership, and do not include material in process or in transit; they are therefore not directly comparable to the figures in table 14.

Consumer Stocks.—Consumer stocks of all lead decreased 6 percent in 1955—from 124,600 tons to 117,500. Stocks of antimonial lead gained 31 percent, but all other classes had decreases ranging from 9 to 21 percent.

TABLE 15.—Consumers' stocks of lead in the United States at end of year, 1951–55, 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
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
1953	75,801	14,867	3,607	7,921	2,083	9,484	113,763
1954	82,039	17,573	3,199	9,367	2,005	10,458	124,641
1955	73,480	23,081	2,914	8,146	1,618	8,219	117,458

PRICES

Prices.—Most of the lead produced domestically was sold at prices based upon New York and St. Louis quotations. The differential between St. Louis and the slightly higher New York prices was about 0.2 cent a pound; this amount approximated the shipping cost between the two cities.

The average quoted price for common lead, New York, was 15.14 cents per pound, or 1.09 cents above the average in 1954. At the beginning of 1955 the price was 15.00 cents per pound, which held until September 23, when an upward movement began that raised the quotation to 15.50 cents on September 26. On December 29 the price advanced to 16.00 cents, the highest since October 1952. The average weighted yearly price for all grades of lead sold in 1955 was 14.90 cents compared with 13.70 cents in 1954. The Government continued to purchase lead at the market price for the National Stockpile, but the quantity offered in the latter half of 1955 was considerably less than in the first half, owing to the rise in commercial demand.

TABLE 16.—Average monthly and yearly quoted prices of lead at St. Louis, New York, and London, 1953–55, in cents per pound [1]

Month	1953			1954			1955		
	St. Louis	New York	London [2]	St. Louis	New York	London [2]	St. Louis	New York	London [2]
January	13.99	14.19	12.51	13.05	13.25	10.85	14.80	15.00	12.94
February	13.30	13.50	11.86	12.62	12.82	10.39	14.80	15.00	12.88
March	13.20	13.40	11.46	12.73	12.93	10.85	14.80	15.00	12.96
April	12.44	12.64	10.34	13.71	13.91	11.77	14.80	15.00	13.04
May	12.55	12.75	10.32	13.80	14.00	11.88	14.80	15.00	12.88
June	13.21	13.41	11.14	13.91	14.11	12.26	14.80	15.00	12.80
July	13.48	13.68	11.71	13.80	14.00	12.04	14.80	15.00	13.17
August	13.80	14.00	11.98	13.86	14.06	12.17	14.80	15.00	13.25
September	13.54	13.74	11.68	14.40	14.60	12.67	14.92	15.12	13.38
October	13.30	13.50	11.59	14.77	14.97	13.57	15.30	15.50	13.32
November	13.30	13.50	11.82	14.80	15.00	13.48	15.30	15.50	13.53
December	13.30	13.50	11.34	14.80	15.00	12.97	15.34	15.54	14.18
Average	13.28	13.48	11.48	13.85	14.05	12.08	14.94	15.14	13.19

[1] St. Louis: Metal Statistics, 1956, p. 510. New York: Metal Statistics, 1956, p. 504. London: E&MJ Metal and Mineral Markets and Quin's Metal Handbook.

[2] Conversion of English quotations into American money based on average rates of exchange recorded by Federal Reserve Board.

The London free lead market was in operation throughout the year. Quotations on the Metal Exchange ranged from a low of £101.75 per long ton on January 14 and February 28 (equivalent to 12.65 cents a pound computed on the average rate of exchange for the month) to a high of £120 per long ton on December 30 (15.01 cents per pound); the price on December 30 was also the highest since open-market trading was resumed on January 2, 1953. The average price for the year was £105.88 (13.19 cents).

FOREIGN TRADE [6]

Imports.—In 1955, general imports of lead in all forms totaled 462,200 tons, 4 percent more than in 1954 but 26 percent under the record high of 628,100 tons in 1952. The surplus of total lead supply over commercial demand in the United States continued but was reduced somewhat by the 11-percent increase in commercial consumption. Deliveries to the Government long-term stockpile absorbed considerable amounts of surplus lead. The quantity of lead imported in ore, flue dust, and matte increased 10 percent to 177,500 tons; that in pigs and bars declined 4 percent to 264,100 tons; and that in reclaimed and scrap increased 264 percent to 20,600 tons. Of the

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

lead contained in ore, flue dust, and matte, Peru supplied 25 percent; Union of South Africa, 23 percent; Canada, 19 percent; Australia, 17 percent; Bolivia, 8 percent; and other countries together, 8 percent. Of the pigs and bars, Mexico supplied 35 percent; Australia, 21 percent; Yugoslavia, 13 percent; Canada, 13 percent; Peru, 9 percent; Spain, 4 percent; and other countries, 5 percent.

TABLE 17.—Total lead imported into the United States in ore, matte, base bullion, pigs, bars, and reclaimed, by countries, 1946–50 (average) and 1951–55, in short tons, in terms of lead content [1]

[U. S. Department of Commerce]

Country	1946–50 (average)	1951	1952	1953	1954	1955
Ore, flue dust, and matte:						
North America:						
Canada	4,812	7,252	12,048	39,242	[2] 40,593	33,090
Newfoundland and Labrador	8,554					
El Salvador	200	286	126			
Guatemala	635	3,169	4,721	5,391	[2] 2,686	5,208
Honduras	188	381	595	1,090	1,636	2,757
Mexico	3,475	2,525	2,497	3,443	2,167	2,201
Other	83	28	(3)		(3)	3
Total	17,947	13,641	19,987	49,166	[2] 47,082	43,259
South America:						
Bolivia	13,000	15,989	18,473	18,984	14,946	13,812
Chile	3,034	1,945	3,197	3,341	173	409
Peru	11,039	16,946	28,213	32,842	38,734	44,223
Other	839	36	92	345	466	628
Total	27,912	34,916	49,975	55,512	54,319	59,072
Europe	43	12	425		696	
Asia:						
Korea, Republic of	154		58			
Philippines	254	789	2,446	2,980	2,160	2,635
Other	134	30	160	92		
Total	542	819	2,664	3,072	2,160	2,635
Africa:						
French Morocco	1,837			2,633		
Union of South Africa	11,443	10,663	22,543	29,777	35,507	41,575
Other	169	10	113	63	19	
Total	13,449	10,673	22,656	32,473	35,526	41,575
Oceania:						
Australia	8,623	7,423	8,954	20,676	[2] 21,478	30,938
Other	33					
Total	8,656	7,423	8,954	20,676	[2] 21,478	30,938
Total ore, flue dust, and matte	68,549	67,484	104,661	160,899	[2] 161,261	177,479
Base bullion:						
North America:						
Guatemala	46		266	736		
Mexico	1,547					
Total	1,593		266	736		
South America:						
Peru	192	47	123	133	41	
Other	(3)					
Total	192	47	123	133	41	
Europe: Yugoslavia			(3)			
Asia:						
Japan	184					
Korea, Republic of	73					
Total	257					

See footnotes at end of table.

TABLE 17.—Total lead imported into the United States in ore, matte, base bullion, pigs, bars, and reclaimed, by countries, 1946–50 (average) and 1951–55, in short tons, in terms of lead content [1]—Continued

[U. S. Department of Commerce]

Country	1946–50 (average)	1951	1952	1953	1954	1955
Base bullion—Continued						
Africa: Union of South Africa	6					
Oceania: Australia	902	2,234				
Total base bullion	2,950	2,281	389	869	41	
Pigs and bars:						
North America:						
Canada	60,036	56,959	104,531	49,000	59,887	34,453
Newfoundland and Labrador	2					
Mexico	116,989	36,987	198,872	140,751	68,695	93,369
Other	14		18	209	20	
Total	177,041	93,946	303,421	189,960	128,602	127,822
South America:						
Bolivia			635	220		
Peru	21,378	31,528	42,169	52,216	20,047	24,509
Other		2	2	9		
Total	21,378	31,530	42,806	52,445	20,047	24,509
Europe:						
Belgium-Luxembourg	1,858	331	1,785	2,017	339	231
Germany	3,395	738	[4] 6,052	[4] 4,006	[4] 799	[4] 496
Italy	4,954					
Netherlands	506		2,747	1,981	156	
Spain	419		5,509		5,580	10,649
United Kingdom	163	299	4,216	1,148	2,386	
Yugoslavia	14,260	36,311	53,997	51,826	38,465	35,659
Other	59		717	1,496	3,902	2,398
Total	25,614	37,679	75,023	62,474	51,627	49,433
Asia:						
Burma	751					
Japan	4,596				10	
Other	631			138		55
Total	5,978			138	10	55
Africa:						
French Morocco		2,279	6,670	9,258	17,555	7,800
Other	117			448		
Total	117	2,279	6,670	9,706	17,555	7,800
Oceania: Australia	17,704	13,598	82,800	70,348	58,445	54,530
Total pigs and bars	247,832	179,032	510,720	385,071	276,286	264,149
Reclaimed, scrap, etc.:						
North America:						
Canada	4,786	1,730	6,047	371	3,023	7,598
Newfoundland and Labrador	16					
Canal Zone	272	228	858	205	35	37
Cuba	56	324		147	319	815
Jamaica	35	252	101	28		
Mexico	692	2,089	872	98	1,298	6,120
Panama	90	234	300	138	180	331
Other	187	301	622	329	298	195
Total	6,134	5,158	8,800	1,316	5,153	15,096
South America:						
Chile	12	84				
Peru		159	297	59	173	166
Venezuela	23	668	196			1,653
Other		113	20			
Total	35	1,024	513	59	173	1,819

See footnotes at end of table.

TABLE 17.—Total lead imported into the United States in ore, matte, base bullion, pigs, bars, and reclaimed, by countries, 1946–50 (average) and 1951–55, in short tons, in terms of lead content[1]—Continued

[U. S. Department of Commerce]

Country	1946–50 (average)	1951	1952	1953	1954	1955
Reclaimed scrap, etc.—Continued						
Europe:						
Belgium-Luxembourg	266			202		576
Denmark	11		47	14		282
France	58	88				
Germany	191				[4] 56	[4] 3
Italy	544					
Netherlands	613	18	454	502		112
Spain						431
Yugoslavia	131		345	103	110	
Other	310	7	229	442	103	136
Total	2,124	113	1,075	1,263	269	1,540
Asia:						
Burma	41		203			
Japan	4,574	470	345	21	13	
Other	1,210	122	141		47	26
Total	5,825	592	689	21	60	26
Africa	260			17		
Oceania:						
Australia	2,049	2,175	924	2,666		2,099
Other	3	81	338	97		
Total	2,052	2,256	1,262	2,763		2,099
Total reclaimed, scrap, etc	16,430	9,143	12,339	5,439	5,655	20,580
Grand total	335,761	257,940	628,109	552,278	[2] 443,243	462,208

[1] Data are "general imports"; that is, they include lead imported for immediate consumption plus material entering the country under bond.
[2] Revised figure.
[3] Less than 1 ton.
[4] West Germany.

TABLE 18.—Lead imported for consumption in the United States, 1946–50 (average) and 1951–55, by classes[1]

[U. S. Department of Commerce]

Year	Lead in ores, flue dust or fume, 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		
1946–50 (average)	64,709	$15,079,377	2,996	$845,278	242,865	$63,647,381	131	$66,480	$35,209	$83,567,662
1951	31,372	8,365,575			179,021	63,682,071	255	123,377	174,265	74,528,528
1952	107,621	32,768,909	2,951	1,137,813	510,718	165,018,991	11	8,446	221,779	202,354,782
1953	67,030	15,214,084	742	294,068	379,119	95,285,223	178	58,291	242,925	111,919,588
1954	196,054	[2] 47,967,269	41	10,149	274,286	[2] 68,419,607	397	[2] 128,812	[2] 149,208	[2] 118,125,081
1955	156,433	[2] 38,142,741			263,977	73,032,055	2,048	534,931	[2] 163,610	[2] 115,804,005

[1] In addition to quantities shown (value included in total value), "reclaimed, scrap. etc.," imported as follows: 1946–50 (average): 16,800 tons, $3,893,937; 1951: 8,020 tons, $2,183,240; 1952: 11,358 tons, $3,198,844; 1953: 3,660 tons, $824,997; 1954: 7,217 tons, [2] $1,450,036; 1955: 18,944 tons, [2] $3,930,668.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not comparable to earlier years.

TABLE 19.—Miscellaneous products containing lead, imported for consumption in the United States, 1946–50 (average) and 1951–55

[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
1946–50 (average)	1,061	662	$781,284	7,451	6,533	$2,388,190
1951	1,533	988	1,494,792	9,128	8,663	3,845,671
1952	1,540	999	1,348,288	10,909	9,415	4,153,960
1953	2,375	1,343	1,869,312	6,366	5,016	1,921,453
1954	2,309	1,572	[1] 1,945,992	4,138	3,367	1,250,938
1955	2,195	1,236	[1] 1,818,749	14,579	13,213	4,378,769

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce data known to be not comparable to earlier years.

Exports.—Exports of lead in 1955 totaled 3,400 tons, of which all but 417 tons was contained in scrap. Only 14 tons was contained in ore and 403 tons in pigs and bars.

TABLE 20.—Total lead exported from the United States in ores, matte, base bullion, pigs, bars, anodes and scrap, by destination, 1946–50 (average) and 1951–55, in short tons [1]

[U. S. Department of Commerce]

Destination	1946–50 (average)	1951	1952	1953	1954	1955
Ore, matte, base bullion (lead content):						
North America:						
Canada	352	557	836	1,038	18	12
Other North America						2
Total	352	557	836	1,038	18	14
Europe: Belgium-Luxembourg	20					
Asia: Japan					84	
Total ore, matte, base bullion	372	557	836	1,038	102	14
Pigs, bars, anodes:						
North America:						
Canada	76	138	40	32	18	13
Canal Zone	18	24	18	1		
Cuba	53	48	52	28	23	36
El Salvador	29	35	23	2	5	5
Guatemala	3	1	1	29	33	
Honduras	11	14	10	3	5	
Mexico	10	4	7	8	34	16
Other North America	19	24	26	100	46	20
Total	219	288	177	203	164	90
South America:						
Argentina	181	55				
Brazil	104	62	433	76	44	5
Chile	34	107	193	18	98	74
Colombia	52	42	10	21	20	27
Ecuador	6	1	84			2
Uruguay	168	424	231			
Venezuela	76	62	67	41	27	42
Other South America	3	3	15	5	13	17
Total	624	756	1,033	161	202	167

See footnotes at end of table.

TABLE 20.—Total lead exported from the United States in ores, matte, base bullion, pigs, bars, anodes and scrap, by destination, 1946–50 (average) and 1951–55, in short tons [1]—Continued

[U. S. Department of Commerce]

Destination	1946–50 (average)	1951	1952	1953	1954	1955
Pigs, bars, anodes—Continued						
Europe:						
Belgium-Luxembourg	15	37				
Denmark	26					
Greece	4	3				10
Turkey	14		280			11
United Kingdom	13					1
Other Europe	27		22	2	2	2
Total	99	40	302	2	2	24
Asia:						
India	29	11	4			5
Pakistan	114					
Philippines	80	17	78	405	192	96
Other Asia	66	169	165	25	34	21
Total	289	197	247	430	226	122
Africa	16	(2)	2	6	2	
Oceania			1	1		
Total pigs, bars, anodes	1,247	1,281	1,762	803	596	403
Scrap:						
North America:						
Canada	(3)	203	20	27		1
Mexico	(3)				370	
Total	(3)	203	20	27	370	1
South America	(3)				(2)	
Europe:						
Belgium-Luxembourg	(3)	31			103	754
Denmark	(3)				318	219
Germany	(3)	145		[4] 39	[4] 29	[4] 495
Netherlands	(3)					148
United Kingdom	(3)	20	55	2,000	1,060	880
Total	(3)	196	55	2,039	1,510	2,496
Asia:						
Japan	(3)	195		640	2,014	486
Lebanon	(3)					
Total	(3)	195		640	2,014	486
Total scrap	(3)	594	75	2,706	3,894	2,983
Grand total		2,432	2,673	4,547	4,592	3,400

[1] In addition foreign lead was reexported as follows: Ore, matte, base bullion 1946–50 (average) 1 ton; 1951–54: none; 1955: 3 tons. Pigs, bars, anodes, 1946–50 (average) 69 tons; 1951: none; 1952: 2 tons; 1953: 799 tons; 1954–55: none. Scrap 1949–53: none; 1954: 121 tons; 1955: none.
[2] Less than 1 ton.
[3] Not separately classified 1946–48; 1949, Belgium-Luxembourg 362 tons; Canada 95 tons; Lebanon 11 tons; United Kingdom 279 tons; total scrap 747 tons; 1950, Canada 41 tons; United Kingdom 1,271 tons; West Germany 264 tons; total, 1,576 tons.
[4] West Germany.

Tariff.—The duties on pig lead and lead in ores and concentrates remained at 1 1/16 cents and 3/4 cent per pound, respectively, throughout 1955. The rates of duty imposed on lead articles under the Tariff Act of 1930, in specified years, and changes made under various trade agreements, 1930–54, are given in the chapter of this series for 1953. The rates were not changed during 1955.

The Reciprocal Trade Agreements Act, giving the President new power to cut tariffs for a period of 3 years to June 30, 1958, was signed by the President June 21, 1955. The bill permits the President to cut tariffs up to 5 percent in each of the 3 years in negotiating for similar concessions from other countries. The first 5-percent reduction authorized must be used in the first year, or it will lapse. The same is true in each of the 2 succeeding years.

TECHNOLOGY

Technologic improvements in methods of exploration, mining, and ore treatment continued to be emphasized as a means of keeping the mines in operation at a profitable level in the face of advancing wage and salary rates and the high cost of supplies and equipment. Large deposits of lead-zinc ore have been found in recent years, particularly in Canada,[7] by the use of new prospecting methods and equipment. At some mines, movement of broken ore from stopes to mine cars has been accelerated and made less costly by the use of self-loading haulage units of various sizes. Research on utilization of lead in new alloys and compounds was intensified in efforts to expand markets to provide an outlet for excess inventories of lead that accumulated at times as the result of large imports. All of the new or improved techniques employed in the lead industry in 1955 were, of course, not covered in the literature released for publication, but much valuable information was provided in papers contributed by the technical staffs of individual companies, trade journals, Federal and State agencies, and others engaged in research.

The Federal Bureau of Mines [8] and the Federal Geological Survey [9] published the results of several investigations during 1955.

A paper was published [10] giving the results of an investigation to test the effectiveness of biogeochemical analyses in exploring for bodies of lead and zinc ore known to crop out in an area of moderate rainfall and temperature. The abstract stated:

> During the spring of 1954 a preliminary biogeochemical study was made of the Shawangunk Mine of Wurtsboro, New York. This is a fissure vein type of lead-zinc deposit containing minor amounts of copper. Copper and zinc were determined in common white birch twigs by a modification of the method of H. V. Warren. In addition lead was determined by modifying a technique of E. B. Sandell. The separations and analyses were carried out in the Chemistry Laboratory of Columbia University using a Lumetron Photoelectric Colorimeter for final determination of the metallic ions.
>
> Results were calculated and tabulated for parts per million of copper, zinc and lead, and copper-zinc ratio. The lead and copper-zinc ratio values, to a greater extent than the copper and zinc values, showed encouraging results in defining the ore body as to content and possible shape.

[7] Seigel, Harold O., Geophysical Prospecting in New Brunswick; Min. Cong. Jour. vol. 42, No. 3, March 1956, pp. 34–39.

[8] Ash, S. H., Dierks, H. A., Felegy, E. W., Huston, K. M., Kennedy, D. O., Miller, P. S., and Rosella, J. J., Corrosive and Erosive Effects of Acid Mine Waters on Metals and Alloys for Mine Pumping Equipment and Drainage Facilities. Anthracite Region of Pennsylvania: Bureau of Mines Bull. 555, 1955, 46 pp.

Bishop, O. M., and Mentch, R. L., Lead (chapter in Mineral Facts and Problems): Bureau of Mines Bull. 556, 1955, pp. 417–444.

Hamilton, W. H., and McLellan, R. R., Investigation of the Kokomo Zinc Deposits, Summit County, Colo.: Bureau of Mines Rept. of Investigation 5138, 1955, 28 pp.

Fine, M. M., and Haug, E. J., Laboratory Recovery of an Oxidized Lead Mineral From a Southeast Missouri Deposit: Min. Eng., vol. 7, No. 4, April 1955, pp. 390–392.

[9] Albritton, C. C., Jr., Richards, Arthur, Brokaw, A. L., and Reinemund, J. A., Geologic Controls of Lead and Zinc Deposits in Goodsprings (Yellow Pine) District, Nev.: Geol. Survey Bull. 1010, 1954 (1955), 111 pp.

Bodenlos, A. J., and Ericksen, G. E., Lead-Zinc Deposits of Cordillera Blanca and Northern Cordillera Huayhuash, Peru: Geol. Survey Bull. 1017, 1955, 166 pp.

Flint, A. E., and Brown, C. E., Exploratory Drilling for Evidence of Zinc And Lead Ore in Dubuque County, Iowa: Geol. Survey Bull. 1027-K, 1956, pp. 471–499.

[10] Worthington, Joseph E., Biogeochemical Prospecting at the Shawangunk Mine—a Case Study: Econ. Geol., vol. 50, No. 4, June-July 1955, pp. 420–429.

An article on the prospecting and development of ore deposits of lead, zinc, copper, gold, and silver in bedded formations was published.[11] According to the authors, stratigraphic and structural interpretations demonstrate a definite relationship between geologic structure and ore deposition and make distinctions between barren, potential, and definite ore-bearing formations possible. Such information has been used effectively to reduce exploration and development costs.

Smelting-technique improvements at the custom lead smelter of the Bunker Hill Co., Kellogg, Idaho, were described.[12] A completely new charge-preparation plant costing $2.5 million was constructed in 1953. The plant consists of the following four separate units: Crushing, proportioning, bedding, and pelletizing. The control offered by the new plant makes possible a nearly uniform charge of proper metallurgical balance to the blast furnace and thus achieves increased capacity.

The means by which a small lead smelter in India boosted production were described.[13] It was stated, in part, that, by inverting the bosh on one blast furnace, converting to single-pass sintering and adding equipment, the lead smelter of Metal Corp. of India, Ltd., at Tundoo, increased capacity from 4 or 5 tons of lead per day to 40 to 45 tons per day.

A review of research progress in the use of lead and its applications [14] contained sections covering: The production and application of superpure lead and its physical and chemical properties, advances in lead physical metallurgy, corrosion characteristics, porcelain-enameled aluminum (made possible by the low fusing temperature of lead frits), engineering advances, and new publications.

Further progress was made in improving lead-base alloys. Research indicates [15] that copper additions of about 0.7 percent markedly reduce the tendency toward segregation in lead-tin-antimony babbitt alloys and result in a more uniform cast structure of heavy bearings. Experimental work [16] done on viscosity and density of liquid lead-tin and antimony-cadmium alloys shows that castability varies inversely with the interval of solidification of antimony and lead.

The fundamental principles of the pyrometallurgical processes for removing bismuth from lead were enumerated in a paper.[17] Qualitative discussion of the phase diagrams concerned was followed by presentation of quantitative diagrams. The practical aspects were mentioned briefly. Data presented showed how chemical lead (0.005 percent bismuth) may be produced by the Jollivet, Dittmer, and Kroll-Betterton processes.

---

[11] Fowler, George M., Hernon, Robert M., Conrow, John M., and Stone, Edwin A., Prospecting and Developing Ore Deposits in Bedded Formations, Eng. and Min. Jour., vol. 156, No. 3a, Mid-March, 1955, pp. 6–18.

[12] Mining World, What's New in Lead Smelting?: Vol. 17, No. 2, February 1955, pp. 44–48.
Engineering and Mining Journal, How Bunker Hill Blends Charge for Better Lead Smelting: Vol. 156 No. 7, July 1955, pp. 83–85.

[13] Mackertoom, J. H., How a Small Lead Smelter Boosted Production: Eng. and Min. Jour., vol. 156, No. 12, December 1955, pp. 96–98.

[14] Roll, Kempton H., Lead and Its Alloys: Chem. Eng. Rev., vol. 47, No. 9, September 1955, Part 2, pp. 1986–1989.

[15] Reichenecker, W. J., Elimination of Segregation in Babbitt Alloy: Metal Prog., vol. 68, No. 6, December 1955, pp. 110–111.

[16] Scott, Howard, and Gordon, Paul, Discussion of article by H. J. Fisher and A. Phillips entitled "Viscosity and Density of Liquid Lead-Tin and Antimony-Cadmium Alloys," and Author's reply: Jour. Metals, vol. 7, No. 11, sec. 2, November 1955, pp. 1264–1265.

[17] Davey, T. R. A., Debismuthizing of Lead: Jour. Metals, vol. 8, No. 3, March 1956, pp. 341–350 (AIME Tech. Paper 4184D; ms. Aug. 15, 1955. New York meeting, February 1956).

The unique properties which lead imparts to ceramics were described in a paper[18] presented to the Lead Industries Association. The author noted that, in addition to established uses as a component of glazes and in lead glass for optical, electrical, and electronic applications, lead is also an important raw material in the only satisfactory enamel for aluminum, providing a dense, hard surface obtained in a firing range well below temperatures that are detrimental to the aluminum base. Special lead glazes for ceramic dielectric bodies have proved superior to all other coatings for high-frequency electronic equipment such as radar. Because of high density and opacity to radioactive energy, high-lead glasses have found use in windows that must provide radiation protection. More recent developments include lead oxide-based piezoelectric ceramics for sensing elements in accelerometers, sound detectors, ultrasonic devices, and transducers. Ultra-low-loss, high-frequency insulating bodies that have zero shrinkage have been developed. The bodies, which contain 40 to 70 percent lead bisilicate, provide for easier fabrication where extremely close tolerances are prerequisite.

Other technical articles published during the year treated: Saving lead with a salt cover,[19] the use of aluminum-lead anodes,[20] lead in metal spinning,[21] and ignition temperatures of lead compound-carbon mixtures.[22]

WORLD REVIEW

World mine production of lead increased in 1955 for the ninth consecutive year, the rate of gain being approximately the same as in 1954. The estimated output of 2,370,000 short tons was nearly double that in 1946, 28 percent more than in 1950, and 7 percent more than in 1954. There were increases over 1954 in Europe, Asia, Africa, Australia, and South America and a small decline in North America. Although it maintained its leading position in mine output by only a small margin over Australia, the United States continued to be by far the leading producer, in terms of smelter output. Lead ores were mined in about 55 countries in 1955; United States, Australia, U. S. S. R., Mexico, Canada, Peru, and South-West Africa together furnished 67 percent of the total mine output.

Smelter production of lead decreased in the Americas and Australia but increased in Europe, Asia, and Africa; the total for the world was estimated to be 2,220,000 tons, a 1-percent gain over 1954. Six countries, the principal producers on a mine basis, supplied 64 percent of the total world smelter output; South-West Africa produced over 100,000 tons of lead on a mine basis but had no lead smelter.

Annual world mine production by countries for 1951–55 and the average of the 5-year period 1946–50, insofar as statistics are available, are given in table 21; world smelter production for the same years is shown in table 22. World smelting and refining facilities outside the United States were listed in the 1953 chapter of this series.

18 Koenig, John, Report on Lead In Ceramics: Presented at 28th Ann. Meeting, Lead Industries Association, Apr. 24–25, 1956, St. Louis, Mo.

19 Owens, Robert L., Salt Cover Saves Lead: Steel, vol. 137, No. 4, July 25, 1955, p. 92.

20 Aluminum-Lead Anodes for Chromium Plating Developed by Reynolds: Am. Metal Market, vol. 62, No. 97, May 19, 1955, p. 9.

21 Falconer, J. M., Metal Spinnings for Modern Communications: Sheet Metal Ind., vol. 32, No. 333, January 1955, pp. 25–28.

22 Nebel, George J., and Cramer, Paul L., Ignition Temperatures of Lead Compound-Carbon Mixtures Ind. Eng. Chem., vol. 47, No. 11, November 1955, pp. 2393–2396.

TABLE 21.—World mine production of lead, by countries, 1946–50 (average) and 1951–55, in short tons [1]

[Compiled by Augusta W. Jann]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	176,490	158,231	168,842	193,706	218,495	201,583
Cuba	28	----------	----------	----------	----------	88
Guatemala	1,785	3,638	4,630	7,789	2,607	5,084
Honduras	[2] 320	500	593	851	1,286	1,961
Mexico	223,865	248,536	271,198	244,216	238,788	232,383
Salvador [3]	280	520	110	----------	----------	----------
United States [4]	390,181	388,164	390,162	342,644	325,419	338,025
Total	792,949	799,589	835,535	789,206	786,595	779,124
South America:						
Argentina	21,270	25,100	21,000	17,600	21,000	26,500
Bolivia (exports) [4]	22,672	33,684	33,083	26,222	20,092	21,070
Brazil	1,852	3,900	3,100	3,300	3,200	4,400
Chile	3,526	8,599	[3] 4,400	[3] 3,500	[3] 3,500	[3] 3,500
Ecuador	299	33	126	126	121	929
Peru	60,703	90,775	105,572	126,303	121,327	130,900
Total	110,322	162,091	[3] 167,300	[3] 177,100	[3] 169,200	[3] 187,300
Europe:						
Austria	3,344	4,985	5,763	5,677	5,432	5,286
Bulgaria [3]	7,700	11,000	11,000	11,000	(5)	(5)
Czechoslovakia [3]	1,370	1,100	1,100	1,100	1,100	1,100
Finland	149	238	238	239	291	853
France	10,113	12,179	13,588	13,681	12,100	9,900
Germany:						
East [3]	2,100	2,900	2,900	3,300	5,500	6,600
West	30,894	55,467	56,510	69,085	74,171	74,334
Greece [6]	2,136	4,200	6,600	6,300	5,900	9,500
Hungary	198	(5)	(5)	(5)	(5)	(5)
Ireland	[7] 184	1,330	2,097	1,005	1,511	[3] 1,300
Italy	31,394	44,300	44,200	44,600	47,400	56,100
Norway	213	456	455	579	772	661
Poland [8]	16,843	20,000	22,000	23,500	24,000	24,300
Portugal	764	1,787	2,118	1,900	1,931	1,550
Rumania [3] [8]	5,800	9,900	10,500	11,000	11,600	12,200
Spain	36,392	44,580	46,720	59,750	61,002	68,994
Sweden	24,758	21,708	22,700	28,146	32,731	36,400
U. S. S. R. [3] [8]	85,450	141,500	170,000	202,000	228,500	255,000
United Kingdom	3,155	5,429	6,369	8,951	9,467	6,800
Yugoslavia	70,847	86,807	87,047	93,864	92,735	99,297
Total [3]	333,800	470,400	512,500	586,200	638,800	704,300
Asia:						
Burma [3]	300	2,200	3,300	8,800	13,200	17,600
China [3]	490	1,700	2,200	6,600	11,000	13,200
Hong Kong	----------	197	330	330	220	220
India	606	1,569	1,722	2,327	2,391	2,502
Iran [9]	[10] 2,200	19,300	18,000	8,800	[3] 13,300	[3] 13,200
Japan	7,992	14,187	19,271	20,562	25,176	28,627
Korea:						
North [3]	3,300	(5)	(5)	(5)	(5)	(5)
Republic of	283	----------	157	164	91	753
Philippines	333	629	2,535	2,683	2,014	2,555
Thailand (Siam)	[7] 482	1,456	1,155	4,000	5,500	6,000
Turkey	970	660	[3] 1,100	[3] 1,500	2,200	3,000
Total [3]	17,000	43,000	50,900	56,900	76,200	89,900
Africa:						
Algeria	1,294	3,261	5,225	8,804	11,244	11,482
Belgian Congo	467	----------	----------	72	184	91
Egypt	15	159	21	276	143	143
French Equatorial Africa	2,269	2,760	3,914	4,877	3,833	3,673
French Morocco	32,823	75,105	92,162	86,928	91,084	98,100
Nigeria	89	4	30	39	10	14
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia [8]	14,456	15,646	14,112	12,890	16,800	17,975
South-West Africa	26,186	43,244	[4] 58,248	[4] 65,287	[4] 77,146	[4] 110,656
Spanish Morocco	188	408	807	739	515	900

See footnotes at end of table.

TABLE 21.—World mine production of lead, by countries, 1946–50 (average) and 1951–55, in short tons [1]—Continued

Country	1946–50 (average)	1951	1952	1953	1954	1955
Africa—Continued						
Tanganyika (exports)	144	1,721	2,655	3,085	2,524	4,835
Tunisia	15,618	23,424	25,650	26,514	28,976	29,306
Uganda (exports)	22	10	9	18	61	90
Union of South Africa	266	990	634	551	181	564
Total	93,837	166,732	203,467	210,080	232,701	277,829
Oceania: Australia	230,670	251,478	260,693	274,303	319,046	328,219
World total (estimate)	1,580,000	1,890,000	2,030,000	2,090,000	2,220,000	2,370,000

[1] This table incorporates a number of revisions of data published in previous Lead chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[2] Average for 1948–50.
[3] Estimate.
[4] Tonnage recoverable from ore.
[5] Data not available; estimate by senior author of chapter included in total.
[6] Includes lead content of zinc-lead concentrates.
[7] Average for 1949–50.
[8] Smelter production.
[9] Year ended March 21 of year following that stated.
[10] Average for 1 year only, as 1950 was first year of commercial production.

TABLE 22.—World smelter production of lead, by countries where smelted, 1946–50 (average) and 1951–55 in short tons [1] [2]

[Compiled by Augusta W. Jann]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	160,909	162,712	183,389	166,356	166,379	149,975
Guatemala	153	66	348	725	[3] 110	----------
Mexico	217,259	241,524	261,736	236,966	230,567	224,474
United States (refined) [4]	432,040	414,628	472,450	467,723	486,624	478,995
Total	810,361	818,930	917,923	871,770	883,680	853,444
South America:						
Argentina	22,008	26,167	21,815	14,330	[3] 25,300	19,842
Brazil	1,498	[3] 3,300	2,145	3,250	3,026	4,409
Chile	----------	----------	----------	----------	49	554
Peru	37,764	48,774	53,597	65,041	63,648	66,533
Total	61,270	78,241	77,557	82,621	[3] 92,000	91,338
Europe:						
Austria [5]	8,410	12,287	11,445	13,113	13,294	12,673
Belgium [5]	59,903	80,271	87,640	84,162	79,208	89,807
Bulgaria	----------	----------	----------	3,000	3,300	3,750
Czechoslovakia [3]	4,400	6,600	6,600	6,600	6,600	6,600
France	48,092	53,970	56,811	60,390	67,704	73,414
Germany:						
East [3]	60,146	18,500	19,800	24,200	33,000	33,000
West		83,845	102,164	118,801	121,504	118,593
Greece	1,710	4,288	2,712	2,600	[3] 3,200	2,900
Hungary	[3] 45	(6)	(6)	(6)	(6)	(6)
Italy	27,011	40,212	37,810	41,881	41,150	46,086
Netherlands [3]	2,480	2,900	1,600	1,100	4,000	4,600
Poland	16,843	20,000	22,000	23,500	24,000	24,300
Portugal	377	798	1,174	973	1,109	1,070
Rumania [3]	5,800	9,900	10,500	11,000	11,600	12,200
Spain	36,515	49,285	51,305	56,492	64,617	67,501
Sweden	11,931	10,259	12,555	17,806	22,147	23,395
U. S. S. R. [3]	85,450	141,500	170,000	202,000	228,500	255,000
United Kingdom [5]	2,840	4,583	5,295	7,446	7,708	6,798
Yugoslavia	52,078	66,214	74,053	78,039	73,556	83,348
Total [3]	424,000	605,500	673,500	753,200	806,300	865,100

See footnotes at end of table.

TABLE 22.—World smelter production of lead, by countries where smelted, 1946–50 (average) and 1951–55 in short tons [1] [2]—Continued

Country	1946–50 (average)	1951	1952	1953	1954	1955
Asia:						
Burma	1,722	5,474	2,949	9,641	12,722	15,568
China [3] [5]	1,650	5,500	6,600	10,000	16,500	19,300
India	446	962	1,268	1,897	2,005	2,502
Iran [7]			550	500	1,000	[3] 1,000
Japan	7,704	11,839	16,707	19,537	28,916	31,918
Korea:						
North	[3] 3,860			[3] 2,200	(6)	(6)
Republic of	210	(6)	139	55	[3] 30	
Total [3]	15,600	24,100	28,200	43,800	66,700	79,100
Africa:						
French Morocco	4,848	24,606	33,166	30,240	29,418	29,432
Rhodesia and Nyasaland, Federation of: Northern Rhodesia	14,456	15,646	14,112	12,890	16,800	17,975
South-West Africa	32					
Tunisia	17,280	25,250	28,116	30,071	29,972	30,123
Total	36,616	65,502	75,394	73,201	76,190	77,530
Australia: Refined lead	171,157	185,649	175,436	193,164	224,459	210,007
Lead content of lead bullion	31,703	35,697	42,234	38,137	42,723	41,879
Total	202,860	221,346	217,670	231,301	267,182	251,886
World Total (estimate)	1,550,000	1,810,000	1,990,000	2,060,000	2,190,000	2,220,000

[1] 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.
[2] This table incorporates a number of revisions of data published in previous lead chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Figures cover lead refined from domestic and foreign ores; refined lead produced from foreign base bullion not included.
[5] Includes scrap but excludes refined lead produced from foreign base bullion.
[6] Data not available; estimate by senior author of chapter included in total.
[7] Year ended March 21 of year following that stated.

NORTH AMERICA

Canada.—Although the mine output of lead in Canada decreased 8 percent from 1954 to 201,600 short tons, it was larger than in any of the years from 1944 through 1953. The output of refined lead, all produced at the Trail, British Columbia, smelter of The Consolidated Mining & Smelting Co. of Canada, Ltd., declined 10 percent to 150,000 tons.

According to a report [23] published by the Canada Department of Mines and Technical Surveys, the mine production of lead (preliminary figures), by Provinces, in 1955 was: British Columbia, 153,400 short tons; Newfoundland, 17,500 tons; Yukon, 12,900 tons; Quebec, 5,300 tons; Ontario, 2,100 tons; Nova Scotia, 2,000 tons; and New Brunswick, 800 tons. Exports of lead contained in concentrate amounted to 58,200 short tons and of refined lead (including scrap) 92,800 tons. Consumption of refined lead (primary and secondary) totaled 66,200 tons.

The largest lead producing mine, which was also the largest zinc producer, was the Sullivan, at Kimberley, British Columbia, owned and operated by the Consolidated Mining & Smelting Co. of Canada,

[23] Neelands, R. E., Lead in Canada, 1955 (Preliminary): Canada Dept. of Mines and Tech Surveys Ottawa, 1956, 7 pp.

Ltd. Sullivan ore milled in 1955 at the company 11,000-ton concentrator at Kimberley totaled 2,836,600 tons.[24] In addition, 52,000 tons of custom ore was milled. At other lead-zinc mines operated by the company, comprising the H. B. mine near Salmo, the Bluebell at Riondell, and the Tulsequah (zinc-copper-lead) on the Northwest coast, 685,800 tons of ore was milled.

Other lead-producing mines in British Columbia were operated by the Giant Mascot Mines, Ltd., near Spillimacheen; Canadian Exploration, Ltd., near Salmo; Reeves MacDonald Mines, Ltd., near Nelway; Sheep Creek Mines, Ltd., Lake Windermere district; Yale Lead & Zinc Mines, Ltd., at Ainsworth; Violamac Mines, Ltd., near Sandon; Sunshine Lardeau Mines Ltd., near Camborne; and Silver Standard Mines, Ltd., near Hazelton.

Buchans Mining Co., Ltd., operating its mine 5 miles north of Red Indian Lake in the interior of Newfoundland, was the second largest producer of lead concentrate in Canada. The company mill has a capacity of 1,300 tons daily and produces zinc and copper concentrates, in addition to lead concentrate. Owing to a 5-week strike, the output declined moderately from 1954.

In Yukon the principal lead producer, the United Keno Hill Mines, Ltd., operated its Hector and Calumet mines in the Mayo district. Mackeno Mines, Ltd., carried on development and produced ore intermittently during the year. Prospectors Airways Co., Ltd., did exploratory drilling on zinc-lead sulfide deposits near the Pelly River northwest of the Canol Road.

Producers of lead concentrate in Quebec included New Calumet Mines, Ltd., on Calumet Island; Golden Manitou Mines, Ltd., Abitibi East County; and Anacon Lead Mines, Ltd., Portneuf County (which suspended operations in July because of exhaustion of developed ore).

In Ontario, Jardun Mines, Ltd., northeast of Sault St. Marie, produced both lead and zinc concentrates. Exploration was continued at the zinc-lead-copper properties of Consolidated Sudbury Basin Mines, Ltd., northwest of Sudbury. In Nova Scotia Mindamar Metals Corp., Ltd., at Stirling, Cape Breton Island, produced lead-copper concentrate and zinc concentrate.

The Brunswick Mining & Smelting Corp., Ltd., New Brunswick, spent about $1,575,000 on exploration, development, and research in connection with bringing into production its recently discovered lead-zinc properties in the Bathurst area.[25] The pilot mill was placed in operation in February 1955 and shut down June 1 because of unsatisfactory results; an extensive research program was initiated with the assistance of Battelle Memorial Institute. Procedures were being developed that will be tested in the pilot mill in 1956. Keymet Mines, Ltd., operated its mine and 200-ton mill near Bathurst, producing lead and zinc concentrates. Heath Steele Mines, Ltd., subsidiary of American Metal Co., worked on developing its lead-zinc-copper-silver property near Newcastle. New Larder "U" Island Mines, Ltd., nearly completed sinking a 1,500-foot shaft on its zinc-lead property south of Bathurst.

[24] Consolidated Mining & Smelting Co. of Canada, Ltd., Annual Report, 50th Anniversary, for the Year Ending Dec. 31, 1955, 24 pp.
[25] St. Joseph Lead Co., Ninety-Second Annual Report to the Stockholders: 1955, 19 pp.

Greenland.—Nordic Mining Co., Ltd., continued to develop and equip the Mestersvig lead-zinc mine in East Greenland. The mill and auxiliary facilities were installed underground in excavations cut out in rock near the ore body. The mill was expected to produce about 11,000 short tons of lead concentrate and 8,800 tons of zinc concentrate annually after capacity operations are reached. The first shipments of concentrate were scheduled for 1956. Because of ice conditions, navigation is usually possible into Mestersvig only 4 or 5 weeks a year, during the August–September season. The cost of developing and equipping the mine (which was discovered in the summer of 1948) has been $4.1 million.[26]

Guatemala.—It was reported [27] that the Compañía Minera de Huehuetenango was installing a lead and zinc mill representing an investment of $1 million at its mine near the city of Huehuetenango, the Export-Import Bank (United States) was participating in the enterprise.

Mexico.—Mine production of lead in Mexico was 232,400 short tons (lead content of ore and concentrate) in 1955, a 3-percent decline from 1954. The lower lead output in the face of a 20-percent increase in zinc production was due to decreasing lead content of zinc-lead ores mined.

A new Law of Taxes and Promotion of Mining was published December 31, 1955. The translation[27a] reveals that several provisions of the law affected lead and zinc mining. Patented mineral concessions for exploiting metallic minerals are taxed $15.00 annually per claim or fraction, independently of their number. Annual production taxes on the first 5 years' output from new minerals exploitations or those that have not been worked for 10 years or more are reduced. Under certain conditions some ores, metals, and metallic compounds are exempted from production taxes; the exemptions include ores of gold, silver, copper, lead, and zinc when the assays are less than 1 gram per metric ton of gold and 50 grams of silver, 1 percent of copper, 3 percent of lead, and 10 percent of zinc. Provision is made for individual tax agreements between mine operators and the Ministry of Finance for stimulation of mining under certain circumstances. The system of tax subsidy to small and medium-size mining operations was extended. Production taxes varied according to the mineral and form of production and ranged as high as 12.6 percent ad valorem. The new law did not alter export taxes; the basic export tax continued to be 25 percent ad valorem on most minerals plus additional ad valorem taxes, which brought the total export tax on most minerals to an average of 28 percent or more in some instances.

Tariff changes affecting export duties on Mexican fabricated-lead products were published in the Diario Oficial on January 5, 1955. These changes, authorized by Presidential decree, provided for a 25-percent ad valorem export duty on the following items: Fraction 81–23, alloying of lead with antimony, even when the alloys have other metals, commercially known as antifriction metals for linotypes, and printing types of other uses; fraction 81–41, solders of

---

[26] Engineering and Mining Journal, Mestersvig Begins Mining: Vol. 157, No. 2, February 1956, p. 166.
[27] Engineering and Mining Journal, vol. 156, No. 9, September 1955, p. 202.
[27a] Bureau of Mines, Mineral Trade Notes: Spec. Suppl. 48, vol. 42, No. 1, January 1956, 21 pp.

tin and lead, when they contain up to 67 percent tin; and fraction 81–42, solders of tin and lead, unspecified.

During the year, revision of the collective labor contracts of most companies resulted in wage increases estimated at 12 percent plus various fringe benefits. Because of labor laws and regulations, mine and smelter operators are not at liberty to reduce their labor force during the periods of weak market prices; therefore, they hesitate to increase their labor force during periods of high prices. Mines were generally utilizing their higher grade ores.

Mines of the American Smelting & Refining Co. producing lead and zinc in Mexico in 1955 were the Charcas unit at Charcas, San Luis Potosi; Nuestra Senora at Cosala, Sinaloa; Parral at Parral, Santa Barbara; Sta. Barbara, and Santa Eulalia at Sta. Eulalia, Chihuahua; and Taxco, at Taxco, Guerrero. Mines leased or owned in part and managed by American Smelting were the Aurora-Xichu unit at Xichu, Guanajuato; Cia. Metalurgica Mexicana mines; Montezuma Lead Co. mines at Santa Barbara; and Plomosas at Pichachos, Chihuahua.

American Smelting & Refining Co. operated smelters at Chihuahua (lead smelting and zinc fuming); Monterrey (lead refining); San Luis Potosi (copper smelting and converting, arsenic refining, lead smelting); and Rosita, Coahuila (zinc-retort smelting).

The American Metal Co., Ltd., subsidiaries and units producing lead or lead and zinc ores or concentrates were the Cia. Minera de Penoles, S. A., Avalos unit, State of Zacatecas; Ocampo unit, Boquillas, State of Coahuila; Calabaza unit, Etzatlan, State of Jalisco; Topia unit, Topia, State of Durango; and Guadalupe unit, Villaldama, State of Nuevo León. Operating smelting and refining units were Cia. Metalurgica Penoles, S. A., lead smelter at Torreon, State of Coahuila; and the Monterrey (State of Nuevo León) lead refinery. Refined-lead production from this refinery during 1955 was 82,400 short tons [28] and represented 37 percent of the total Mexican refined production. The smelter receives ores and concentrates from a number of sources: From the mining operations of Compania Minera de Penoles, S. A., subsidiary of American Metal Co.; from a large number of custom shippers throughout Mexico; and from the operations of San Francisco Mines of Mexico, Ltd. (in which the American Metal Co. has an interest), at San Francisco del Oro, Chihuahua.

The San Francisco mill had a daily capacity of 2,200 short tons; it produced 89,200 short tons of zinc concentrate, 62,800 tons of lead concentrate, and 8,000 tons of copper concentrate for the year ended September 30, 1955.[29]

El Potosi Mining Co. (subsidiary of Howe Sound Co.) a large producer of lead and zinc concentrates, continued to operate its El Potosi mine at Chihuahua and El Carmen at Batophilas, both in the State of Chihuahua. At the El Carmen mine development and exploration work was successful, and ore reserves increased moderately. At the El Potosi the ore-reserve situation remained unchanged because enough ore was developed during the year to offset extraction.[30]

The Fresnillo Co. continued operations at its Fresnillo mine and

[28] American Metal Co., Annual Report for 1955: 52 pp.
[29] Metal Bulletin (London), Zinc: Nov. 8, 1955, No. 4042, p. 27.
[30] Howe Sound Co., Annual Report: 1955, 15 pp.

mill at Zacatecas and its Naica mine and mill, State of Chihuahua, producing zinc, lead, and copper concentrates at each mill.

Minas de Iquala, S. A., subsidiary of Eagle-Picher Co., operated its zinc-lead-copper mine at Parral, State of Chihuahua. Mill-operating schedules continued to be geared to a run-of-mine ore output of 28,500 short tons per month.

SOUTH AMERICA

Argentina.—As in other years, almost the entire 1955 Argentina lead and zinc output came from the Aguilar mine of Compania Minera Aguilar, S. A., subsidiary of the St. Joseph Lead Co. According to the annual report of the St. Joseph Lead Co., the mine produced 30,800 short tons of lead concentrate and 46,500 tons of zinc concentrate in 1955 compared with 24,900 and 39,900 tons, respectively, in 1954. The excellent progress in improving production facilities at Aguilar was due to the granting of foreign exchange for purchasing new equipment.

National Lead Co. reported [31] that development of its lead-zinc-silver mining property, Mina Castano in San Juan Province, was progressing satisfactorily and that the new mill will be producing by mid-1956. Lead concentrate will be sent to the company smelter at Puerto Villelas, which ships pig lead to the metal-fabricating plant in Buenos Aires.

Bolivia.—Continued low rates of mineral production and inadequate investment and exploration characterized the Bolivian mining industry during 1954 and 1955. Mine production of lead (21,100 short tons) was 5 percent more than in 1954 but 37 percent less than in 1951, the last full year before the nationalization of 24 producing tin, tungsten, copper, lead, and zinc mines in 1952. Neither the nationalized mines nor the medium and small privately owned mines have benefited from much new investment in recent years. Labor output has declined.

In late 1955 a decision was made to invite bids from foreign firms to exploit the lead-zinc deposits at the nationalized Mathilde mine. A study evaluating all factors and recommending measures to improve production was undertaken by a United States consulting firm (Ford, Bacon & Davis) with funds provided by the International Cooperation Administration at the request of the Bolivian Government.

Brazil.—The total mine output of lead in 1955 was 4,400 short tons compared with 3,200 tons in 1954. Several small mines in the State of São Paulo and the mine of Plumbum, S. A., in the State of Paraná (Municipality of Mocaiuva) produced lead. The small lead-smelting plant, Usina Experimental de Apiai, in the State of São Paulo has been producing during the past 4 years but was recently shut down by the governor of the State as unprofitable.

Chile.—Lead ores and concentrates produced in Chile totaled about 5,000 short tons averaging 75 percent lead. Most of the concentrate was produced by Compañía Minera Aysen and exported.

Peru.—Mine production of lead in Peru increased 8 percent over 1954 to 130,900 short tons in 1955. The Cerro de Pasco Corp., largest individual producer of lead in Peru, continued to operate a lead smelter and refinery, copper smelter and refinery, and electro-

[31] National Lead Co., 64th Annual Report, 1955, 35 pp.

lytic zinc refinery at La Oroya and its several copper-silver and copper-lead-zinc-silver mines and mills in the Departments of Pasco, Junín, and Lima. The company output of refined lead [32] (comprising 29,900 short tons from company and leased mines and 35,300 tons from purchased ores) totaled 65,200 tons compared with 63,500 tons in 1954.

Operating mills of the Mining Bank of Peru increased from 4 to 5 on October 23, 1955, when the new 70-ton concentrator at Huarochiri, Department of Lima, began producing.[33] The mill, in an area with many small mines, has a capacity that can be increased to 150 tons daily. Other Mining Bank mills are at La Virreyna, Province of Castrovirreyna; Huachocolpa, Department of Huancavelica; Sacracancha, near Morococha; and Hualgayoc, Department of Cajamarca.

The American Smelting & Refining Co. continued to operate the Chilete mine, at Chilete, which produces silver, lead, and zinc.

EUROPE

Austria.—The only producer of primary lead in Austria in 1955 was Bleiberger Bergwerks Union, a nationalized company operating lead-zinc mines at Bleiberg-Kreuth and a lead smelter and an electrolytic zinc plant at Gailitz, all in the Province of Carinthia. The company output of lead-zinc ores was 194,600 short tons, of which 56,500 tons was reclaimed from dumps. The flotation plant produced 7,300 short tons of lead concentrate (containing 5,300 tons of extractable metal) and 11,800 short tons of zinc concentrate (containing 5,800 tons of metal). The lead smelter has a capacity of 12,000 to 13,000 short tons of pig lead annually. Lead concentrate of Italian origin is also handled; in 1955, 5,800 short tons of Italian concentrate was shipped to the smelter from Raibl, Italy, a mine near the Austrian border. Between 3,300 and 4,400 short tons of secondary lead metal was produced from remelted scrap. The total smelter output of lead from all sources in 1955 was 12,700 short tons.

Finland.—Production of lead concentrate in Finland was 1,500 short tons in 1955 compared with 500 tons in 1954; the output came from the mines of the Outokumpu Co., which chiefly produced zinc.

France.—Production of lead contained in concentrate by mines in France totaled about 9,900 short tons in 1955 against 12,100 tons in 1954. The principal producers were the La Loubatière mine at Carcasonne (Aude), La Plagne at Aime (Savoie), Les Malines at St. Laurent-de-Minièr (Gard). Smelters in France produced 73,400 short tons of pig lead, most of which was derived from treatment of concentrate received from French Africa and foreign countries. Imports of pig lead amounted to 48,200 short tons, mostly from French Africa, and imports of scrap tataled 14,100 tons. Exports of pig lead were 15,100 tons.

Germany, West.—Consumption of lead in West Germany increased 13 percent in 1955, but domestic mine production remained at virtually the same level as in 1954. Technical difficulties, shortage of outside capital, and tax laws hampered efforts to increase mine output. Although no large lead-zinc mines were shut down during the year, most of them were marginal operations. There was a drop in production when prices declined in June, followed by a gradual increase as prices

[32] Cerro de Pasco Corp., 1955 Annual Report. 24 pp.
[33] Engineering and Mining Journal, vol. 156, No. 12, December 1955, p. 166.

improved later in the year. The total mine output of lead was 74,300 short tons against 74,200 tons in 1954. The major lead-producing mines were in the Harz Mountains and the Rhineland. Published articles described operations at the Bad Grund,[34] Ramsbeck,[35] and Rammelsberg[36] mines and mills. Smelter production of primary lead was 118,600 short tons, a little less than in 1954. Secondary lead produced from scrap totaled 43,900 tons. Imports of lead ore decreased from 90,300 short tons in 1954 to 81,200 tons in 1955. The ore, almost entirely in the form of concentrates, included small quantities from more than 18 countries. Imports of foreign metal, including scrap, increased from 65,500 short tons to 93,100. Domestic consumption rose from 206,700 short tons to 233,700.

Ireland.—Lead production in Ireland in 1955 was reported at 1,300 short tons or 200 tons less than in 1954. The producing companies included Abbeytown Mining Co. in County Sligo; Silvermines Lead & Zinc Co. Ltd. (operating the reopened Shalle mine in County Tipperary); and Wicklow Mining Co. in County Wicklow.

Italy.—The mine output of lead in Italy was 56,100 short tons in 1955, an 18-percent increase over 1954. The bulk of the production continued to come from mines in the southwestern part of the island of Sardinia; but the Raibl mine, on the mainland near the Austrian border north of Trieste, was a substantial producer of lead concentrate. Among the principal companies producing on Sardinia were Montevecchio Societa Italiana del Piombo e dello Zinco and Societa di Monteponi, each of which operated lead-zinc mines, mills, a lead smelter and an electrolytic zinc plant. On the mainland, Societa Minera & Metallurgica di Pertusola operated a lead smelter at La Spezia. Smelter output of lead in Italy was 46,100 short tons in 1955, compared with 41,100 tons in 1954.

Spain.—Production of lead contained in ore (69,000 short tons) increased 13 percent over 1954, and that of pig lead (67,500 short tons) rose 4 percent. Active lead mines were in the districts of Jaen, Murcia, Santander, Badajoz, and some others. The Penarroya smelter of the Sociedad Minera y Metalurgica de Penarroya was the leading producer of pig lead in Spain. Other companies operating smelters were Real Compania Asturiana de Minas, Compania "La Cruz," Compania Minero-Metalurgica "Los Guindos," Minera Industrial Pirenaica, S. A., Minas del Priorato, S. A., and Industries Reunidas Minero-Metalurgica, S. A.

Sweden.—Mines in Sweden produced 48,400 short tons of lead concentrate in 1955, of which 14,300 tons was exported.[37] There were 2 lead smelters in Sweden; the largest, operated by Bolidens Gruv, a.-b., is at Ronnskar, and the other, operated by Svenska Ackumulator, a.-b., Jungner, is at Fliseryd. The output of pig lead was 23,400 short tons, a small increase over 1954.

U. S. S. R.—Official data on lead production in the U. S. S. R. and other closely associated countries were not available for 1955, but estimates are included in table 21. Available information indi-

[34] Mining Magazine (London), A Lead-Zinc Concentrator in Harz Mountains: Vol. 93, No. 5, November 1955, p. 273–278.

[35] Mining Journal (London), The Lead-Zinc Concentrator at Ramsbeck, Western Germany: Vol. 245, No. 6264, Sept. 9, 1955, p. 289.

[36] Mining Journal (London), The Ore-Treatment Plants at Rammelsberg and Bollrich, Western Germany: Vol. 245, No. 6258, July 29, 1955, pp. 128–129.

[37] Mining World, vol. 18, No. 5, Apr. 16, 1956, p. 124.

cates that the U. S. S. R. has made large gains in production in recent years and in 1955 ranked second among the countries of the world in smelter production of lead. Poland and Rumania also produced substantial quantities of lead.

Some information was published on ore-dressing plants in Hungary.[38] The ore-dressing plant at Gyöngyösoroszi, opened September 3, 1955, will save considerable foreign currency by reducing the importation of lead and zinc into the country. Construction of the plant was begun in 1952. Ore is hauled by diesel locomotive over a pull distance of about 2.1 miles. The Gyöngyösoroszi plant cost £2,100,000. The plant consists of the office building, a flotation plant and mills.

United Kingdom.[39]—The lead content of concentrate made from ores mined in the United Kingdom in 1955 was 6,800 short tons. The producing mines included the Greenside at Westmoreland and the Weardale Lead Co. mine at Weardale in northern England and the Halkyn District United Mines in North Wales.

The smelter output of soft lead refined from secondary and scrap material and from domestic ores totaled 92,800 short tons, or 900 tons more than in 1954. Imports of lead bullion and pig lead (mostly from Australia and Canada) amounted to 243,800 short tons, an increase of 11 percent over 1954. The total of exports and reexports of pig lead decreased 58 percent to 5,400 tons.

Consumption of lead in the United Kingdom increased to 415,300 short tons in 1955, or 10 percent more than in 1954. Total stocks of refined lead (excluding Government stocks but including base bullion awaiting refining) were 45,900 tons at the end of 1955 against 34,900 tons at the end of 1954.

Yugoslavia.—Refined lead produced from ores mined in Yugoslavia totaled 83,300 short tons in 1955, a 13-percent gain over 1954. Some 1,800,000 tons of lead-zinc ore was mined in the country during the year. The Trepca group of mines in Serbia was the largest lead producer in Europe and was also one of the major zinc producers. The group is in the southernmost corner of the Kopaonik Mountain Range near Kosovska Mitrovica. Important byproducts recovered from the ore include silver, bismuth, and iron pyrites. Other lead-zinc mines and mills were operating, mostly in Serbia, Macedonia, Slovenia, and Montenegro. Several Trepca reduction plants, including a flotation mill, smelters and refinery, are at Zvecan, a few miles north of Kosovska Mitrovica. These plants, besides handling ore from the Trepca mines, are a central collection point for further treatment and processing of ores of other lead-zinc mines in Serbia and Macedonia. The Zvecan refinery has a rated annual capacity of 66,000 short tons of refined lead. Another smelting and refining plant at Mezica in Slovenia has an annual capacity of 16,500 short tons of refined lead.

ASIA

Burma.—The Burma Corp., Ltd., continued to operate the Baldwin silver-lead-zinc mine in the Shan States of northern Burma. Production of ore during the year ended June 30, 1955, was 114,000 short

[38] Mining Journal (London), Ore-Dressing Plants in Hungary: Vol. 245, No. 6275, Nov. 25, 1955, p. 614.
[39] Statistical data compiled from Monthly Bulletins of The British Bureau of Non-Ferrous Metal Statistics.

tons, which was treated in the company mill and smelting and refining works at Namtu, 13 miles from the mine. The ore treated yielded 12,900 short tons of refined lead, 1,036,813 fine ounces of silver, 300 tons of copper matte, 600 tons of nickel speiss, 400 tons of antimonial lead, and 14,600 tons of zinc concentrate. Most of the lead produced was exported to India.

India.—The Metal Corp. of India, Ltd., worked lead and zinc mines at Zawar in Rajasthan and operated a lead smelter at Tundoo. Data on mine production of lead in India in 1955 are not available. The Tundoo smelter [40] produced 2,000 short tons of refined lead in 1954 and 2,100 tons in 1955.

Japan.—Most of the mine output of lead in Japan comes from ore that contains about 1 part lead to 5 parts zinc. The leading producer of both lead and zinc was the Kamioaka mine of Mitsui Metal Mining Co., Ltd. The total Japanese production of lead concentrate was 45,700 short tons averaging 62.6 percent lead. Primary smelter production of lead was 32,000 short tons (28,900 tons in 1954) and that of secondary lead 48,400 short tons. Imports of lead concentrate totaled 30,400 tons, mostly from Australia, Peru, and Bolivia. About 4,400 tons of lead metal was exported, and approximately the same tonnage was imported.

AFRICA

Algeria.—Production of lead concentrate in Algeria, at 16,300 short tons in 1955, was nearly the same as in 1954. The larger producers included the Mines de Sidi Kambar, Compagnie des Mines d'Ouasta de Mesloula, Société Algerienne du Zinc, and Société Minière and Métallurgique de Penarroya.

Federation of Rhodesia and Nyasaland.—Rhodesia Broken Hill Development Co., Ltd., at New Broken Hill, continued to operate its mine, mill, lead smelter, and electrolytic zinc plant in 1955, and during the year began operating a new lead refinery equipped to produce high-purity lead. Operations of the refinery were described.[41] The output of refined lead totaled 18,000 short tons and that of zinc 31,200 short tons. This was the largest annual production in the history of the mine.

French Equatorial Africa.—Compagnie Minière du Congo Français, operating the M'Fouati mine and mill, produced 7,200 short tons of lead concentrate in 1955, a slight decline from 1954.[42]

French Morocco.—The production of lead concentrate in French Morocco totaled 134,600 short tons in 1955 compared with 126,100 tons in 1954. The concentrate averaged 72 to 73 percent lead. Exports of lead concentrate totaled 104,900 short tons, of which 104,600 tons went to France and 300 tons to other countries. In addition to lead concentrate, the mines produced 86,000 short tons of zinc concentrate. Most of the output came from the Oudja area in eastern Morocco on the Algerian border. The principal producing companies included the Société des Mines de Zellidja (Bou Beker mines), Société des Mines d'Aouli (Aouli and Mibladen), Compagnie Royale Asturienne des Mines (Touissit mine), Société Minière de

[40] Work cited in footnote 13.
[41] Mining Journal (London), The Desilverization of Lead in Northern Rhodesia: Vol. 244, No. 6253, June 24, 1955, p. 719.
[42] Mining World, vol. 18, No. 5, Apr. 16, 1956, p. 128.

Haut-Guier, Société des Mines de l'Atlas Marocain, and Société des Mines de Ksiba.

It was reported[43] that the new lead district in central Morocco was making steady progress. The deposits of Djebel Aouam, Djebel Khetem, and Tisili N'Roumi produced 5,000 short tons of lead concentrate in 1955 compared with 2,500 tons in 1954.

The Zellidja-Penarroya lead smelter at Oued-El-Heimer treated 45,700 short tons of concentrates yielding 29,400 tons of refined lead, virtually the same as in 1954. Pig lead exported totaled 27,900 short tons, of which France received 17,600 tons, United States 7,800 tons, and Algeria 2,500 tons.

Nigeria.—Official data for 1955 are not available on activity in developing the lead-zinc ore reserves in the Ameri and Nyeba areas; press reports indicated that some development work was done by Nigerian Lead-Zinc Mining Co., Ltd., at the Ameri property.

South-West Africa.—The Tsumeb mine of Tsumeb Corp., Ltd., was the leading producer of lead in Africa in 1955 and also produced copper, zinc, silver, cadmium, and germanium. All the production was in the form of concentrates, which were exported to Belgium and the United States for smelting. Ore milled, totaling 595,000 short tons, yielded 136,900 tons of lead-copper concentrate and 37,300 tons of high-grade and 5,500 tons of low-grade zinc concentrates. Concentrates sold totaled 189,700 short tons containing 83,700 short tons of lead, 23,600 tons of copper, 23,200 tons of zinc, 1,279,200 ounces of silver, 701 tons of cadmium, and 5 tons of germanium.

The Southwest Africa Co. at Abenab continued to produce lead-vanadium ore from its mine; the output of lead-vanadium concentrates declined 32 percent from 1954.

Tanganyika.—The output of lead concentrate in Tanganyika (all from the Mpanda lead-copper mine of Uruwira Minerals, Ltd.) was 9,700 short tons in 1955[44] compared with 5,200 tons in 1954. During the year the company completed construction of the new 1,200-ton-per-day lead-copper heavy medium separation and flotation plant at Mukwamba. The construction was financed mainly through a United States Government loan of $1,640,000, to be repaid by delivery of metals.

Tunisia.—Lead contained in concentrate produced in Tunisia in 1955 was 29,300 short tons, a very slight increase over 1954. The following mines, in order of rank in production, contributed 88 percent of the total output of lead concentrate in 1955: Djebel Semene, El-Grefa, Sidi-Bou-Aouane, Djebel Hallouf, Rassas-Touireuf, Djebel-Rassas, Sidi Amor, Sakiet-Sidi-Youssef, El-Akhouat, Oued Naden. The El Akhouat and Sakiet-Sidi-Youssef also produced zinc concentrates.

Lead bullion produced by smelters in Tunisia totaled 30,100 short tons, nearly the same as in 1954. The Megrine smelter produced 26,500 tons, the Djebel-Hallouf smelter 3,400 tons, and the Bizerte smelter 200 tons. Nearly all of this lead was exported to France.

---

[43] Mining World (Directory Number) vol. 18, No. 5, Apr. 16, 1956, p. 129.
[44] Mining World, vol. 18, No. 5, April 16, 1956, p .135.

OCEANIA

Australia.—Mine production of lead in Australia increased in 1955 for the sixth consecutive year. The record output of 328,200 short tons, although only 3 percent above that in 1954, was 37 percent more than in 1949. The large producing districts were Broken Hill and Captain's Flat in New South Wales, Cloncurry (Mount Isa field) in Queensland, and Read-Rosebery in Tasmania. Besides lead, the mines produced zinc and silver, and some of them yielded important quantities of copper. Smelters at Port Pirie in South Australia and Mount Isa in North Queensland treated most of the output of lead concentrate, but a considerable tonnage was exported for smelting in Belgium, United Kingdom, United States, and other countries. Consumption of lead amounted to about one-sixth of Australia's total mine production, leaving some five-sixths available for export.

All four large producing mines or groups of mines in the Broken Hill district were equipped with mills. Output from the properties of New Broken Hill Consolidated, Ltd., in 1955 [45] was 595,200 short tons of ore, with an average grade of 8.9 percent lead, 13.8 percent zinc, and 2 ounces of silver per ton. During the year, 383,600 short tons of ore was treated in the company mill and 210,100 in the Zinc Corp. mill. Ore reserves at the end of the year were 3.4 million short tons compared with 3.1 million tons a year earlier. The mines of Zinc Corp., Ltd., produced [46] 731,000 short tons of ore yielding 93,500 tons of lead, 131,000 tons of zinc concentrate, and 1,833,000 ounces of silver. Broken Hill South, Ltd., and Barrier Central Mines together produced 379,300 short tons of ore yielding 59,400 tons of lead concentrate averaging 71.7 percent lead and 39.08 ounces of silver per ton and 72,100 tons of zinc concentrate averaging 50.2 percent zinc during the fiscal year ended June 30, 1955. North Broken Hill, Ltd., was also a large producer of lead, zinc, and silver.

In the Captain Flats district, output by the Lake George Mines (Pty), Ltd., in its fiscal year ended June 30, 1955 was much lower than in its 1954 fiscal year, as operations were suspended from June 25, 1954 to February 1, 1955, owing to a labor dispute. Production in its fiscal year 1955 was 61,400 short tons of ore, which was treated in the mill and yielded 4,800 dry tons of lead concentrate, 9,500 tons of zinc concentrate, and 1,600 tons of copper concentrate.[47]

Mount Isa Mines, Ltd., continued to operate its mine, mill, and lead and copper smelters in the Cloncurry district, North Queensland. According to the annual report of the American Smelting & Refining Co., major stockholder in Mount Isa Mines, Ltd., Mount Isa, during its fiscal year ended June 30, 1955, produced metals aggregating 3,648,000 ounces of silver, 53,400 short tons of lead, 23,400 tons of zinc and 28,000 tons of copper, which were extracted from a total of 1,560,700 tons of ores treated. The net profit amounted to A£3,307,300.

In the Read-Rosebery district of Tasmania, Electrolytic Zinc Co. of Australasia, Ltd., operated its Rosebery and Hercules mines and

[45] Metal Bulletin (London), No. 4100 June 8, 1956, p. 21.
[46] Mining World, vol. 18, No. 3, March 1956, p. 73.
[47] Metal Bulletin (London), No. 4059, Jan. 10, 1956, p.20

concentration mill. According to the company annual report (No. 55), ore milled during the fiscal year ended June 30, 1955, totaled 203,000 short tons assaying 18.15 percent zinc, 5.45 percent lead, 0.51 percent copper, and 6.40 ounces of silver, and 1.90 dwt. of gold to the ton. Mill output was 57,100 tons of zinc concentrate averaging 55.3 percent zinc, 9,100 tons of lead concentrate averaging 58.65 percent lead, and 7,500 tons of copper concentrate assaying 8.03 percent copper, 16.25 percent zinc, 38.60 percent lead, and 100.95 ounces of silver, and 28.50 dwt. of gold to the ton. The lead and copper concentrates were exported, and the zinc concentrate was shipped to the company Risdon electrolytic zinc plant.

Lead and Zinc Pigments and Zinc Salts

By O. M. Bishop[1] and Esther B. Miller[2]

THE HIGH LEVEL of construction and manufacturing throughout 1955 caused a 10-percent greater demand and somewhat higher prices for lead and zinc pigments and zinc salts in the United States than in 1954. Domestic shipments of red lead, litharge, lead-free zinc oxide, zinc chloride, and zinc sulfate in 1955 increased over corresponding shipments in 1954 by 8, 6, 20, 12, and 25 percent, respectively. White-lead shipments remained relatively constant, and leaded zinc oxide and lithopone decreased only slightly.

The larger shipments of pigments and zinc salts were directly related to expanded activity, particularly in industries consuming important quantities of these products. The production of passenger automobiles in 1955, at 7.9 million units, was 42 percent above 1954, and the production of trucks and buses rose 20 percent, to 1.2 million units. Similarly, shipments of automotive replacement batteries, at 25.4 million units, was 10 percent above 1954. Consumption of natural and synthetic rubber in automobile tires increased 26 percent to 1.5 million tons. The value of public and private construction rose 13 percent, and the value of sales of paints, varnish, and lacquer materials increased 15 percent in 1955.

Lead and zinc (metal, ore, and scrap), the chief raw materials of the pigments industry, were in plentiful supply throughout 1955, and the production of lead and zinc pigments was adequate to meet demands. Lead and zinc prices increased slightly but were fairly stable during 1955.

Lead-pigment price quotations trended upward following increased pig-lead prices. Zinc-pigment price quotations increased, in line with the increased price of slab zinc.

Dry white-lead shipments in 1955 increased 4 percent over those in 1954; the "in-oil" variety decreased 7 percent under 1954. Shipments of white lead essentially equaled those in 1954 but 67 percent below 1884, when records for this pigment were first kept. Lower shipments reflected increased competition from other white pigments, notably titanium dioxide, and reduction or elimination of white lead from paint formulations. Tonnages of red lead and litharge shipped in 1955 exceeded those in 1954 by 2,100 and 8,600 tons (8 and 6 percent), respectively.

---

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

457676—58——44

TABLE 1.—Salient statistics of the lead[1] and zinc pigments industry of the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Production (shipments)[2] of principal pigments:						
White lead (dry and in oil) short tons	49,772	35,415	26,663	26,217	25,571	25,575
Red lead do	31,863	35,352	30,926	31,333	27,163	29,272
Litharge do	150,867	154,753	140,798	154,518	139,877	148,511
Zinc oxide do	148,108	147,716	142,210	148,627	140,285	168,541
Leaded zinc oxide short tons	63,513	44,341	37,892	39,712	33,972	32,661
Lithopone do	127,209	102,837	61,832	52,439	44,011	42,845
Value of products:						
All lead pigments	$72,471,000	$89,273,000	$72,230,000	$64,303,000	$61,756,000	$69,133,000
All zinc pigments	57,621,400	74,599,000	63,950,000	56,475,000	50,438,000	58,031,000
Total	130,092,400	163,872,000	136,180,000	120,778,000	112,194,000	127,164,000
Value per ton received by producers:						
White lead (dry)	$296	$426	$403	$378	$383	$392
Red lead	313	397	376	312	323	342
Litharge	301	383	348	285	303	326
Zinc oxide	205	311	307	264	255	258
Leaded zinc oxide	216	320	313	259	258	259
Lithopone	106	141	137	132	135	140
Foreign trade:						
Lead pigments:						
Value of exports	$993,800	$984,000	$933,000	$799,000	$872,000	$976,000
Value of imports	256,600	1,797,000	451,000	16,000	149,000	195,000
Zinc pigments:						
Value of exports	4,048,800	6,855,000	4,352,000	1,468,000	1,351,000	1,073,000
Value of imports	274,800	930,000	90,000	287,000	515,000	773,000
Export balance	4,511,200	5,112,000	4,744,000	1,964,000	1,559,000	1,081,000

[1] Excludes basic lead sulfate, data for which are withheld to avoid disclosure of individual company confidential data.
[2] Reported as sales before 1945.

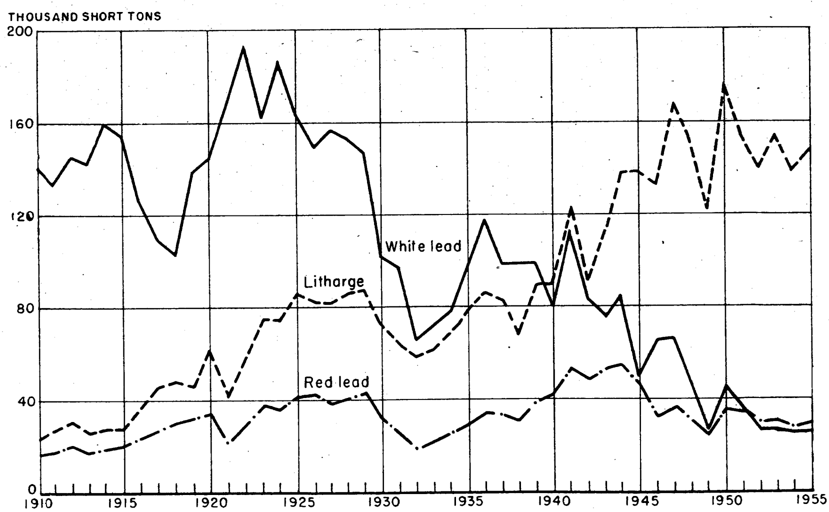

FIGURE 1.—Trends in shipments of lead pigments, 1910–55.

Lead-free zinc oxide shipments increased 20 percent as demand for rubber, paints, ceramics, and textiles increased. Shipments of leaded zinc oxide declined 4 percent. Lithopone shipments declined 3 percent, indicating decreasing use as a pigment.

The distribution of pigments to consumers in 1955 was essentially the same as in previous years. The paint industry, continuing as the principal user of white lead, leaded zinc oxide, and lithopone, received approximately 78, 99, and 71 percent, respectively, of the total shipments of these products. The paint industry was also the leading consumer of red lead, taking 49 percent of that shipped. Paint production consumed 20 percent of the zinc oxide (lead-free) and 4 percent of the litharge shipped. Storage-battery makers were the chief users of litharge and the second-ranking user of red lead, receiving 61 and 41 percent, respectively, of producers' shipments. The rubber industry continued to be the leading consumer of zinc oxide, using 51 percent of total shipments. Manufacture of rubber products also used small quantities of litharge and lithopone. The ceramics industry, ranking fourth in consumption of lead and zinc pigments in 1955, used 16 percent of all litharge shipments, 6 percent of lead-free zinc oxide shipments, 2 percent of red-lead shipments, and 2 percent of white-lead shipments.

Titanium pigments continued to furnish the chief competition to lead and zinc pigments in paintmaking. Production and shipments of titanium pigments, based on the titanium dioxide content, established new records, increasing about 10 and 15 percent, respectively, over the previous highs established in 1954. The use of titanium pigments has about doubled over the past 11 years, displacing lead and zinc pigments, especially white lead and lithopone, in many paint formulations.

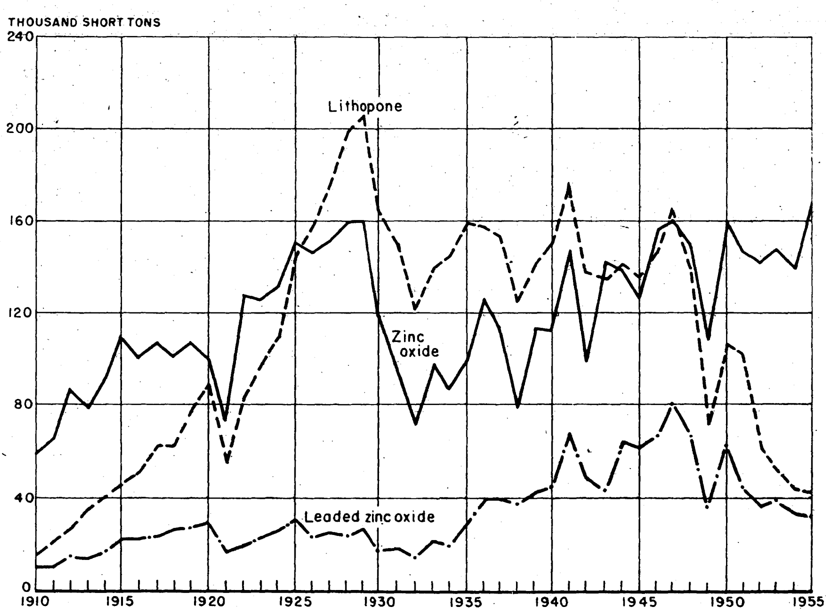

FIGURE 2.—Trends in shipments of zinc pigments, 1910–55.

PRODUCERS AND PLANTS

Lead- and zinc-pigments and zinc-salt manufacturers, their plants, and products were listed in the Minerals Yearbook, Volume 1, 1953. There were very few changes in 1954–55.

PRODUCTION

The value of shipments of lead and zinc pigments in 1955 (exclusive of that for basic lead sulfate and zinc sulfide, which cannot be shown) was $127 million, an increase of 13 percent above the 1954 value. Lead pigments comprised 54 percent of the total value and zinc pigments, 46 percent, compared with 55 and 45 percent, respectively, in 1954.

LEAD PIGMENTS

Combined shipments of the lead pigments increased 6 percent in quantity and 12 percent in value in 1955. The average value of white lead (dry) in 1955 was $392 per ton compared with $383 per ton in 1954; red lead averaged $342 per ton compared with $323 in 1954; litharge averaged $326 per ton compared with $303 per ton in 1954.

TABLE 2.—Production and shipments of lead pigments [1] in the United States, 1954–55

Pigment	1954				1955			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Short tons	Value [2]			Short tons	Value [2]	
			Total	Average			Total	Average
White lead:								
Dry	17,359	17,235	$6,598,680	$383	18,249	17,858	$7,005,318	$392
In oil [3]	8,479	8,336	3,990,053	479	7,861	7,717	3,638,660	472
Red lead	26,906	27,163	8,765,997	323	29,017	29,272	10,018,471	342
Litharge	140,084	139,877	42,401,256	303	148,345	148,511	48,470,892	326

[1] Except for basic lead sulfate and orange mineral, figures for which are withheld to avoid disclosure of individual company confidential data.
[2] At plant, exclusive of container.
[3] Weight of white lead only, but value of paste.

TABLE 3.—Lead pigments [1] shipped by manufacturers in the United States, 1946–50 (average) and 1951–55, in short tons

Year	White lead			Red lead	Orange mineral	Litharge
	Dry	In oil	Total			
1946–50 (average)	29,343	20,429	49,772	31,863	25	150,867
1951	23,359	12,056	35,415	35,352		154,753
1952	15,779	10,884	26,663	30,926		140,798
1953	16,784	9,433	26,217	31,333		154,518
1954	17,235	8,336	25,571	27,163	(2)	139,877
1955	17,858	7,717	25,575	29,272	(2)	148,511

[1] Excludes basic lead sulfate, and orange mineral, data for which are withheld to avoid disclosure of individual company confidential data.
[2] Bureau of Mines not at liberty to publish.

Battery makers produced 113,800 tons of black or gray suboxide of lead in 1955 for their own use in place of litharge. This quantity compares with 79,000 tons in 1954 and 82,000 tons in 1953. Lead suboxide production required 109,000 tons of pig lead in 1955, 76,000 tons in 1954, and 78,000 tons in 1953. Five additional plants producing suboxide of lead reported in 1955.

ZINC PIGMENTS AND SALTS

Total shipments of the principal zinc pigments increased 12 percent in quantity and 15 percent in value in 1955. Shipments of lead-free zinc oxide, the most important zinc pigment in tonnage and value, increased 20 percent. Shipments of leaded zinc oxide declined 4 percent, and shipments of lithopone decreased 3 percent.

Average values of zinc pigments, as reported by producers, about equaled the 1954 prices. The average price for zinc oxide (lead-free) in 1955 increased $3 per ton to $258; leaded zinc oxide rose $1 per ton to $259; lithopone advanced $5 per ton to $140.

Shipments of the zinc salts, zinc chloride, and zinc sulfate, increased 12 and 25 percent, respectively, in 1955. The average value of zinc chloride (50° B.) increased $2 per ton to $92; the average price received for zinc sulfate decreased 7 percent to $147 per ton.

TABLE 4.—Production and shipments of zinc pigments[1] and salts in the United States, 1954–55

Pigment or salt	1954				1955			
	Production (short tons)	Shipments			Production (short tons)	Shipments		
		Short tons	Value[2]			Short tons	Value[2]	
			Total	Average			Total	Average
Zinc oxide[3]	135,908	140,285	$35,742,797	$255	169,639	168,541	$43,561,776	$258
Leaded zinc oxide[3]	34,318	33,972	8,765,719	258	29,725	32,661	8,466,456	259
Lithopone	39,090	44,011	5,929,789	135	43,819	42,845	6,002,832	140
Zinc chloride, 50° B	52,241	48,252	4,357,178	90	54,877	54,161	4,957,869	92
Zinc sulfate	18,496	19,027	3,004,621	158	24,280	23,864	3,497,455	147

[1] Excludes zinc sulfide, data for which are withheld to avoid disclosure of individual company confidential data.
[2] Value at plant, exclusive of container.
[3] 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[1] and salts shipped by manufacturers in the United States, 1946–50 (average) and 1951–55, in short tons

Year	Zinc oxide	Leaded zinc oxide	Lithopone	Zinc chloride (50° B.)	Zinc sulfate
1946–50 (average)	148,108	63,513	127,209	62,262	22,394
1951	147,716	44,341	102,837	60,730	23,524
1952	142,210	37,892	61,832	51,966	19,587
1953	148,627	39,712	52,439	57,537	22,220
1954	140,285	33,972	44,011	48,252	19,027
1955	168,541	32,661	42,845	54,161	23,864

[1] Excludes zinc sulfide, data for which are withheld to avoid disclosure of individual company confidential data.

Zinc Oxide.—Lead-free zinc oxide shipments increased 20 percent from the 1954 total. The proportion of production by different processes, as given in table 6, showed little change.

TABLE 6.—Production of zinc oxide (lead-free) by processes, 1946–50 (average) and 1951–55, as percent of total

Process	1946–50 (average)	1951	1952	1953	1954	1955
American process (ore and primary residues)	73	75	74	74	68	69
French process (metal and scrap)	17	18	20	20	21	21
Other	10	7	6	6	11	10
Total	100	100	100	100	100	100

Leaded Zinc Oxide.—Shipments of leaded zinc oxide decreased 4 percent and were the smallest since 1935.

Four grades of leaded zinc oxide, classified according to lead content, were produced in the United States. The 5- to 35-percent grade constituted most of the output; smaller quantities were produced as less than 5-percent grade, over 35- to 50-percent grade, and over 50-percent grade. Outputs in 1955 (comparison with 1954 in parentheses) follow: 27,900 (30,300) tons of 35 percent lead and under and 1,900 (4,000) tons of over 35 percent lead.

Lithopone.—Shipments of lithopone dropped 3 percent from the 1954 total and were the lowest since 1914.

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 manufacturing titanated lithopone has decreased almost continuously since 1937, when 19,400 tons was used in making the titanated variety. The Bureau of Mines is not at liberty to divulge the 1954 or 1955 production of titanated lithopone or of regular lithopone used in its manufacture, but the tonnage of regular lithopone so consumed in 1953 was 60 percent below the quantity so used in 1952 and the smallest on record to that time.

TABLE 7.—Titanated lithopone produced in the United States and ordinary lithopone used in its manufacture, 1946–50 (average) and 1951–55, in short tons

Year	Titanated lithopone produced	Ordinary lithopone used	Year	Titanated lithopone produced	Ordinary lithopone used
1946–50 (average)	3,520	2,970	1953	360	300
1951	1,550	1,300	1954	(1)	(1)
1952	900	750	1955	(1)	(1)

[1] Figure withheld to avoid disclosure of individual company confidential data.

RAW MATERIALS USED

Kinds and quantities of raw materials used in making each pigment and salt in 1954 and 1955 are shown in tables 8 and 9.

White lead, red lead, litharge, and orange mineral were manufactured directly or indirectly from pig lead and contained 96 percent of all lead used in pigments. The lead content of leaded zinc oxide supplied the remaining 4 percent of the lead used in pigments. Basic lead sulfate and lead silicate are not reported except to the degree that basic lead sulfate may enter into leaded zinc oxide.

Zinc pigments and salts can be manufactured from a variety of materials, including ore, refined metal, and such secondary materials as scrap metal, residues, drosses, skimmings, and zinc ashes.

Zinc oxide was the only pigment for which considerable slab zinc was used. Zinc oxide, leaded zinc oxide, lithopone, zinc sulfate, and zinc sulfide were manufactured from ore. A large proportion of the zinc contained in lithopone and all that in zinc chloride produced in the United States was derived from secondary materials. The proportion of zinc oxide production derived from metal and scrap decreased to 32 percent in 1955, compared with 33 percent in 1954.

TABLE 8.—Lead content of lead and zinc pigments[1] produced by domestic manufacturers, by sources, 1954–55, in short tons

Pigment	1954				1955			
	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			20,670	20,670			20,888	20,888
Red lead			24,390	24,390			26,304	26,304
Litharge			131,016	131,016			133,511	133,511
Leaded zinc oxide	5,240	2,729		7,969	4,616	1,930		6,546
Total	5,240	2,729	176,076	184,045	4,616	1,930	180,703	187,249

[1] Excludes lead in basic lead sulfate and orange mineral, data for which are withheld to avoid disclosure of individual company confidental data.

TABLE 9.—Zinc content of zinc pigments[1] and salts produced by domestic manufacturers, by sources, 1954–55, in short tons

Pigment or salt	1954					1955				
	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	53,112	19,969	18,584	17,051	108,716	58,260	34,421	22,139	22,473	137,293
Leaded zinc oxide	11,207	6,553			17,760	10,822	4,892			15,714
Lithopone	3,061	2,883		1,593	7,537	(3)	(3)		(3)	[4] 16,839
Total pigments	67,380	29,405	18,584	18,644	134,013			22,139		169,846
Zinc chloride				12,271	12,271				12,871	12,871
Zinc sulfate	1,418	1,044		3,907	6,369	(3)	(3)		(3)	(5)

[1] Excludes zinc sulfide, data for which are withheld to avoid disclosure of individual company confidential data.
[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.
[3] Bureau of Mines not at liberty to publish.
[4] Includes zinc sulfate production.
[5] Included with lithopone.

CONSUMPTION AND USES

LEAD PIGMENTS

White lead.—White lead was used principally in paintmaking; shipments to the paint industry comprised 78 percent of the total. In 1955, however, and in other recent years, the percentage used in paint was not properly indicated by available statistics. 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 were 2 and 5 percent, respectively, of total distribution in 1955.

TABLE 10.—Distribution of white lead (dry and in oil) shipments,[1] by industries, 1946–50 (average) and 1951–55, in short tons

Industry	1946–50 (average)	1951	1952	1953	1954	1955
Paints	44, 455	28, 718	21, 223	21, 030	20, 929	19, 825
Ceramics	1, 422	1, 548	1, 079	785	487	484
Other	3, 895	[2] 5, 149	[2] 4, 361	[2] 4, 402	[2] 4, 155	[2] 5, 266
Total	49, 772	35, 415	26, 663	26, 217	25, 571	25, 575

[1] Excludes basic lead sulfate, data for which are withheld to avoid disclosure of individual company confidential data.
[2] Includes the following tonnages for plasticizers and stabilizers: 1951—1,003; 1952—986; 1953—1,089; 1954—1,133; 1955—1,355.

Basic Lead Sulfate.—Substantial quantities of lead sulfate were used as an intermediate product in manufacturing leaded zinc oxide. Such quantities have always been shown in this chapter under leaded zinc oxide to avoid disclosure of individual company confidential data on basic lead sulfate.

Red Lead.—The paint industry, the principal consumer, received 49 percent of all shipments of red lead in 1955. Storage-battery makers (the leading users until 1953) received 41 percent of total shipments in 1955 compared with 44 percent in 1954. The ceramic industry consumed about 2 percent of the red lead shipped.

TABLE 11.—Distribution of red-lead shipments, by industries, 1946–50 (average) and 1951–55, in short tons

Industry	1946–50 (average)	1951	1952	1953	1954	1955
Paints	16, 898	14, 740	13, 149	14, 570	12, 568	14, 308
Storage batteries	11, 056	16, 722	13, 796	13, 975	12, 062	11, 998
Ceramics	1, 013	834	388	1, 188	1, 207	667
Other	2, 896	3, 056	3, 593	1, 600	1, 326	2, 299
Total	31, 863	35, 352	30, 926	31, 333	27, 163	29, 272

Orange Mineral.—Orange mineral was used in manufacturing ink.

Litharge.—About two-thirds of litharge shipments are usually directed to storage-battery makers. In 1955 the proportion was 61 percent, compared with 68 and 67 percent in 1954 and 1953, respectively. The ceramics industry was the second-ranking consumer of litharge in 1955, taking 24,200 tons or 16 percent of total shipments. Shipments for making chrome pigments increased 39 percent but remained well below the level of other recent years. Shipments for insecticides and varnish increased 41 and 25 percent, respectively. Total shipments for all purposes increased 6 percent over 1954.

TABLE 12.—Distribution of litharge shipments, by industries, 1946–50 (average) and 1951–55, in short tons

Industry	1946–50 (average)	1951	1952	1953	1954	1955
Storage batteries	94, 209	94, 064	97, 656	103, 849	94, 656	90, 200
Ceramics	18, 515	22, 815	15, 906	20, 924	17, 118	24, 173
Chrome pigments	9, 227	11, 117	8, 376	8, 821	4, 335	6, 025
Varnish	4, 123	5, 584	5, 572	3, 915	4, 162	5, 206
Oil refining	6, 765	6, 068	4, 080	4, 342	3, 775	3, 853
Insecticides	8, 717	5, 691	2, 724	2, 305	2, 501	3, 521
Rubber	2, 323	2, 641	2, 109	2, 230	1, 768	1, 947
Floor coverings	136	1, 772	791	603	596	803
Other	6, 852	5, 001	3, 584	7, 529	10, 966	12, 783
Total	150, 867	154, 753	140, 798	154, 518	139, 877	148, 511

ZINC PIGMENTS AND SALTS

Zinc Oxide.—Shipments of lead-free zinc oxide to consuming industries followed the distribution in previous years. The rubber industry and paint manufacturers were the leading consumers, using 51 percent (51 percent in 1954) and 20 percent (22 percent in 1954), respectively, of total shipments. Shipments to the rubber industry increased 22 percent to 86,700 tons of zinc oxide. Shipments for ceramics and coated fabrics and textiles (chiefly rayon) comprised 6 and 7 percent, respectively, of the total. Shipments to all consuming industries increased in 1955, surpassing the former peak year 1928 by 5 percent.

TABLE 13.—Distribution of zinc oxide shipments, by industries, 1946–50 (average) and 1951–55, in short tons

Industry	1946–50 (average)	1951	1952	1953	1954	1955
Rubber	78, 072	71, 507	72, 774	78, 439	71, 058	86, 677
Paints	32, 067	32, 934	31, 424	31, 920	31, 157	33, 932
Coated fabrics and textiles [1]	8, 020	7, 265	6, 262	8, 718	6, 322	11, 263
Ceramics	10, 479	10, 324	7, 760	8, 862	8, 990	10, 617
Floor coverings	3, 771	3, 114	2, 413	2, 234	1, 749	2, 281
Chemical warfare					(2)	(2)
Other	15, 699	22, 572	21, 577	18, 454	21, 009	23, 771
Total	148, 108	147, 716	142, 210	148, 627	140, 285	168, 541

[1] Includes the following tonnages for rayon: 1951—5,275; 1952—5,852; 1953—7,388; 1954—5,603; 1955—4,584.
[2] Included under "Other."

Leaded Zinc Oxide.—Leaded zinc oxide (all grades) was used almost exclusively as a pigment in paint production in 1954 and 1955. That not used in paint (about 1 percent) was used in manufacturing rubber and miscellaneous minor products.

TABLE 14.—Distribution of leaded zinc oxide shipments, by industries, 1946–50 (average) and 1951–55, in short tons

Industry	1946–50 (average)	1951	1952	1953	1954	1955
Paints	61, 332	43, 678	37, 607	39, 276	33, 690	32, 178
Rubber	176	82	9	41	7	} 483
Other	2, 005	581	276	395	275	
Total	63, 513	44, 341	37, 892	39, 712	33, 972	32, 661

Lithopone.—Lithopone was used principally in manufacturing paint, varnish, and lacquer. In 1955, shipments to the paint industry comprised 71 percent (73 percent in 1954) of total shipments. Although paint shipments increased 1 percent in 1955, shipments of lithopone to the paint industry declined 5 percent below 1954 and 31 percent below the 1946–50 average. Lithopone was also used in coated fabrics and textiles (10 percent) and in floor coverings, paper, rubber, and printing ink. Although generally declining over the past decade, 1955 shipments of lithopone for these uses increased 4 percent, only 44 percent of the average shipment in 1946–50.

TABLE 15.—Distribution of lithopone shipments, by industries, 1946–50 (average) and 1951–55, in short tons

Industry	1946–50 (average)	1951	1952	1953	1954	1955
Paint, varnish, and lacquers [1]	99, 375	76, 614	45, 267	37, 452	32, 177	30, 522
Coated fabrics and textiles	7, 806	4, 814	5, 698	5, 806	3, 995	4, 242
Floor coverings	8, 138	4, 620	3, 009	2, 575	2, 351	2, 378
Rubber	3, 244	3, 295	1, 523	1, 723	1, 701	2, 163
Paper	3, 618	6, 462	3, 089	2, 096	1, 841	1, 970
Printing ink	(2)	868	657	716	195	} 1, 570
Other	5, 028	6, 164	2, 589	2, 071	1, 751	
Total	127, 209	102, 837	61, 832	52, 439	44, 011	42, 845

[1] Includes a small quantity, not separable, used for printing ink, except in 1951 and 1952.
[2] Included with "Other" before 1950, except for those quantities reported under "Paint, varnish, and lacquers."

TABLE 16.—Distribution of zinc sulfate shipments, by industry, 1946–50 (average) and 1951–55, in short tons

Industry	1946–50 (average)	1951		1952		1953		1954		1955	
	Gross weight	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis	Gross weight	Dry basis
Rayon	9, 510	10, 073	7, 925	8, 181	6, 812	9, 008	7, 612	6, 615	5, 740	10, 732	9, 537
Agriculture	6, 824	5, 588	4, 847	5, 111	4, 446	6, 773	5, 894	7, 067	6, 139	8, 187	7, 089
Chemicals	1, 837	2, 871	2, 243	1, 675	1, 489	2, 539	2, 105	2, 300	1, 973	(1)	(1)
Glue	546	396	337	391	329	601	501	648	545	(1)	(1)
Electrogalvanizing	316	190	129	342	243	337	225	454	301	258	177
Flotation reagents	1, 140	858	736	1, 070	950	736	648	357	317	226	202
Paint and varnish processing	242	32	20	172	130	106	70	130	114	(1)	(1)
Textile dyeing and printing	179	1, 400	1, 163	350	301	155	138	4	4	-------	-------
Other	1, 800	2, 116	1, 274	2, 295	1, 422	1, 965	1, 219	1, 452	1, 024	4, 461	3, 343
Total	22, 394	23, 524	18, 674	19, 587	16, 122	22, 220	18, 412	19, 027	16, 157	23, 864	20, 348

[1] Included with "Other."

Zinc Chloride.—The principal uses of the salt were for soldering and tinning fluxes, battery manufacturing, galvanizing, vulcanizing fiber, wood preserving, oil refining, and fungicides.

Zinc Sulfate.—The rayon industry was the chief consumer of zinc sulfate in 1955. Of the total, shipments for agricultural purposes (fertilizers and fungicides) required 35 percent (37 percent in 1954); rayon, 47 percent (35 percent in 1954). Shipments for glue, electrogalvanizing, and paint and varnish processing increased 5 percent; shipments for chemicals, flotation reagents, and textile dyeing and printing decreased by 4 percent from 1954.

PRICES

Total and average values received by producers for lead and zinc pigments and zinc salts are given in tables 1, 2, and 4. Average values of litharge, red lead, and white lead increased $23, $19, and $9 per ton, respectively, in 1955 but remained well below the record highs established in 1951. The average quoted price for common lead at New York was 15.14 cents, compared with 14.05 cents in 1954. The average weighted sale price of lead was 14.90 cents a pound, compared with 13.70 cents in 1954.

Average values received for zinc oxide, leaded zinc oxide, and lithopone (zinc pigments), increased $3, $1, and $5 per ton, respectively, in 1955. The average quoted price of Prime Western zinc was 12.30 cents per pound, compared with 10.69 cents in 1954; the average weighted sale price for all grades of slab zinc was 12.30 cents a pound, compared with 10.80 cents in 1954.

TABLE 17.—Range of quotations on lead pigments, and zinc pigments and salts at New York (or delivered in the East), 1952–55, in cents per pound

[Oil, Paint and Drug Reporter]

Product	1952	1953	1954	1955
White lead (basic lead carbonate), dry, carlots, bags	16.25–20.10	16.25–17.25	16.00–17.50	17.50–18.00
Basic lead sulfate (sublimed lead), less than carlots, bags	15.75–20.19	15.00–15.75	15.75–16.75	16.75–17.25
Red lead, dry, 95 percent or less, less than carlots, barrels	17.25–22.57	15.75–18.50	15.50–18.00	18.00–18.50
Orange mineral, American, less than carlots, barrels	19.60–24.92	18.10–20.85	17.85–20.60	20.35–21.10
Litharge, commercial, powdered, less than carlots, barrels	16.25–21.65	14.75–17.50	14.50–17.00	17.00–17.50
Zinc oxide:				
American process, lead free, bags, carlots	14.25–17.60	13.50–14.25	13.50	13.50–14.00
American process, 5 to 35 percent lead, bags, carlots	14.40–18.35	14.00–14.40	14.00–14.25	14.25–14.63
French process, red seal, bags, carlots	15.25–18.85	14.75–15.50	14.75	14.75–15.25
French process, green seal, bags, carlots	16.00–19.35	15.25–16.00	15.25	15.25–15.75
French process, white seal, bags, carlots	16.50–19.85	15.75–16.50	15.75	15.75–16.25
Lithopone, ordinary, less than carlots, bags	8.25– 8.90	8.25– 8.50	8.25– 8.50	8.25– 8.50
Zinc sulfide, less than carlots, bags, barrels	26.30	25.30–26.30	25.30	25.30
Zinc chloride, works:				
Solution, tanks	4.10– 5.35	4.10– 4.85	4.85	4.85
Fused, drums	9.60– 9.85	9.85–10.85	10.10–10.85	10.10
Zinc sulfate, crystals,[1] less than carlots, barrels	18.10–11.20	8.10–10.30	7.90– 8.60	8.60–10.60

[1] Includes granulated.

FOREIGN TRADE [3]

Foreign trade in lead and zinc pigments and salts was of comparatively minor importance in relation to domestic shipments. Tonnage and value in 1955 increased 50 percent over 1954 for imports, but declined 14 percent and 5 percent, respectively, for exports. The value of imports was $1.2 million compared with $751,000 in 1954. The value of the principal exports was $2.3 million, compared with $2.4 million in 1954.

As in 1954, imports of lead pigments were small consisting chiefly of litharge, which totaled 750 tons (600 tons in 1954). Imports of zinc products included 3,300 tons of zinc oxide, 600 tons of zinc sulfate, 500 tons of zinc chloride, and 300 tons of zinc sulfide.

The United States exported comparatively little litharge, white lead, lead arsenate, and red lead in 1955; the totals constituted only a small portion of shipments by domestic producers. Pigments (covered by this report) exported in greatest quantity from the United States were zinc oxide and lithopone; tonnage of the two commodities comprising 2 and 4 percent, respectively, of total shipments by producers, decreased 15 and 37 percent, respectively, in 1955.

TABLE 18.—Value of foreign trade of the United States in lead and zinc pigments and salts, 1953–55

[U. S. Department of Commerce]

	Imports for consumption			Exports		
	1953	1954	1955	1953	1954	1955
Lead pigments:						
White lead	$44			$219,514	$289,901	$284,735
Red lead	47	$508	$923	153,830	124,613	133,580
Litharge	15,281	134,413	174,895	425,848	457,078	558,029
Other lead pigments	678	14,219	18,708	(1)	(1)	(1)
Total	16,050	149,140	194,526	(1)	(1)	(1)
Zinc pigments:						
Zinc oxide	275,122	[2] 475,913	685,186	883,821	897,065	771,621
Zinc sulfide	6,460	31,858	83,732	(1)	(1)	(1)
Lithopone	5,658	7,029	4,355	584,279	454,461	300,960
Total	287,240	[2] 514,800	773,273	1,468,100	1,351,526	1,072,581
Lead and zinc salts:						
Lead arsenate				83,139	161,607	215,206
Other lead compounds	6,457	[2] 20,337	72,089	10,573	23,555	21,181
Zinc arsenate	27		1,760	(1)	(1)	(1)
Zinc chloride	25,379	34,075	72,369	(1)	(1)	(1)
Zinc sulfate	3,958	32,957	56,301	(1)	(1)	(1)
Total	35,821	[2] 87,369	202,519	(1)	(1)	(1)
Grand total	339,111	[2] 751,309	1,170,318	(1)	(1)	(1)

[1] Data not available.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to earlier years.

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

TABLE 19.—Lead pigments and salts exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Short tons					Total value
	White lead	Red lead	Litharge	Lead arsenate	Other lead compounds	
1946–50 (average)	790	937	1,401	984	(1)	$1,346,158
1951	767	585	1,038	313	70	1,195,400
1952	675	435	1,233	128	36	1,028,266
1953	818	417	1,238	152	12	892,904
1954	951	335	1,284	355	31	1,056,754
1955	957	325	1,459	540	33	1,212,731

[1] Classification established 1949; quantity and value not included in averages.

TABLE 20.—Lead pigments and salts imported for consumption in the United States, 1946–50 (average) and 1951–55

[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	
1946–50 (average)	262	83	321	32	13	12	(1)	$261,007
1951	2,575	215	1,855	53	----------	7	180	1,868,034
1952	390	2	621	53	(1)	81	32	499,986
1953	(1)	(1)	60	1	4	----------	18	22,507
1954	----------	2	596	28	----------	----------	86	[2] 169,477
1955	----------	3	751	34	6	----------	352	266,615

[1] Less than 1 ton.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to earlier years.

TABLE 21.—Zinc pigments and salts imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Short tons							Total value
	Zinc oxide		Lithopone	Zinc sulfide	Zinc chloride	Zinc arsenate	Zinc sulfate	
	Dry	In oil						
1946–50 (average)	1,103	(1)	243	7	46	----------	234	$293,979
1951	1,772	10	794	----------	714	----------	201	1,140,624
1952	173	(1)	11	----------	275	(1)	66	180,798
1953	1,157	29	30	23	179	(1)	46	316,604
1954	2,348	----------	65	106	260	----------	399	[2] 581,832
1955	3,320	----------	30	265	500	(1)	634	903,703

[1] Less than 1 ton.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to earlier years.

TABLE 22.—Zinc pigments exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Short tons		Total value	Year	Short tons		Total value
	Zinc oxide	Lithopone			Zinc oxide	Lithopone	
1946–50 (average)	9, 363	13, 627	$4, 049, 031	1953	2, 971	3, 927	$1, 468, 100
1951	8, 895	20, 473	6, 854, 600	1954	3, 111	3, 013	1, 351, 526
1952	7, 615	9, 985	4, 352, 309	1955	2, 649	1, 892	1, 072, 581

Lime

By Oliver Bowles,[1] Annie L. Marks,[2] and James M. Foley[2]

LIME output in the United States in 1955 reached an alltime high of 10.5 million short tons compared with 8.6 million tons in 1954 and was 8 percent greater than the previous record reached in 1953. Open-market sales in 1955 totaled nearly 9 million tons, an increase of 24 percent over 1954. Agricultural use was the only category showing a decline in 1955; sales were about 6 percent lower than in 1954. Sales for building uses increased 16 percent and for chemical and industrial applications 19 percent. The high level of activity in the metallurgical industries was reflected in a 40-percent increase in sales of refractory lime (dead-burned dolomite). Of the total sold or used, 59 percent was in the form of quicklime, 21 percent hydrated lime, and 20 percent dead-burned dolomite.

TABLE 1.—Salient statistics of lime sold or used in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Active plants	178	155	160	156	154	150
Sold or used by producers:						
By types:						
Quicklime ... short tons	3,585,676	4,369,269	4,262,229	5,337,268	5,128,370	6,113,215
Hydrated lime ... do	1,761,580	1,919,783	1,882,824	2,042,100	1,979,895	2,237,753
Dead-burned dolomite ... do	1,419,218	1,966,460	1,928,025	2,294,815	1,520,854	2,128,960
Total lime:						
Short tons	6,766,474	8,255,512	8,073,078	9,674,183	8,629,119	10,479,928
Value [1]	$68,517,829	$96,934,611	$95,231,221	$112,158,060	$101,723,102	$127,144,035
Per ton	$10.13	$11.74	$11.80	$11.59	$11.79	$12.13
Total open-market lime short tons	6,387,477	7,720,333	7,587,443	8,114,396	7,180,159	8,929,803
Total captive tonnage lime short tons	[2] 378,997	[2] 535,179	[2] 485,635	1,559,787	1,448,960	1,550,125
By uses:						
Agricultural ... short tons	341,907	343,619	392,383	329,455	323,557	305,417
Building ... do	1,059,084	1,234,136	1,191,263	1,166,240	1,130,032	1,309,774
Chemical and industrial ... do	3,946,265	4,711,297	4,561,407	5,883,673	5,654,676	6,735,777
Refractory (dead-burned dolomite) ... short tons	1,419,218	1,966,460	1,928,025	2,294,815	1,520,854	2,128,960
Imports for consumption ... do	31,385	34,025	24,008	37,202	36,298	39,616
Exports ... do	51,566	63,295	64,952	79,934	73,246	82,461

[1] Selling value, f. o. b. plant, excluding cost of containers.
[2] Incomplete figures; before 1953 there was only a partial coverage of captive plants.

Figure 1 shows the relation of building-lime sales to the volume of new building construction. A fair parallelism may be noted until 1950, but thereafter building-lime output lagged behind new construction.

Because of the many industrial and metallurgical uses of lime, output of chemical and refractory lime has tended to follow the trend of

[1] Commodity specialist.
[2] Statistical assistant.

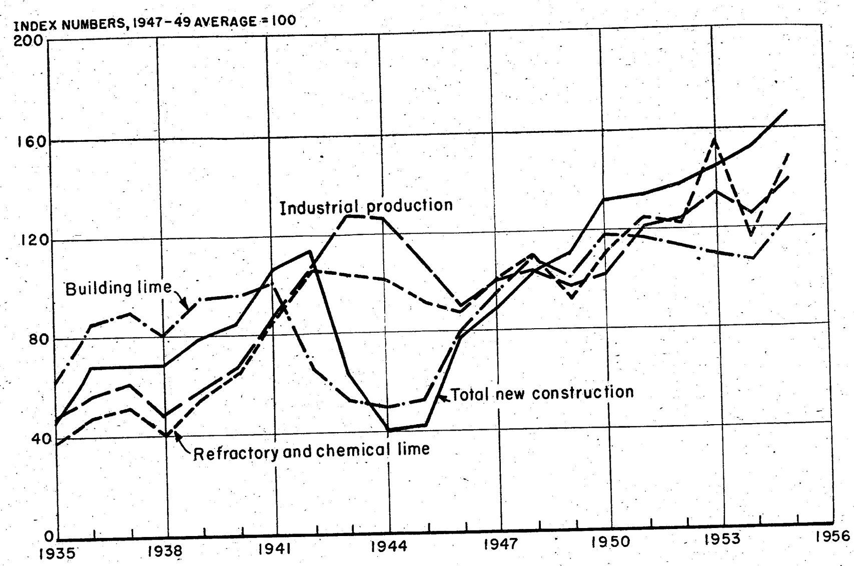

FIGURE 1.—Production of building lime compared with physical volume of total new construction and output of refractory and chemical lime compared with industrial production, 1935–55. Units are reduced to percentages of the 1947–49 average. Statistics on new construction from Construction and Building Materials, U. S. Department of Commerce, and on industrial production from Federal Reserve Board.

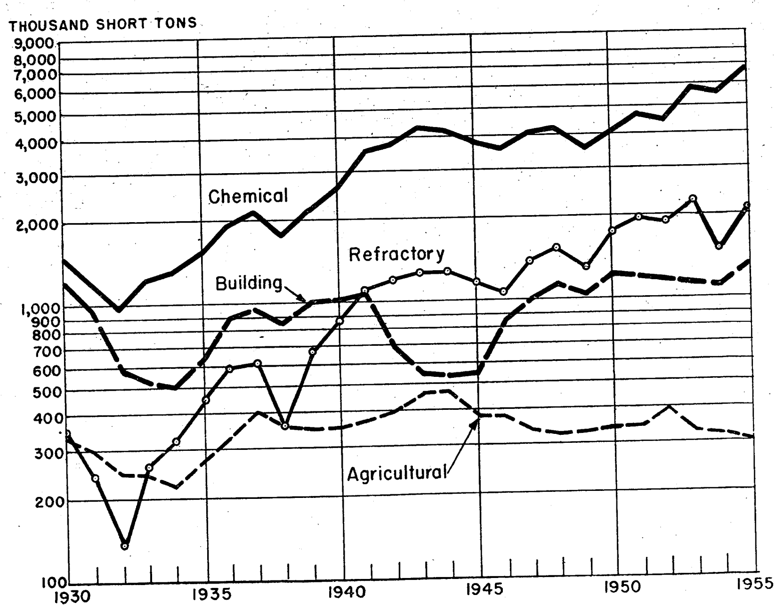

FIGURE 2.—Trends in major uses of lime, 1930–55.

industrial production. This relationship is shown in figure 1. The apparent strong upward trend in refractory and chemical lime shown for the years after 1952 is due in part to the better statistical coverage. Figure 2 shows the trends in principal uses over a period of years.

DOMESTIC PRODUCTION

Lime production in 1955, measured by the total tonnage sold or used, was 21 percent higher than in 1954, establishing an alltime high record. In 1955, 15 percent of the total was captive compared with 17 percent in 1954. The coverage on captive lime has been more complete since 1952 than during preceding years.

Lime was produced in 33 States and 2 Territories in 1955. Ohio, Missouri, and Pennsylvania continued to be the leading producers, furnishing about 57 percent of the total output. Illinois, Texas, Virginia, Alabama, and California, next in order of output, together supplied about 23 percent of the total. Thus, eight States produced four-fifths of the lime output in the United States in 1955.

West End Chemical Co. announced the discovery and acquisition of a high-grade limestone deposit immediately north of its present

TABLE 2.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States, 1954–55, by States

State or Territory	1954			1955		
	Active plants	Short tons	Value	Active plants	Short tons	Value
Alabama	8	421,807	$4,488,167	8	462,194	$5,185,706
Arizona	5	88,932	1,131,334	5	112,028	1,437,632
Arkansas	2	(1)	(1)	2	(1)	(1)
California	6	212,381	3,387,981	6	268,009	4,372,789
Connecticut	1	(1)	(1)	1	(1)	(1)
Florida	2	(1)	(1)	2	(1)	(1)
Georgia	1	(1)	(1)	---	---	---
Hawaii	1	8,375	251,610	1	6,453	202,005
Illinois	6	532,051	7,420,849	6	644,181	9,416,136
Indiana	1	(1)	(1)	1	(1)	(1)
Iowa	1	(1)	(1)	1	(1)	(1)
Louisiana	1	(1)	(1)	1	(1)	(1)
Maine	1	(1)	(1)	1	(1)	(1)
Maryland	5	67,081	685,427	5	74,497	669,228
Massachusetts	3	127,836	1,709,341	3	134,952	1,957,346
Michigan	3	(1)	(1)	3	(1)	(1)
Minnesota	1	(1)	(1)	1	(1)	(1)
Missouri	8	1,125,919	11,165,381	6	1,464,828	14,408,279
Montana	2	(1)	(1)	2	(1)	(1)
Nevada	3	(1)	(1)	3	(1)	(1)
New Jersey	2	(1)	(1)	2	(1)	(1)
New York	3	(1)	(1)	3	(1)	(1)
Ohio	17	2,549,046	31,444,083	18	3,038,949	39,393,634
Oklahoma	1	(1)	(1)	1	(1)	(1)
Pennsylvania	24	1,081,583	13,206,310	22	1,424,051	17,631,795
Puerto Rico	2	8,384	198,452	2	10,392	254,121
South Dakota	1	(1)	(1)	1	(1)	(1)
Tennessee	3	80,372	968,078	3	103,257	1,102,005
Texas	10	547,436	5,421,732	9	584,855	5,549,309
Utah	3	(1)	(1)	3	38,710	582,760
Vermont	2	(1)	(1)	2	(1)	(1)
Virginia	11	445,158	4,610,645	11	494,293	5,048,697
Washington	1	(1)	(1)	1	(1)	(1)
West Virginia	5	(1)	(1)	6	(1)	(1)
Wisconsin	8	115,397	1,557,579	8	134,635	1,767,563
Undistributed [1]		1,217,361	14,076,133		1,483,644	18,165,030
Total	154	8,629,119	101,723,102	150	10,479,928	127,144,035

[1] Figures that may not be shown separately are combined as "Undistributed" to avoid disclosure of individual company operations.

457676—58——45

plant at Westend, Inyo County, Calif. Transfer of present plant facilities to the new site was anticipated; under consideration was the use of a rotary kiln, burning natural gas as fuel, to produce 170 tons of lime per day.[3]

The Paul lime plant, Paul Spur, Ariz., has added a second rotary kiln, and a third was awaiting placement. Copper smelting was an important use of the high-calcium lime produced.[4]

The Colorado Yule Marble Co. quarry at Marble, Colo., idle since 1940, was to be reactivated for producing lime, according to a press report.[5]

Size of Plants.—The gradual sustained trend toward fewer plants with larger individual production was evident in 1955. Twenty-nine plants, each producing more than 100,000 tons per year, furnished 67 percent of the total lime output; 22 plants producing 50,000 to 100,000 tons each furnished 16 percent of the total; and 33 plants producing 25,000 to 50,000 tons each per year supplied 12 percent of the total. Thus, 84 plants out of a total of 150 furnished 95 percent of the lime output in 1955. The average output per plant in 1955 was 70,000 tons compared with 56,000 tons in 1954.

Hydrated Lime.—As hydrated lime has certain advantages over quicklime in transportation and use, it is preferred by some consuming industries. About 21 percent of the total was hydrated in 1955 compared with 23 percent in 1954.

TABLE 3.—Lime sold or used by producers in the United States,[1] 1954–55, by types and major uses

	1954				1955				Change from 1954 percent
	Sold	Used	Total	Percent of total	Sold	Used	Total	Percent of total	
By type:									
Quicklime	5,393,973	1,255,251	6,649,224	77	6,916,688	1,325,487	8,242,175	79	+24
Hydrated lime	1,786,186	193,709	1,979,895	23	2,013,115	224,638	2,237,753	21	+13
Total lime	7,180,159	1,448,960	8,629,119	100	8,929,803	1,550,125	10,479,928	100	+21
By use:									
Agricultural:									
Quicklime	123,285	1,361	124,646	1	116,428	1,125	117,553	1	−6
Hydrated lime	198,911		198,911	2	187,826	38	187,864	2	−6
Total	322,196	1,361	323,557	3	304,254	1,163	305,417	3	−6
Building:									
Quicklime	150,550	46,763	197,313	2	176,612	54,973	231,585	2	+17
Hydrated lime	908,198	24,521	932,719	11	1,056,052	22,137	1,078,189	10	+16
Total	1,058,748	71,284	1,130,032	13	1,232,664	77,110	1,309,774	12	+16
Chemical and other industrial:									
Quicklime	3,618,942	1,187,469	4,806,411	56	4,558,612	1,205,465	5,764,077	55	+20
Hydrated	679,077	169,188	848,265	10	769,237	202,463	971,700	10	+15
Total	4,298,019	1,356,657	5,654,676	66	5,327,849	1,407,928	6,735,777	65	+19
Refractory (dead-burned dolomite)	1,501,196	19,658	1,520,854	18	2,065,036	63,924	2,128,960	20	+40

[1] Includes Hawaii and Puerto Rico.

[3] Western Mining and Industrial News, West End Co. To Install New Kiln at Inyo Discovery: vol. 23, No. 7, July 1955, p. 5.

[4] Utley, Harry F., Paul Lime Plant Adds Second Rotary—Third Awaits Installation: Pit and Quarry, vol. 47, No. 11, May 1955, pp. 144–145.

[5] Mining Congress Journal, Colorado Lime: vol. 41, No. 5, May 1955, p. 75.

TABLE 4.—Distribution of lime (including refractory) plants, 1953–55, according to size of production [1]

Size group (short tons)	1953			1954			1955		
	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	11	6,507	(2)	10	4,656	(2)	10	4,855	(2)
1,000 to less than 5,000	17	52,010	1	28	83,319	1	20	53,585	(2)
5,000 to less than 10,000	21	144,837	1	16	108,563	1	14	95,335	1
10,000 to less than 25,000	23	375,001	4	22	386,135	4	22	386,119	4
25,000 to less than 50,000	33	1,190,762	12	30	1,043,448	12	33	1,285,061	12
50,000 to less than 100,000	23	1,551,233	16	22	1,427,969	17	22	1,641,229	16
100,000 and over	28	6,353,833	66	26	5,575,029	65	29	7,013,744	67
Total	156	9,674,183	100	154	8,629,119	100	150	10,479,928	100

[1] Includes captive tonnage.
[2] Less than 1 percent.

TABLE 5.—Hydrated lime sold or used by producers in the United States, 1954–55, by States, in short tons

State or Territory	1954				1955			
	Active plants	Open market	Captive	Total	Active plants	Open market	Captive	Total
Alabama	6	(1)	(1)	72,645	6	(1)	(1)	76,313
California	5	(1)	(1)	32,649	5	(1)	(1)	35,599
Georgia	(2)	(2)		(2)				
Hawaii	1	8,351		8,351	1	6,437		6,437
Illinois	4	64,775		64,775	4	72,702		72,702
Maryland	3	17,727		17,727	3	17,572		17,572
Massachusetts	3	(1)	(1)	55,458	3	(1)	(1)	58,254
Missouri	7	208,235		208,235	5	223,777		223,777
Ohio	13	(1)	(1)	603,583	14	732,789	10,708	743,497
Pennsylvania	14	307,566		307,566	14	316,269		316,269
Tennessee	3	20,567		20,567	3	22,845		22,845
Texas	7	72,278	168,725	241,003	7	76,106	201,427	277,533
Virginia	8	(1)	(1)	55,366	7	55,577		55,577
Other States [2]	31	285,529	6,441	291,970	32	325,115	6,263	331,378
Undistributed		801,158	18,543			163,926	6,240	
Total	105	1,786,186	193,709	1,979,895	104	2,013,115	224,638	2,237,753

[1] Figures that may not be shown separately are combined as "Undistributed" to avoid disclosure of individual company operations.
[2] Includes the following States and number of plants in 1955 (1954 same as 1955 unless shown differently in parentheses): Arizona 3, Arkansas 1, Connecticut 1, Florida 1, Georgia 1 (1954 only), Iowa 1, Maine 1, Michigan 1, Minnesota 1, Montana 1, Nevada 2, New Jersey 2, New York 2, Oklahoma 1, Puerto Rico 1, Utah 2 (1), Vermont 1, Washington 1 (1955 only), West Virginia 4, and Wisconsin 5.

CONSUMPTION AND USES

Sixty-five percent of the total lime produced in 1955 was consumed in chemical and industrial plants, 20 percent was employed as a refractory in metallurgical plants, 12 percent was used by the building trades, and 3 percent was applied to agricultural uses.

Quicklime and hydrated lime are used in three major fields—the chemical and industrial plants, the building trades, and agriculture. Of the total sold (or used by producers), 81 percent was employed for chemical and industrial applications, 16 percent in building construction, and 3 percent in agriculture.

TABLE 6.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States in 1955, 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	15,378	$123,497	45,891	$715,348	133,843	$1,967,693			195,112	$2,806,538
Districts 2 and 3: Maryland, New Jersey, New York, Pennsylvania, and West Virginia	211,674	2,277,480	144,591	1,839,308	1,334,068	16,469,594	260,089	$3,688,541	1,950,422	24,274,923
District 4: Virginia	26,945	333,464	4,355	52,034	462,993	4,663,199			494,293	5,048,697
District 5: Ohio	43,852	544,361	639,338	10,352,762	1,086,415	9,827,930	1,269,344	18,668,581	3,038,949	39,393,634
District 7: Illinois, Indiana, and that portion of Missouri east of the 93d meridian			107,936	999,802	1,343,669	13,451,879	517,091	7,612,339	1,968,696	22,064,020
Districts 6, 8, and 9: Iowa, Michigan, Minnesota, South Dakota, and Wisconsin	(2)	(2)	(2)	(2)	352,055	4,153,282			395,204	4,722,144
Districts 10–11: Alabama, Florida, and Tennessee	(2)	(2)	88,447	1,184,257	510,536	5,502,656	(2)	(2)	603,693	6,747,917
District 12: Arkansas, Oklahoma, Louisiana, and that portion of Missouri west of the 93d meridian			76,545	937,095	512,984	5,247,542			589,529	6,184,637
District 13: Texas	350	3,425	37,771	413,660	546,734	5,132,224			584,855	5,549,309
Districts 14 and 15: Arizona, California, Montana, Nevada, Utah, and Washington	(2)	(2)	119,094	2,354,879	442,010	6,096,453	(2)	(2)	642,330	9,896,090
Noncontiguous Territories:										
Hawaii	(2)	(2)	(2)	(2)	(2)	(2)			6,453	202,005
Puerto Rico	(2)	(2)	(2)	(2)	(2)	(2)			10,392	254,121
Undistributed[2]	7,218	87,216	45,806	710,265	10,470	278,143	82,436	1,455,126		
Total	305,417	3,369,443	1,309,774	19,559,410	6,735,777	72,790,595	2,128,960	31,424,587	10,479,928	127,144,035

[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 operations.

TABLE 7.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States, 1954–55, by uses, in short tons

Use	1954			1955		
	Open market	Captive	Total	Open market	Captive	Total
Agriculture	322,196	1,361	323,557	304,254	1,163	305,417
Building:						
Finishing lime	474,145	9,861	484,006	607,579	9,328	616,907
Mason's lime	470,702	5,592	476,294	529,927	2,041	531,968
Other (including masonry mortars)	113,901	55,831	169,732	95,158	65,741	160,899
Total	1,058,748	71,284	1,130,032	1,232,664	77,110	1,309,774
Chemical and other industrial:						
Alkalies (ammonium, potassium, and sodium compounds)	9,429	911,194	920,623	3,599	868,014	871,613
Asphalts and other bitumens	(1)		(1)	(1)		(1)
Bleach, liquid and powder [2]	4,223		4,223	4,682		4,682
Brick, sand-lime and slag	11,826		11,826	12,732		12,732
Brick, silica (refractory)	16,491		16,491	29,497		29,497
Calcium carbide and cyanamide	562,482		562,482	692,766		692,766
Calcium carbonate (precipitated)	19,512		19,512	32,870		32,870
Coke and gas (gas purification and plant byproducts)	14,250		14,250	34,800		34,800
Explosives	6,102		6,102	8,569		8,569
Food and food byproducts	23,656		23,656	21,246		21,246
Glassworks	249,073		249,073	276,399		276,399
Glue	2,554		2,554	2,551		2,551
Grease, lubricating	3,575		3,575	2,897		2,897
Insecticides, fungicides, and disinfectants	69,481		69,481	74,983		74,983
Medicines and drugs	(1)		(1)	(1)		(1)
Metallurgy:						
Nonferrous smelter flux	(1)	(1)	47,902	(1)		(1)
Steel (open-hearth and electric furnace flux)	1,149,019	121,564	1,270,583	1,622,539	134,011	1,756,550
Ore concentration [3]	143,768	149,878	293,646	170,048	274,189	444,237
Wire drawing	2,159		2,159	1,566		1,566
Other [4]	(1)	(1)	59,161	123,467		123,467
Oil drilling	12,399		12,399	20,830		20,830
Paints	(1)	(1)	26,529	(1)	(1)	36,628
Paper mills	(1)	(1)	732,670	(1)	(1)	773,979
Petrochemicals (glycol)	91,680		91,680	101,817		101,817
Petroleum refining	43,546		43,546	(1)	(1)	47,016
Rubber manufacture	1,555		1,555	1,465		1,465
Salt refining	(1)		(1)	1,544		1,544
Sewage and trade-wastes treatment	100,586	1,394	101,980	140,660	2,775	143,435
Soap and fat	(1)		(1)	(1)		(1)
Sugar refining	(1)	(1)	33,685	(1)	(1)	36,711
Tanneries	69,185		69,185	76,396		76,396
Varnish	(1)		(1)			
Water purification	618,034	19,332	637,366	709,681	20,258	729,939
Wood distillation	(1)		(1)			
Undistributed [5]	871,483	112,125	83,661	931,286	108,681	145,633
Unspecified	201,951	41,170	243,121	228,959		228,959
Total	4,298,019	1,356,657	5,654,676	5,327,849	1,407,928	6,735,777
Refractory lime (dead-burned dolomite)	1,501,196	19,658	1,520,854	2,065,036	63,924	2,128,960
Grand total lime	7,180,159	1,448,960	8,629,119	8,929,803	1,550,125	10,479,928
Hydrated lime included in above distribution	1,786,186	193,709	1,979,895	2,013,115	224,638	2,237,753

[1] Included with "Undistributed" and "Total" columns to avoid disclosure of individual company operations.
[2] Bleach used in paper mills excluded from "Bleach" and included with "Paper mills."
[3] Includes flotation, cyanidation, bauxite purification, and magnesium manufacture.
[4] Includes barium and vanadium processing, cupola, gold recovery, and unspecified metallurgical uses.
[5] Includes alcohol, asphalt, medicine and drugs, magnesium products, paints, paper mills, polishing compounds, retarder, soap and fat, sugar, sulfur, varnish, and miscellaneous industrial uses.

Most of the captive tonnage was consumed in chemical and industrial plants. Seventy-eight percent of open-market lime (not including refractory) was applied to chemical and industrial uses, 18 percent was shipped to the building trades, and 4 percent was used for land improvement. Dead-burned dolomite furnished 20 percent of the overall lime production. It was used for refractory linings of metallurgical furnaces.

Open-market sales to chemical and other industrial consumers were 24 percent greater in 1955 than in 1954; captive tonnage gained 4 percent. Total captive and open-market was 19 percent higher than in 1954.

Substantial gains were recorded in many applications, notably in flux for steelmaking, ore concentration, sewage and trade-waste disposal, and in water purification. Small increases were reported for lime used in bleach, sand-lime brick, petroleum refining, and sugar manufacture. The quantities used for alkali, wire drawing, lubricating grease, and rubber manufacture declined. To supply a comprehensive picture of the agricultural use, table 10 compares agricultural lime, oystershells, limestone, and calcareous marl consumption for soil improvement in 1954 and 1955.

Lime is produced in abundance in some States and in relatively small quantities or none in others. Because of differences in composition and properties from plant to plant, shipments of lime from distant points to meet specialized needs of consumers were sometimes required. Accordingly, as table 11 indicates, large quantities of lime enter interstate commerce. The principal States from which lime was shipped were Ohio, Missouri, Pennsylvania, and Virginia.

TABLE 8.—Lime (quick, hydrated, and dead-burned dolomite) sold or used by producers in the United States,[1] 1954–55, by major uses

Use	1954			1955		
	Short tons	Value [2]		Short tons	Value [2]	
		Total	Average		Total	Average
Agricultural	323,557	$3,714,081	$11.48	305,417	$3,369,443	$11.03
Building:						
Finishing lime	484,006	7,817,816	16.15	616,907	10,288,502	16.68
Mason's lime	476,294	6,675,040	14.01	531,968	6,976,726	13.11
Other (including masonry mortars)	169,732	2,202,802	12.98	160,899	2,294,182	14.26
Total, building	1,130,032	16,695,658	14.77	1,309,774	19,559,410	14.93
Chemical and industrial uses	5,654,676	59,352,679	10.50	6,735,777	72,790,595	10.81
Refractory (dead-burned dolomite)	1,520,854	21,960,684	14.44	2,128,960	31,424,587	14.76
Grand total, lime	8,629,119	101,723,102	11.79	10,479,928	127,144,035	12.13

[1] Includes Hawaii and Puerto Rico.
[2] Selling value, f. o. b. plant, excluding cost of container.

TABLE 9.—Hydrated lime sold or used by producers in the United States, 1954–55 by uses, in short tons

Use	1954			1955		
	Open market	Captive	Total	Open market	Captive	Total
Agricultural	198,911	----------	198,911	187,826	38	187,864
Building	908,198	24,521	932,719	1,056,052	22,137	1,078,189
Chemical and industrial:						
Bleach, liquid and powder	(1)	----------	(1)	(1)	----------	(1)
Brick, sand-lime and slag	4,536	----------	4,536	6,351	----------	6,351
Brick, silica	13,867	----------	13,867	25,539	----------	25,539
Coke and gas	895	----------	895	6,154	----------	6,154
Food products	11,905	----------	11,905	9,524	----------	9,524
Insecticides, fungicides, and disinfectants	54,555	----------	54,555	57,495	----------	57,495
Metallurgy	50,128	----------	50,128	(1)	(1)	82,018
Paints	(1)	(1)	14,908	(1)	(1)	14,836
Paper mills	44,281	----------	44,281	(1)	(1)	51,718
Petroleum	22,667	----------	22,667	(1)	(1)	28,098
Sewage and trade-waste treatment	(1)	(1)	40,433	52,359	----------	52,359
Sugar refining	21,527	----------	21,527	20,610	----------	20,610
Tanneries	40,964	----------	40,964	44,740	----------	44,740
Water purification	225,439	----------	225,439	261,381	----------	261,381
Undistributed [2]	112,082	169,188	225,929	199,619	202,463	225,412
Unspecified	76,231	----------	76,231	85,465	----------	85,465
Total	679,077	169,188	848,265	769,237	202,463	971,700
Grand total, hydrated lime	1,786,186	193,709	1,979,895	2,013,115	224,638	2,237,753

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Includes alkalies, cement products, glass, glue, grease (lubricating), medicines and drugs, oil-well drilling, rubber, and miscellaneous industrial uses.

TABLE 10.—Agricultural lime and other liming materials sold or used by producers in the United States, 1954–55, by kinds

Kind	1954				1955			
	Short tons		Value		Short tons		Value	
	Gross weight	Effective lime content [1]	Total	Average	Gross weight	Effective lime content [1]	Total	Average
Lime:								
Quicklime	124,646	105,949	}$3,714,081	$11.48	117,553	99,920	}$3,369,443	$11.03
Hydrated lime	198,911	139,238			187,864	131,505		
Oystershell (crushed) [2]	84,154	39,552	574,666	6.83	72,086	33,880	304,256	4.22
Limestone	[3] 18,247,121	[3] 8,576,147	30,199,337	[3] 1.66	18,360,040	8,629,219	29,455,066	1.60
Calcareous marl	206,257	86,628	152,491	.74	183,044	76,878	128,340	.70
Total	----------	[3] 8,947,514	34,640,575	------	----------	8,971,402	33,257,105	------

[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 limestone and oystershells, 47 percent; calcareous marl, 42 percent.
[2] Figures compiled by Fish and Wildlife Service.
[3] Revised figure.

TABLE 11.—Apparent consumption of lime sold and used in continental United States in 1955, by States, in short tons

State	Sales by producers	Shipments from States [1]	Shipments into States	Apparent consumption		Total
				Quicklime	Hydrated lime	
Alabama	462,194	204,779	16,995	248,980	25,430	274,410
Arizona	112,028	8,145	10,110	104,901	9,092	113,993
Arkansas	(2)	(2)	(2)	77,469	9,745	87,214
California	268,009	12,851	113,594	270,397	98,355	368,752
Colorado			29,051	20,463	8,588	29,051
Connecticut	(2)	(2)	(2)	39,292	25,043	64,335
Delaware			59,541	48,267	11,274	59,541
District of Columbia			35,445	11,527	23,918	35,445
Florida	(2)		(2)	105,844	61,994	167,838
Georgia			76,130	57,134	18,996	76,130
Idaho			24,132	17,765	6,367	24,132
Illinois	644,181	350,842	345,140	470,125	168,354	638,479
Indiana	(2)		(2)	475,127	42,353	517,480
Iowa	(2)	(2)	(2)	98,041	25,403	123,444
Kansas			66,767	50,254	16,513	66,767
Kentucky			560,221	538,405	21,816	560,221
Louisiana	(2)		(2)	350,577	72,400	422,977
Maine	(2)		(2)	68,935	7,208	76,143
Maryland	74,497	12,664	172,283	191,021	43,095	234,116
Massachusetts	134,952	90,437	40,766	30,814	54,467	85,281
Michigan	(2)	(2)	(2)	322,680	67,786	390,466
Minnesota	(2)	(2)	(2)	101,117	22,402	123,519
Mississippi			49,945	44,961	4,984	49,945
Missouri	1,464,828	1,233,173	23,359	189,001	66,013	255,014
Montana	(2)	(2)	(2)	37,658	3,569	41,227
Nebraska			12,588	2,599	9,989	12,588
Nevada	(2)	(2)	(2)	44,336	15,892	60,228
New Hampshire			15,685	9,038	6,647	15,685
New Jersey	(2)	(2)	(2)	94,799	92,059	186,858
New Mexico			22,233	10,899	11,334	22,233
New York	(2)	(2)	(2)	250,856	126,309	377,165
North Carolina			155,557	110,808	44,749	155,557
North Dakota			7,509	5,140	2,369	7,509
Ohio	3,038,949	1,717,527	226,863	1,391,974	156,311	1,548,285
Oklahoma	(2)	(2)	(2)	183,518	44,076	227,594
Oregon			53,115	40,716	12,399	53,115
Pennsylvania	1,424,051	637,360	644,606	1,169,158	262,139	1,431,297
Rhode Island			14,800	8,169	6,631	14,800
South Carolina			21,664	10,070	11,594	21,664
South Dakota	(2)		(2)	7,681	6,485	14,166
Tennessee	103,257	85,614	26,011	16,742	26,912	43,654
Texas	584,855	88,227	60,231	289,806	267,053	556,859
Utah	38,710	1,556	97,982	102,606	32,530	135,136
Vermont	(2)	(2)	(2)	54	4,884	4,938
Virginia	494,293	444,754	46,809	57,953	38,395	96,348
Washington	(2)	(2)	(2)	34,530	14,682	49,212
West Virginia	(2)	(2)	(2)	229,893	29,677	259,570
Wisconsin	134,635	79,298	105,719	115,711	45,345	161,056
Wyoming			2,380	305	2,075	2,380
Undistributed [2]	1,483,644	652,640	2,363,370			
Total	10,463,083	5,619,867	5,500,601	8,158,116	2,185,701	10,343,817

[1] Includes 136,111 tons exported or unclassified as to destination.
[2] Combined in "Undistributed" to avoid disclosure of individual company operations.

TABLE 12.—Apparent consumption of lime in continental United States in 1955, 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			Florida, Georgia, Virginia			Alabama, Tennessee, Louisiana		
	Quicklime	Hydrated lime	Total	Quicklime	Hydrated lime	Total	Quicklime	Hydrated lime	Total	Quicklime	Hydrated lime	Total	Quicklime	Hydrated lime	Total
Illinois, Indiana, Michigan, Ohio	2,219,910	349,884	2,569,794	100,341	4,518	104,859	3	302	305	17,703	385	18,088	332	1,935	2,267
Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, West Virginia	522,378	200,834	723,212	1,173,429	338,725	1,512,154	26,043	15,829	41,872	231,041	16,523	247,564	10,126	725	10,851
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont	2,881	35,243	38,124	62,030	6,275	68,305	89,630	62,109	151,739	113	--------	113	1,628	--------	1,628
Florida, Georgia, North Carolina, South Carolina, Virginia	12,595	84,369	96,964	41,053	7,039	48,092	--------	65	65	130,011	37,750	167,761	153,295	44,590	197,885
Alabama, Kentucky, Louisiana, Mississippi, Tennessee	65,798	29,534	95,332	21,682	4,975	26,657	--------	5	5	11,643	33	11,676	552,057	47,822	599,879
Arkansas, Kansas, Nebraska, Oklahoma, Texas	34,129	12,165	46,294	132,206	29,543	161,749	--------	--------	--------	11,585	362	11,947	--------	--------	--------
Iowa, Minnesota, Missouri, Wisconsin	74,296	59,350	133,646	1,594	--------	1,594	--------	17	17	3,437	139	3,576	--------	175	175
Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming	45,144	31,582	76,726	5,903	7,844	13,747	47	240	287	59,664	12,146	71,810	--------	--------	--------

TABLE 12.—Apparent consumption of lime in continental United States in 1955, by region of origin and destination, in short tons—Con.

Destination	Origin: Arkansas, Oklahoma, Texas, Kansas, Nebraska			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	Quicklime	Hydrated lime	Total
Illinois, Indiana, Michigan, Ohio	817	144	961	320,800	77,636	398,436				2,659,906	434,804	3,094,710
Delaware, District of Columbia, Maryland, New Jersey, New York, Pennsylvania, West Virginia		10	10	32,504	15,825	48,329				1,995,521	588,471	2,583,992
Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont				20	1,253	1,273				156,302	104,880	261,182
Florida, Georgia, North Carolina, South Carolina, Virginia		1,093	1,093	4,835	822	5,657	20		20	341,809	175,728	517,537
Alabama, Kentucky, Louisiana, Mississippi, Tennessee	76,420	45,088	121,508	472,065	24,085	496,150				1,199,665	151,542	1,351,207
Arkansas, Kansas, Nebraska, Oklahoma, Texas	353,927	277,438	631,365	71,682	27,868	99,550	117		117	603,646	347,376	951,022
Iowa, Minnesota, Missouri, Wisconsin	5,164	186	5,350	419,379	99,296	518,675				503,870	159,163	663,033
Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, North Dakota, Oregon, South Dakota, Utah, Washington, Wyoming	16,368	4,279	20,647	70,432	29,357	99,789	499,839	138,289	638,128	697,397	223,737	921,134

PRICES

The average price of lime sold in 1955 was $12.13 per short ton compared with $11.79 in 1954. The trend in prices over a period of years is shown in figure 3.

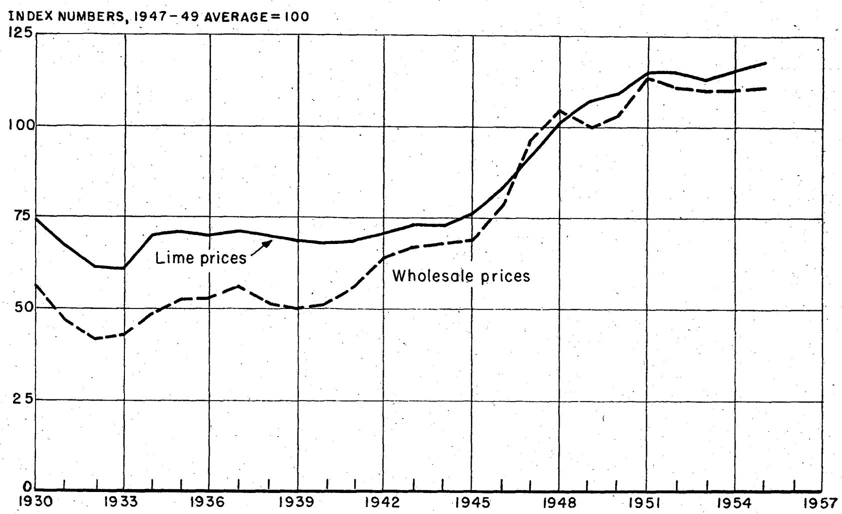

FIGURE 3.—Average price of lime per ton compared with wholesale prices of all commodities, 1930–55. Units are reduced to percentages of the 1947–49 average. Wholesale prices from U. S. Department of Labor.

FOREIGN TRADE [6]

Imports.—Imports of lime into the United States, tables 13 and 14, were relatively small and were confined, except for small quantities from Mexico, to movements from Canada to border areas in Washington and the Buffalo district of New York.

Exports.—Exports, although relatively small, were more than twice as large as imports (tables 15 and 16). Over 95 percent of the exports were destined to North American countries, chiefly Canada, Costa Rica, Honduras, and Panama.

TECHNOLOGY

Patents.—Molded thermal-insulation shapes of high strength and low density may be made by a patented process involving the reaction of a cellular siliceous material, such as diatomite with lime.[7]

A patent was issued for a method of improving the characteristics of hydrated lime by adding diatomite, clay, pyrophyllite, white portland cement, or asbestos.[8]

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

[7] Binkley, M. F. (assigned to Johns-Manville Corp., New York, N. Y.), Method of Manufacturing Heat Insulating Shapes: U. S. Patent No. 2,699,097, Jan. 11, 1955.

[8] Huntsicker, H. N. (assigned to U. S. Gypsum Co., Chicago, Ill.), Plastic Lime of Enhanced Hoddability: U. S. Patent No. 2,701,209, Feb. 1, 1955.

TABLE 13.—Lime imported for consumption in the United States, 1946–50 (average) and 1951–55

[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
1946–50 (average)	1,660	$28,064	28,433	$398,192	1,292	$50,582	31,385	$476,838
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
1953	2,177	30,944	31,149	506,704	3,876	259,427	37,202	797,075
1954	1,259	[3] 17,326	30,613	537,676	4,426	344,665	36,298	[3] 899,667
1955	1,359	[3] 17,983	30,264	559,216	7,993	[3] 557,554	39,616	[3] 1,134,753

[1] "Dead-burned basic refractory material consisting chiefly of magnesia and lime."
[2] Includes weight of immediate container.
[3] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data are not comparable to those for years preceding 1954.

TABLE 14.—Lime imported for consumption in the United States, 1953–55, by countries and customs districts [1]

[U. S. Department of Commerce]

Country and customs district	1953		1954		1955	
	Short tons [2]	Value	Short tons [2]	Value	Short tons [2]	Value
North America:						
Canada:						
Buffalo	11,875	$135,195	4,531	$53,880	1,880	$23,063
Duluth and Superior					108	1,874
Maine and New Hampshire	101	1,040	172	1,518	166	2,062
St. Lawrence					1	3
Vermont	2,853	37,130	1,559	20,034	31	468
Washington	18,496	364,253	25,524	478,802	28,676	542,925
Total	33,325	537,618	31,786	554,234	30,862	570,395
Mexico: El Paso			86	768	761	6,804
Total	33,325	537,618	31,872	555,002	31,623	577,199
Europe: United Kingdom: Massachusetts	1	30				
Grand total	33,326	537,648	31,872	[3] 555,002	31,623	[3] 577,199

[1] Exclusive of dead-burned basic refractory material.
[2] Includes weight of immediate container.
[3] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data are not comparable to those for years preceding 1954.

TABLE 15.—Lime exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1946–50 (average)	51,566	$753,236	1953	79,934	$1,422,238
1951	63,295	1,157,652	1954	73,246	1,299,681
1952	64,952	1,156,991	1955	82,461	1,464,036

TABLE 16.—Lime exported from the United States, 1953–55, by countries of destination

[U. S. Department of Commerce]

Destination	1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
North America:						
Bahamas	92	$3,145	25	$500	---	---
Canada	37,976	546,226	37,691	588,753	45,542	$730,837
Costa Rica	12,242	236,269	12,241	224,016	11,588	218,814
Cuba	15	541	---	---	295	6,310
Dominican Republic	---	---	---	---	406	11,090
El Salvador	100	2,909	50	1,050	118	2,990
Honduras	14,212	244,839	10,137	190,738	10,648	201,068
Mexico	3,110	84,218	2,315	60,046	2,502	54,641
Netherlands Antilles	33	631	---	---	150	2,920
Nicaragua	555	12,793	500	11,523	300	5,680
Panama	6,155	152,319	4,817	96,928	7,029	140,684
Other North America	94	4,912	55	1,196	121	2,973
Total	74,584	1,288,802	67,831	1,174,750	78,699	1,378,007
South America:						
Colombia	4,410	97,778	4,274	94,276	2,926	59,639
Venezuela	594	21,057	619	13,488	505	11,140
Other South America	---	---	84	2,862	50	2,265
Total	5,004	118,835	4,977	110,626	3,481	73,044
Europe	15	317	(1)	774	13	1,236
Asia:						
Japan } Nansei and Nanpo Islands }	25	1,250	31	2,850		
Japan					16	2,000
Nansei and Nanpo Islands					123	3,810
Philippines	90	5,101	342	8,644	94	2,204
Saudi Arabia	114	4,422	---	---	---	---
Other Asia	---	---	20	564	5	212
Total	229	10,773	393	12,058	238	8,226
Africa:						
Liberia	52	1,843	---	---	---	---
Other Africa	50	1,668	45	1,473	21	2,083
Total	102	3,511	45	1,473	21	2,083
Oceania: Australia	---	---	---	---	9	1,440
Grand total	79,934	1,422,238	73,246	1,299,681	82,461	1,464,036

[1] Less than 1 ton.

A method was patented for precipitating magnesium hydroxide from sea water by reacting the water with lime, and separating the various solids mechanically.[9]

New types of drilling fluids include lime as one of the ingredients.[10]

A process was patented for manufacturing a thermal insulating material using lime combined with asbestos, bentonite, diatomite, and silica.[11]

A new type of roofing and siding shingle consists of asphalt, glass and asbestos fibers, mineral wool, sand, and lime or limestone dust.[12]

[9] Clarke, R. E., and Collins, N. R. (assigned to Merck & Co., Rahway, N. J.), Process for the Manufacture of Magnesium Products: U. S. Patent No. 2,703,748, Mar. 8, 1955.

[10] Davis, R. W., and Lummus, J. L. (assigned to Standard Oil & Gas Co., Tulsa, Okla.), Settable Drilling Fluid: U. S. Patent No. 2,705,050, Mar. 29, 1955.

[11] Seipt, W. R. (assigned to Keasbey & Mattison Co., Ambler, Pa.), Lime-Silica Insulation and Method of Making: U. S. Patent No. 2,716,070, Aug. 23, 1955.

[12] Bierly, L. A. (assigned to Presque Isle Laboratories & Manufacturing, Inc., Erie, Pa.), Asphalt Coated Sheet: U. S. Patent No. 2,718,479, Sept. 20, 1955.

Certain filter porcelains, made from a mixture of quartz and potassium-sodium sulfate, were enameled with a composition of lime, silica, soda ash, and potash.[13]

A new type of flux used in acetylene or other flame-type welding employs lime with borax and other chemical compounds.[14]

Mustard-gas decontamination compositions developed consist of calcium hypochlorite together with lime, chalk, soda ash, and sodium chloride.[15]

The principal ingredients of building brick, somewhat similar to a sand-lime brick, were fly ash and furnace clinker to which lime is added to form a binder.[16]

A new composition for surfacing walls and ceilings consists of a plaster to which are added lime, exfoliated vermiculite, and portland cement, together with small quantities of plasticizing agents such as barite, chalk, whiting, or kaolin.[17]

Calcination.—A series of articles concerned current rotary-kiln performance, reasons for low thermal efficiency of such kilns, and methods suggested for overcoming the deficiencies.[18]

Although fuel efficiency in rotary kilns may be low, the rotary calciners have certain advantages over shaft kilns that may more than outweigh the lower fuel efficiency. Among the advantages claimed are more complete utilization of all sizes of stone; ability to utilize low-cost fuels; lower labor costs, both direct and indirect; and better control of calcining conditions. These factors, in relation to the design and operation of small rotary kilns, were discussed in some detail.[19]

A new batch process was used to produce high-quality lime suitable for chemical and metallurgical applications. The process is essentially the dehydration of carefully selected hydrated lime because an optimum grade of lime could be obtained in this way. The retort in which the reaction is accomplished is heated by external gas burners, as such indirect firing prevents contamination of the lime with fuel gases. The design and operations of the equipment were described.[20]

Basic research on calcination of limestone was continued at Massachusetts Institute of Technology under a fellowship sponsored by the National Lime Association. One phase of the study demonstrated that the bulk density of the lime increases as the heating rate is increased, particularly in the higher range of temperatures. A detailed description of the experimental work was published.[21]

---

13 Garbati, A., Process for the Manufacture of Filter Porcelains; U. S. Patent No. 2,718,686, Sept. 27, 1955.

14 Veltri, C. P., Flux Composition and Its Method of Production: U. S. Patent No. 2,719,800, Oct. 4, 1955.

15 MacMahon, J. D. (assigned to Olin Mathieson Chemical Corp., of Virginia), Decontaminating Composition: U. S. Patent No. 2,719,828, Oct. 4, 1955.

16 Gunzelmann, R., Erythropel, H., and Krüger, G. (assigned to Atlas-Werke, A. G., Bremen, Germany, and Steinkohlen Elektrizität Aktiengesellschaft, Essen, Germany): U. S. Patent No. 2,724,656, Nov. 22, 1955.

17 Clipson, S., Composition of Surfacing Walls, Ceilings, and the Like: U. S. Patent No. 2,728,681, Dec. 27, 1955.

18 Azbe, Victor J., Rotary Kiln, Its Performance and Development: Rock Products, vol. 58, 1955, pt. 1, No. 2, February, pp. 101–102, 104, 106, 109; pt. 2, No. 3, March, pp. 82–85, 106, 108; pt. 3, No. 5, May, pp. 77–82; pt. 4, No. 6, June, pp. 108, 110, 114, 130; pt. 5, No. 7, July, pp. 58, 60, 62, 64, 102; pt. 6, No. 8, August, pp. 154, 156; pt. 7, No. 9, September, pp. 70, 72, 74; pt. 8, No. 10, October, pp. 118, 120, 122, 124, 138, 140.

19 Bauer, Wolf G., Design Factors for Small Rotary Kiln Systems: Pit and Quarry, vol. 47, No. 11, May 1955, pp. 116–117, 120, 122.

20 Gibadlo, Frank, Calcination of Lime by Indirect-Fired Batch Process: Rock Products, vol. 58, No. 10, October 1955, pp. 126, 132, 134, 142, 144.

21 Fischer, H. C., Calcination of Calcite. I—Effect of Heating Rate and Temperature on Bulk Density of Calcium Oxide; II—Size and Growth Rate of Calcium Oxide Crystallites: Jour. Am. Ceram. Soc., vol. 38, No. 7-8, July–August 1955, pp. 245–251, 284–288.

Hydration.—The principles involved in lime hydration, the properties of hydrated lime, and processes of manufacture were discussed in some detail by two British consulting engineers.[22]

Uses and Specifications.—A use for lime that has attained some prominence is in the treatment of lake water for clarification and for neutralization of acid conditions that are detrimental to fish life.[23]

The following research fellowships pertaining to lime utilization were sponsored by the National Lime Association.

Work under a research fellowship at Purdue University developed fundamental data on the advantages of lime as a stabilizer on clay roads. This fellowship terminated in 1954, and a new fellowship was established at the University of Texas to continue the work.[24]

A second fellowship at Purdue University involved research on development of a continuous process for using lime and ferrous sulfate to break oil emulsions in the treatment of petroleum trade wastes.

A fellowship at Rutgers University was devoted to research on lime neutralization of acid wastes. Fellowship research was completed at Toledo University on replacing portland cement with lime and pozzolan in autoclaved concrete products.

Committee C–7 on Lime of the American Society for Testing Materials (ASTM) was considering a proposed specification for lime used in glass manufacture. Four types of glass are involved—optical, plate, sheet, and bottle.[25]

Reuse.—Specifications were presented for constructing a lime plant at Dayton, Ohio, to use the lime carbonate sludge from the water filtration and softening plant as raw material. Such a procedure would recover not only the lime used in water softening but also the calcium carbonate precipitated from the water.[26]

The St. Regis Paper Co., Jacksonville, Fla., used a 9- by 175-foot rotary kiln to produce 100 tons of lime a day, employing as raw material the calcium carbonate sludge that results from causticizing the green liquor used in the sulfate-pulp process. The recovered lime supplied 95 percent of the plant requirements; the other 5 percent was purchased.[27]

The municipal water supply at Lansing, Mich., was so "hard" that treatment with lime resulted in an accumulation of about 40 tons a day of calcium carbonate sludge. This created such a difficult disposal problem that the city constructed a Fluosolids recalcination plant, which began operation early in 1955. The lime produced was said to be of high quality.

---

[22] Knibbs, N. V. S., and Thyer, E. G. S., Increase Efficiency in Hydration of Lime: Rock Products, vol. 58, No. 6, June 1955, pp. 84, 88, 92, 94, 134, 136, 138; No. 7, July, pp. 70, 72, 74, 76, 104, 106, 108.

[23] Rock Products, Liming for Lakes: Vol. 58, No. 1, January 1955, p. 78.

[24] Boynton, Robert S., Postwar Research by the National Lime Association: Rock Products, vol. 58, No. 1, January 1955, pp. 118, 120, 123, 128.

[25] Rock Products, ASTM Committee Activities: vol. 58, No. 5, May 1955, p. 65.

[26] Rock Products, Lime Recovery Plant: Vol. 58, No. 11, November 1955, p. 59.

[27] Gutschick, Kenneth A., Lime Recovery System Used at St. Regis Pulp and Paper Mill: Pit and Quarry, vol. 47, No. 12, June 1955, pp. 120–122.

WORLD REVIEW

NORTH AMERICA

Canada.—Canadian lime production reached a peak in 1955 of 1,303,499 tons valued at Can $15,190,328 compared with 1,214,839 tons valued at Can $14,742,149 in 1954. These figures include both quick and hydrated lime. The increased demand reflected the high level of industrial activity and building construction. Six of the ten Provinces produced lime at a total of 40 plants having approximately 140 kilns. Canada exports small quantities to the United States on the west coast, and imports small shipments in the East. Prices of hydrated lime in the Montreal area in 1955 ranged from Can $15 to $18 per ton.[28] Placement of a new rotary kiln was in progress at the Gypsum, Lime & Alabastine Co. plant at Beachville, Ontario. The new facility will supplement the present five gas-fired shaft kilns.

EUROPE

Germany, West.—Problems of the German lime industry were discussed in some detail at a meeting of the Deutsche Kalk Industrie in Germany. Summaries of the leading papers were translated for publication in the United States.[29]

AFRICA

Belgian Congo and Ruanda-Urundi.—Unofficial sources report an output of 84,895 metric tons of lime in 1954. Katanga was the principal producer.[30]

Union of South Africa.—Part of the lime produced at a new lime plant at Silverstreams, about 100 miles west of Kimberley, will be used in a uranium-extraction process. A large output was forecast.[31]

---

[28] Department of Mines and Technical Surveys, Lime in Canada, 1955 (preliminary): Ottawa, Canada, 5 pp.

[29] Pearson, B. M., German Lime Technicians Discuss Industry Problems: Pit and Quarry, vol. 47, No. 12, June 1955, pp. 92–93.

[30] Bureau of Mines, Mineral Trade Notes, vol. 41, No. 4, October 1955, p. 40.

[31] Rock Products, Africa's Largest Lime Plant: Vol. 58, No. 9, September 1955, p. 94.

Lithium

By Albert E. Schreck[1] and Annie L. Marks[2]

OUTPUT of the lithium industry in 1955 was adequate to fulfill consumer demands. Development of new uses and markets, expansion of present markets, construction of new processing facilities, and expansion of already existing facilities characterized the domestic industry. Production of spodumene concentrate in Canada was started.

DOMESTIC PRODUCTION

Shipments of lithium ores and concentrates from mines reached an alltime high in 1955.

Expansion of lithium facilities in the Kings Mountain district of North Carolina continued. Foote Mineral Co. completed a second expansion of its chemical-processing facilities at Sunbright, Va. This plant operated on spodumene produced at the company mine at Kings Mountain.

TABLE 1.—Shipments of lithium ores and compounds from mines in the United States, 1935–39 (average), 1946–50 (average), and 1951–55

Year	Ore (short tons)	Value	Li_2O (short tons)	Year	Ore (short tons)	Value	Li_2O (short tons)
1935–39 (average)	1,327	$48,280	88	1953	27,240	[1]$2,134,000	1,767
1946–50 (average)	4,706	318,338	407	1954	37,830	[1] 3,126,000	2,459
1951	12,897	[1] 896,000	956	1955	(2)	(2)	(2)
1952	15,611	[1] 1,052,000	1,088				

[1] Partly estimated.
[2] Data not available.

Lithium Corp. of America began production of lithium chemicals at its new Bessemer City, N. C., plant. The plant processed spodumene from its North Carolina mines and planned also to process spodumene imported from Canada. Because of the new ore supplies from its North Carolina holdings and imports from Canada, this firm announced that it would put its South Dakota operations on a standby basis early in 1956.[3]

[1] Commodity specialist.
[2] Statistical assistant.
[3] Chemical and Engineering News, vol. 33, No. 49, Dec. 5, 1955, p. 5254.

457676—58——46

Lithium Corp. of America also announced plans for expanding its electrolytic plant at St. Louis Park, Minn. This was necessary to increase capacity for lithium-metal and lithium hydride production.[4]

American Lithium Chemicals, Inc., a subsidiary of American Potash & Chemical Corp., expected to complete early in 1956 a chemical plant being constructed at San Antonio, Tex. Lepidolite imported from Southern Rhodesia will be converted to lithium chemicals at this plant.

American Potash & Chemical Corp. continued production of dilithium-sodium phosphate from the brines of Searles Lake, Trona, Calif.

Maywood Chemical Works reported moderate increases in production of lithium chemicals and continued to produce hand-cobbed spodumene from its Etta mine in South Dakota.

A lithium-chemical plant in the Black Hills was reported being built by Midwest Lithium Corp. of Rapid City, S. Dak.[5] A small tonnage of lithium ore was produced at the company mine in Pennington County, S. Dak., during the year.

Exploration of the spodumene-bearing pegmatites in the Kings Mountain area continued, and many new lithium firms were organized.

A small tonnage of spodumene was produced by Whitehall Co., Inc., from a mine near Newry, Oxford County, Maine.

The following firms, other than those previously mentioned, reported the production of lithium minerals in the Black Hills, S. Dak., during 1955. The minerals mined by each firm are shown in parenthesis. Uranium & Allied Minerals, Inc., from Dyke lode and Edison mine, Pennington County (amblygonite and spodumene): Black Hills-Keystone Corp. from the Ingersoll mine, Pennington County (lepidolite and spodumene), and George Bland Mining Co. from the Beecher & Mohawk mines, Custer County (amblygonite).

United States Lithium Corp. reported that the lithium ore reserve on its Brown Derby and Tucker group properties in Gunnison County, Colo., was approximately 1.5 million tons.[6] The company mill, 26 miles from Gunnison, Colo., was expected to begin operations in 1956. Additional classifiers were installed at the Gunnison plant, and the Brown Derby mine was renovated.[7]

It was reported that the Morrow Mining Associates were starting lithium operations at a mine north of Morristown, Ariz. Marketing would be through American Lithium Co.[8]

CONSUMPTION AND USES

Consumption of lithium compounds in various applications increased during 1955. More than two-thirds of the commercial lithium consumption probably was used in all-purpose greases and ceramics, the largest consumers. Lithium added to greases helps them to retain their lubricating properties over wide temperature ranges and increases water resistance. In ceramics lithium and its compounds were used in glasses, glazes, and enamels when high gloss, and superior

[4] Chemical Week, vol. 77, No. 22, Nov. 26, 1955, p. 19.
[5] Engineering and Mining Journal, vol. 156, No. 11, November 1955, p. 148.
[6] Engineering and Mining Journal, vol. 156, No. 8, August 1955, p. 128.
[7] Mining World, vol. 17, No. 3, March 1955, pp. 97–98.
[8] Mining World, vol. 17, No. 2, February 1955, p. 89.

scratch and chemical resistance were desired. Lithium chloride and lithium bromide were used in air-conditioning systems; lithium hydroxide monohydrate in alkaline storage batteries as a catalytic agent and also to increase capacity and life of the cell; lithium fluoride and chloride as oxide scavengers in brazing or welding aluminum; and lithium metal and hydride in various organic syntheses. Lithium or its compounds in small percentages are also used in medicines, cosmetics, paints, waxes, and for other purposes.

The lithium panel of the Materials Advisory Board of the National Academy of Sciences issued a report on the availability and the potential uses of lithium.[9] It stated that the factors that would expand the use of lithium and its compounds were assured availability, lower prices, and research and development. The most immediate growth potential for lithium was thought to be in ceramics. If the price handicap could be overcome, the use of lithium hypochlorite in household bleaches would provide a large consumption potential (10 million pounds a year). Research programs on other than improved extraction and production methods should cover developing the uses of lithium and its compounds in the following applications: Ceramics, organic synthesis, metallurgy, sources of energy (such as propellants), and biochemical processes.

A new use for lithium metal—one that may provide a large potential market for it—is as a catalyst in manufacturing a synthetic rubber that closely resembles natural tree rubber.[10] In this process 0.1 part of lithium metal is reacted with 100 parts of isoprene at 30° to 40° C.

The following estimate (in terms of thousand pounds of lithium carbonate) on the quantity of lithium used in 1955:[11]

Lubricating grease	3, 500
Ceramics	3, 500
Welding and brazing flux	750
Storage batteries	550
Air conditioning and refrigeration	450
Pharmaceuticals	200

RESERVES

The Federal Geological Survey published a report [12] in which reserves of domestic lithium ores were estimated at 14 million of units Li_2O in indicated reserves and 124 million units of Li_2O in inferred reserves. The geology of the known lithium deposits in North America was discussed briefly.

Additional reserve estimates for individual lithium properties can be found in the Domestic Production and World Review sections in this chapter.

[9] Materials Advisory Board, National Research Council, Lithium: Rept. MAB-88-M, June 15, 1955, 77 pp.
[10] Chemical and Engineering News, vol. 33, No. 7, Nov. 21, 1955, p. 5026.
[11] Eigo, D. P., Franklin, J. W., and Cleaver, G. H., Lithium: Eng. and Min. Jour., vol. 156, No. 9, September 1955, p. 83.
[12] Norton, J. J., and Schlegel, D. M., Lithium Resources of North America: Geol. Survey Bull. 1027-G, 1955, p. 27.

PRICES

Prices of lithium minerals are seldom quoted in trade journals; however, the September 1955 issue of Engineering and Mining Journal quoted the following prices for lithium concentrates in 1955, at the mine (subject to negotiation).

Spodumene 6 percent Li_2O	$11–12 per short-ton unit.
Amblygonite	$60–75 per short ton.
Lepidolite, hand-picked	$11–12 per short-ton unit.
Petalite, hand-picked	$11 per short-ton unit.

E&MJ Metal & Mineral Markets quoted lithium metal, 98 percent pure, at $11 to $14 a pound.

Prices for the major lithium compounds (carbonate, chloride and hydroxide) quoted in Oil, Paint and Drug Reporter decreased in 1955. The prices of other lithium compounds remained stable. Reductions in price reportedly were made in an effort to increase the demand and broaden the markets for these compounds. Price ranges for selected lithium compounds are listed in the following table.

TABLE 2.—Range of prices per pound on selected lithium compounds, 1955

[Oil, Paint and Drug Reporter]

Name of compound	January 1955	December 1955
Lithium benzoate, drum	$1.65 -$1.67	$1.65-$1.67
Lithium bromide, N. F., drum, works freight equalized	2.16	2.30
Lithium carbonate, technical, carlots, works and delivered	.95 - 1.00	
Less than carlots, same basis	1.00 - 1.20	
Technical, drum, carlots, ton lots, delivered, freight allowed, works		.82- 1.10½
Less than carlots, same basis		.85- 1.11½
N. F., carlots, delivered	1.42½	
Less than carlots, drum	1.43½- 1.48½	
N. F., drum, carlot, ton lot, delivered		1.29½
Ton lots to ton lots, delivered		1.30
Lithium chloride, technical, crystals, drum	1.10 - 1.25	
Technical, anhydrous, drum, carlots, ton lots, delivered, or works, freight allowed		1.00- 1.05
Less than carlots, same basis		1.05- 1.05½
Lithium hydride, powder, drum, works	12.00 -14.00	
Powder, drum, 500-pound lots, works		12.00
Lithium hydroxide, monohydrate, drum, ton lots, works, delivered	.95 - .98½	
Drum, carlots, ton lots, delivered or works, freight allowed		.80- .80½
Less than carlots, same basis		.81- .81½
Lithium nitrate, drum, 100-pound lots	2.25	
Technical, drum, 100-pound lots		1.25
Lithium stearate, drum, carlots, works		.47½
Ton lots, works		.48½
Less-ton lots, works		.53½

FOREIGN TRADE

The greatest portion of lithium minerals imported in 1955 came from Canada, the Federation of Rhodesia and Nyasaland and South-West Africa.

Canada became an important exporter of lithium minerals when Quebec Lithium Corp. began exporting spodumene concentrates to the Lithium Corp. of America plant late in 1955. It was also reported that a small tonnage of amblygonite was exported from the Northwest Territories to the United States.

Imports of lepidolite from Southern Rhodesia increased in 1955. This mineral was for use as the raw material at the American Lithium Chemical plant at San Antonio, Tex.

Commencing April 28, 1955, the United States Department of Commerce required exporters to obtain special licenses for shipments of lithium ores and concentrates, lithium-containing minerals, and certain lithium alloys to any nation other than Canada.[13]

Figures on imports and exports of lithium minerals and compounds are not separately classified by the United States Department of Commerce on the import or export schedules.

TECHNOLOGY

A field method for detecting the presence of lithium in rocks was described.[14] The equipment necessary for the test is a portable acetylene torch and didymium glasses. When rocks containing lithium are heated, in the area just above the blue cone of the acetylene flame, the lithium present imparts to the flame a characteristic crimson color. The didymium glasses filter out other flame colors that might obscure the crimson flame color of lithium.

The mining methods, both underground and open pit, and the concentration methods, including hand sorting, heavy-medium separation, and froth flotation, used at the spodumene mines in the Black Hills were described.[15] In this article the geology of the Edison, Mateen, Longview-Beecher and other lithium deposits in that area also were discussed briefly.

Methods for extracting lithium from its ores, including processes involving base exchange with alkali sulfates, roasting lithium ore with lime, the gypsum lime-roast process, various chloride-volatilization processes, and the processes used by Lithium Corp. of America at its Bessemer City, N. C., and Minneapolis, Minn., plants were described.[16] An article was published that discussed the heat capacities at low temperatures and entropies of lithium aluminate and lithium ferrite.[17]

Data available on thermodynamic properties of lithium were analyzed, and selected values of the thermodynamic properties were presented in table form in a publication.[18]

A patent was issued on the use of lithium compounds in fuels as an antiknock constituent.[19] Certain lithium compounds, in which the lithium is not directly attached to a carbon atom have reportedly reduced deposit-induced preignition by 77.6 percent.[20]

[13] Northern Miner, vol. 41, No. 5, Apr. 28, 1955, p. 11.
[14] MacKay, A. M., and Brown, D. F. G., Field Method for Detecting Lithium: Precambrian, vol. 2, No. 7, July 1955, p. 12.
[15] Munson, Gerald A., and Clarke, Fremont F. Mining and Concentrating Spodumene In The Black Hills, S. Dak.: Min. Eng., vol. 7, No. 11, November 1955, pp. 1041–1045.
[16] Ellestad, R. B., and Clarke, F. F., Extraction of Lithium From Its Ores: Min. Eng., vol. 7, No. 11, November 1955, pp. 1045–1047.
[17] King, E. G., Heat Capacities at Low Temperatures snd Entropies at 298.16° K. of Aluminates and Ferrites of Lithium and Sodium: Jour. Am. Chem. Soc., vol. 77, No. 12, June 20, 1955, pp. 3189–3190.
[18] Evans, W. H., Jacobsen, Rosemary, Munson, T. R., and Wagman, D. D., Thermodynamic Properties of the Alkali Metals: Nat. Bureau of Standards Jour. Research, vol. 55, August 1955, pp. 83–96.
[19] Hirschler, D. A., Jr., and Irish, G., Antiknock Fluids (assigned to Ethyl Corp., New York, N. Y.): U. S. Patent 2,728,648, Dec. 27, 1955.
[20] Chemical Abstracts, vol. 50, No. 8, Apr. 25, 1956, col. 6035e.

A process for preparing high-purity lithium chloride from dilute solutions was patented.[21] In this process the lithium chloride is obtained from an aqueous solution having a concentration of 2 percent or more lithium chloride by concentrating the solution by separating the water to approximately 40–44 percent by weight of lithium chloride, reducing the temperature to 25°–50° C., removing by filtration the solid NaCl and KCl in the solution, and bringing the filtered solution into contact with a water-insoluble inert, polar organic solvent. From the resulting solution the high-purity lithium chloride is recovered with water or steam. The lithium chloride can be used as a liquid or dried.

WORLD REVIEW

NORTH AMERICA

Canada.—Widespread exploration and staking of lithium claims continued during 1955. Late in the year Quebec Lithium Corp. began producing spodumene concentrate at its mine and mill in LaCorne Township about 25 miles north of Val d'Or. Initial output has been contracted for by Lithium Corp. of America. Reserves of the lithium bearing spodumene are reported to be about 15 million tons.[22]

Frenzied lithium activity took place in Northwest Ontario. It was reported that during one two-week period in the Thunder Bay Area, over 2,000 claims had been recorded.[23]

In the Beardmore area of northwestern Ontario Nama Creek mines ordered a production shaft for its property. The opening (of 4 compartments) initially will be carried to a depth of 780 feet and have 5 levels. A steel headframe also was ordered and clearing started for a plant site. Reserves are reported to approximate 4 million tons, averaging 1.06 percent lithia.[24]

Spodumene of better than average grade, reportedly covering a considerable area, was found by prospectors in the Herb Lake area of Manitoba.[25] By the close of the year numerous firms had claims in the area, and diamond drilling had begun.

Violamac Mines planned to sink a 1,000-foot production shaft on its Cat Lake property, which is approximately 85 miles northeast of Winnepeg, Manitoba. Indicated reserves were reportedly around 4 million tons, averaging 1.28 percent Li_2O.[26] It was reported that preliminary results of metallurgical testing were encouraging, and both the iron and manganese content of the ore was low.[27]

Also in the Cat Lake area of Manitoba, Lithium Corp. of Canada was reportedly planning to begin sinking a 500-foot, 3-level shaft from which underground exploration of its Irgon claims would commence. Reserves were said to be estimated at over 1 million tons of ore averaging 1.44 percent Li_2O. Metallurgical tests were reported

[21] Cunningham, G. L. (assigned to Chempatents, Inc., New York, N. Y.), Preparation of High Purity Lithium Chloride From Crude Aqueous Lithium Chloride: U. S. Patent 2,726,138, Dec. 6, 1955.
[22] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 2, February 1956, p. 31.
[23] Northern Miner, vol. 41, No. 10, June 2, 1955, pp. 1, 4, 9.
[24] Northern Miner, vol. 41, No. 32, Nov. 3, 1955, pp. 1, 5.
[25] Canadian Mining and Metallurgical Bulletin, vol. 49, No. 525, January 1956, p. 57.
[26] Northern Miner, vol. 41, No. 26, Sept. 22, 1955, pp. 1, 4.
[27] Northern Miner, vol. 41, No. 15, July 7, 1955, pp. 1, 7.

to indicate an 87-percent recovery, from which a concentrate averaging 5.9 percent Li_2O can be obtained.[28]

Exploration activity continued in the Yellowknife-Beaulieu region of the Northwest Territories and in the Province of Quebec.

Quebec Beryllium, Ltd., ran tests on lithium ore at its 100-ton pilot mill 9 miles south of Amos, Quebec. The ore for the test came from a pegmatite dike on the company property in LaCorne Township. Quarry methods were expected to be used, and the ore was estimated to contain 20 percent of spodumene.[29]

A preliminary report on lithium in Canada was published. This report briefly described the areas of activity, reserves estimated, and general market information.[30]

AFRICA

Belgian Congo.—Production of amblygonite was reported by Minetain from the Buranga mine near Katumba, eastern Ruanda. Geomines at Manono recovered spodumene as a byproduct of its tin operations. This firm had applied for patents on making lithium salts and had announced plans for the installation of a plant at Manono.[31]

Rhodesia and Nyasaland, Federation of.—Production of lithium minerals, primarily from the Fort Victoria district, totaled 82,000 tons in 1955. It was reported that Bikita Minerals plans to increase its production to 90,000 tons annually.[32] The 1954 production of lithium minerals was 54,050 tons, composed mainly of lepidolite and petalite.[33]

TABLE 3.—Exports of lithium minerals from the Federation of Rhodesia and Nyasaland, 1953–54 [1]

Country of destination	1953		1954	
	Short tons	Value	Short tons	Value
United States	15,243	$314,605	22,572	$422,112
Germany, West	1,596	48,904	2,305	57,562
United Kingdom	1,378	41,526	1,734	52,010
Netherlands	25	641	1,405	27,063
France	843	13,865	683	14,842
Japan			1	22
Total	19,085	419,541	28,700	573,611

[1] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, pp. 41–42.

The majority of the lithium ore produced in Southern Rhodesia was exported to the United States. A screening and crushing plant was to be erected by Bikita Minerals at a cost of approximately $250,000.[34]

Bikita Minerals (Pty.), Ltd., and George H. Nolan (Pvt.), Ltd., were the principal producers.

[28] Northern Miner, vol. 41, No. 19, Aug. 4, 1955, p. 3.
[29] Engineering and Mining Journal, vol. 156, No. 4, April 1955, p. 160.
[30] Haw, V.A., Lithium Minerals, 1955 (Preliminary): Canadian Dept. of Mines and Tech. Surveys, Ottawa, Bull. 13, 7 pp.
[31] U. S. Consulate, Elisabethville, Belgian Congo, Foreign Service Dispatch 1, July 18, 1956.
[32] Mining Journal (London), vol. 246, No. 6293, Mar. 30, 1956, p. 397.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, pp. 41, 42.
[34] South African Mining and Engineering Journal, vol. 66, p. 1, No. 3261, Aug. 13, 1955, p. 975.

South-West Africa.—Lithium mineral production in South-West Africa decreased in 1954. Toward the close of that year, S. W. African Lithium Mines, Inc., began developing and exploiting petalite rather than the lepidolite, as the latter mineral required concentration to meet American consumer specifications.[35]

TABLE 5.—Production of lithium minerals in South-West Africa, 1953–54, in short tons [1]

Mineral	Percent Li_2O	1953	1954
Amblygonite	6-8	338	1,172
Lepidolite	3-3.6	8,443	4,178
Petalite	3-4	1,598	1,936
Total		10,379	7,286

[1] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 41.

TABLE 4.—Exports of lithium from South-West Africa, 1953–54, by country of destination [1]

Country of destination	1953		1954	
	Short tons	Value f. o. b.	Short tons	Value f. o. b.
Amblygonite:				
United Kingdom	28	$2,469	424	$33,449
Germany, West	344	32,239	332	30,464
Netherlands	31	3,080	39	2,940
United States	45	3,393		
Total	448	40,181	795	66,853
Lepidolite:				
United States	9,083	157,869	2,502	38,206
Netherlands	60	1,408	630	26,068
Germany, West	280	4,911	500	11,320
Belgium			278	4,883
France	637	11,121		
Total	10,060	175,309	3,910	80,477
Petalite:				
United States	1,481	25,925	363	6,350
Germany, West			321	7,070
Netherlands			123	2,170
United Kingdom			22	700
Total	1,481	25,925	829	16,290
Grand total	11,989	241,415	5,534	163,620

[1] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 41.

Union of South Africa.—Lithium-ore production totaled 57 short tons in 1954, compared with 60 tons in 1953. None of the production was sold locally, and the total exports of 27 tons went solely to the United Kingdom. Thirty-seven tons was exported in 1953; all of it went to Germany.[36]

OCEANIA

Australia.—Prospecting for lepidolite and spodumene was reportedly started in an area near Pelgangoora, 60 miles southeast of Port Hedland, Western Australia.[37]

[35] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 41.
[36] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 41.
[37] Engineering and Mining Journal, vol. 156, No. 8, August 1955, p. 166.

Magnesium

By H. B. Comstock[1]

PRODUCTION of primary magnesium in the United States in 1955 was 12 percent below that in 1954, but consumption increased 18 percent above 1954. For the second consecutive year more magnesium was consumed for distributive or sacrificial purposes than for producing structural products owing to increased use of the metal in powder; as an alloying constituent; scavenger and deoxidizer of other metals; and as a reducing agent for producing other metals. In June 1955 the initial test flight of an all-magnesium aircraft, the F-80C jet fighter, was said to have shown excellent performance. A number of improved magnesium alloys, alloying techniques, and protective coatings were the basis of increased applications of magnesium where other metals had been used previously. Although increased production of magnesium in a number of European countries was reported in 1955, the United States continued to lead. Exports of the metal from the United States in 1955 more than doubled the quantity exported in 1954.

TABLE 1.—Salient statistics of magnesium-metal industry in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Production:						
Primary magnesium [1] short tons	10,998	40,881	105,821	93,075	69,729	61,135
Secondary magnesium [1] do		11,526	11,477	11,930	8,250	10,246
Average quoted price per pound-primary [2] cents	20.8	24.5	24.5	26.6	27.0	29.5
Domestic consumption short tons	11,287	33,756	42,387	46,843	39,218	46,463
Exports [3] do	536	761	1,163	2,949	3,257	7,847
World production do	36,000	90,000	170,000	170,000	140,000	140,000

[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, 1956).
[3] Primary magnesium and alloys.

[1] Commodity specialist.

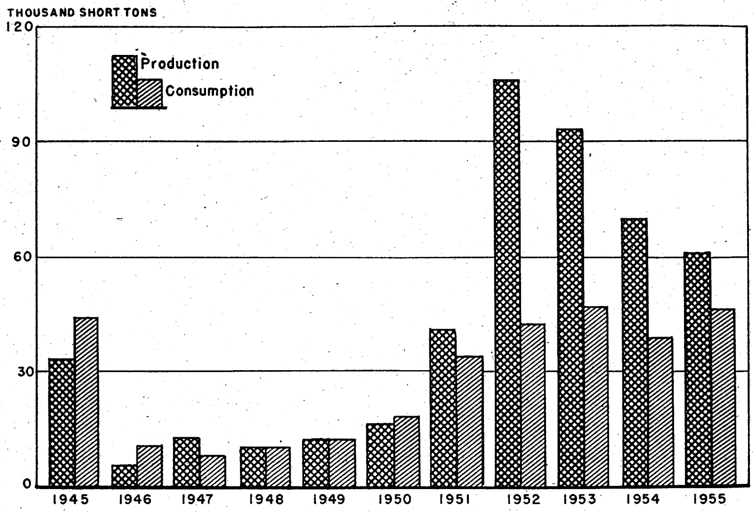

FIGURE 1.—Trends in domestic production and consumption of primary magnesium, 1945–55.

TABLE 2.—Production of primary magnesium in the United States, 1946–50 (average) and 1951–55, by months, in short tons

Month	1946–50 (average)	1951	1952	1953	1954	1955
January	874	1,876	7,425	9,908	6,447	5,090
February	782	1,709	7,794	9,078	5,856	4,647
March	861	1,885	8,893	10,352	6,545	4,942
April	774	2,043	8,800	9,751	6,204	1,859
May	737	2,194	9,093	9,116	6,460	4,277
June	796	2,512	8,670	7,286	6,191	4,757
July	941	2,998	9,529	6,207	6,049	5,112
August	983	3,418	9,771	6,266	5,772	5,881
September	1,060	4,166	8,422	6,076	5,325	5,923
October	1,083	5,147	8,990	6,341	5,149	6,287
November	994	6,010	9,122	6,227	4,942	6,130
December	1,113	6,923	9,312	6,467	4,789	6,230
Total	10,998	40,881	105,821	93,075	69,729	61,135

DOMESTIC PRODUCTION

Primary.—In 1955, Dow Chemical Co. was the sole commercial producer of primary magnesium at its Freeport, Tex., plant and the Government-owned plant at Velasco, Tex. The lease on the Velasco plant extended to January 31, 1958. The total output of these 2 electrolytic plants in 1955 was 61,100 tons, 12 percent below 1954.

Nelco Metals, Inc., produced calcium and magnesium for defense purposes at the Government-owned silicothermic plant, Canaan, Conn., which had a rated annual production capacity of 5,000 tons.

Titanium Metals Corp. of America continued to recycle a small quantity of magnesium as an integrated operation with its production of titanium at Henderson, Nev.

The Government continued to maintain in standby condition the magnesium plants at Luckey and Painesville, Ohio; Wingdale, N. Y.;

Manteca, Calif.; and Spokane, Wash. These plants represented a total annual production capacity of 54,000 tons.

Secondary.—In 1955, total recovery of secondary magnesium from scrap including that treated on toll was 10,246 short tons, compared with 8,250 tons in 1954. Consumption of magnesium-base scrap was 26 percent above 1954, most of which was obtained from an increased supply of cast magnesium scrap. As a minor addition to primary magnesium in making primary magnesium alloy ingot, 1,100 tons of magnesium scrap was consumed. The greatest increase in consumption of magnesium scrap was in producing magnesium anodes for the protection of ships, ground pipeline, water tanks, and other equipment subject to water corrosion.

(See Secondary Metals-Nonferrous chapter for tables listing magnesium recovered from scrap and consumption of magnesium scrap.)

CONSUMPTION AND USES

Consumption of magnesium in 1955 increased 18 percent above that in 1954. Distributive or sacrificial uses continued to require more magnesium than was used to produce structural products. The marked rise in titanium, zirconium, and hafnium production in 1955 explained the 26-percent increased use of magnesium as a reducing agent. Magnesium as an alloying constituent in aluminum and other metals rose 40 percent above 1954.

TABLE 3.—Domestic consumption of primary magnesium (ingot equivalent and magnesium content of magnesium-base alloys) by uses, 1946–50 (average) and 1951–55, in short tons

Product	1946–50 (average)	1951	1952	1953	1954	1955
For structural products:						
Castings:						
Sand	1,984	10,179	14,513	14,306	9,545	6,872
Die	221	994	2,777	2,401	1,743	2,619
Permanent mold	135	646	1,115	1,106	785	876
Wrought products:						
Sheet and plate	1,963	4,988	5,150	5,443	3,033	6,424
Extrusions (structural shapes, tubing)	2,720	4,060	2,715	4,744	2,461	4,106
Forgings	122	735	12	24	110	307
Total for structural products	7,145	21,602	26,282	28,024	17,677	21,204
For distributive or sacrificial purposes:						
Powder	51	482	1,553	1,219	582	681
Aluminum alloys	2,396	5,994	8,598	10,347	8,061	11,104
Other alloys	84	401	960	418	103	364
Scavenger and deoxidizer	394	1,332	1,229	423	80	654
Chemical	284	447	566	363	63	124
Cathodic protection (anodes)	685	2,364	2,100	2,539	5,479	3,941
Reducing agent for titanium, zirconium and hafnium	(1)	(1)	(1)	(1)	6,386	8,056
Other [2]	248	1,134	1,099	3,510	787	335
Total for distributive or sacrificial purposes	4,142	12,154	16,105	18,819	21,541	25,259
Grand total	11,287	33,756	42,387	46,843	39,218	46,463

[1] This use, which was very small before 1954, was included in the figure for other distributive purposes.
[2] Includes primary metal consumed for experimental purposes, debismuthizing lead, production of nodular iron, and secondary magnesium alloys.

The greatest increase in volume of consumption of magnesium in structural applications in 1955 was in sheet and plate.[2] The greatest percentage of increase was for forgings. Their expanded use was in helicopter rotor-hub plates and aircraft landing wheels and brake parts.[3] The 50-percent increase above 1954 in consumption of magnesium for die castings was noted both in requirements for military items and the civilian market.[4]

A favorable report was published concerning the service of all-magnesium wings that had been installed on Air Force aircraft in 1946.[5]

The first all-magnesium aircraft was given an initial test flight on June 11, 1955, by the Air Force. Excellent performance was reported for this single-jet plane, designated as the F-80C jet fighter. About half as many parts were said to have been used as compared with aluminum construction. The thicker magnesium sections were more rigid than aluminum pieces of the same weight, and fewer stiffening members and fasterners were required, according to the design engineers.[6]

New uses for magnesium sheet and castings were announced by the Air Force.[7]

Increased use of magnesium for automotive equipment was reported in 1955. Magnesium truck bodies were produced on an assembly-line basis for the first time.[8] Added requirements for magnesium were reported for producing binoculars, lawn mowers, portable chain saws, and luggage.[9]

Commercial uses of magnesium were increased in producing dock boards, printing plate, tooling plate, and handling equipment for stores and bakeries.[10]

---

[2] Modern Metals, Dow Rolls Wider Sheet: Vol. 12, No. 1, February 1956, p. 96.
[3] Hanawalt, J. D., 87th Annual Survey and Outlook-Magnesium: Eng. Min. Journal, vol. 157, No. 2, February 1956, p. 95.
[4] Winston, A. W., Magnesium Outlook: Modern Metals, vol. 11, No. 12, January 1956, pp. 88-89.
[5] Light Metals Bulletin, Magnesium: Vol. 17, No. 10, May 13, 1955, p. 470.
[6] E & M J Metal and Mineral Markets, All-Magnesium Aircraft are here: Vol. 26, No. 25, June 23, 1955, p. 7.
American Metal Market, All-Magnesium Plane has half as many parts as Aluminum Counterpart: Vol. 62, No. 114, June 14, 1955, p. 10.
[7] Materials and Methods, Magnesium and Plastics Make Light Jet Target: Vol. 41, No. 6, June 1955, p. 114.
Modern Metals, 100-Foot Magnesium Mast Weighs Only 800 Pounds: Vol. 12, No. 2, March 1956, p. 66.
[8] American Metal Market, Magline Develops New All-Magnesium Truck: Vol. 62, No. 99, May 21, 1955, p. 5.
Light Metal Age, Magnesium Refrigerated Truck Body: Vol. 14, Nos. 3, 4, April 1956, p. 33.
[9] Business Week, Magnesium Goes Civilian: No. 1367, Nov. 12, 1955, pp. 186-192.
Modern Metals, Switched from Aluminum: Vol. 11, No. 8, September 1955, pp. 52-53. Magnesium Make New Luggage Ultralite: Vol. 11, No. 1, February 1955, pp. 78-79.
Light Metals Bulletin, First Magnesium Consumer Product: Vol. 17, No. 6, Mar. 18, 1955, p. 287.
[10] American Metal Market, Development of Dock-Board System Made of Magnesium Announced: Vol. 62, No. 101, May 25, 1955, p. 9. New Magnesium Conveyor. Vol. 62, No. 98, May 20, 1955, p. 9.
Steel, High Spots In Magnesium's Expanding Market: Vol. 137, No. 10, Sept. 5, 1955, p. 46.
Magnesium Topics (Dow Chemical Co.), Demountable Printing: Vol. 6, No. 2, March 1956, p. 5.
Modern Metals, Print It With Magnesium: Vol. 12, No. 3, April 1956, p. 16. New Magnesium Dolly: Vol. 11, No. 10, November 1955, p. 105.
Church, F. L., Goodwill Ambassador, Magnesium Tooling Plate: Modern Metals, vol. 12, No. 4, May 1956, pp. 80-88.
Bohrman, Thor H., Magnesium—Aid to Tooling: Light Metal Age, vol. 13, No. 12, December 1955, pp. 18-19, 36.
Iron Age, Tooling Plate—Don't Overlook Magnesium: Vol. 177, No. 12, Mar. 22, 1956, p. 41.
Close, Gilbert C., Magnesium Tooling Plate: Light Metal Age, vol. 14, Nos. 3, 4, April 1956, pp. 12-13.

STOCKS

At the close of 1955, producers' and consumers' stocks were 23,000 tons of primary magnesium and 6,638 tons of primary magnesium-alloy ingot. Government agencies continued to hold quantities of primary magnesium, as provided by the Critical Materials Stockpiling Act.

PRICES

The base price of domestic primary magnesium ingot, at 27 cents per pound throughout 1954, was increased twice in 1955; on March 21 it rose to 28 cents per pound, f. o. b. Velasco, Tex.,[11] and on August 16 to 32.5 cents per pound.[12]

FOREIGN TRADE [13]

Imports.—During 1955 imports of magnesium rose 150 percent above 1954; approximately 4 percent was scrap metal; but most came from Norway as primary pig and ingot and from Canada in the forms of primary ingot, alloy ingot, and fabricated alloys. Tariff rates remained the same as in 1954: Magnesium metal, 20 cents per pound; alloys, powder, sheets, tubing, wire, manufactures, etc., 20 cents per pound on magnesium content plus 10 percent ad valorem. Public Law 66 of the 84th Congress, 1st sess., extended the suspension of duty on magnesium metallic scrap to June 30, 1956. Imports were received from 4 countries in 1955 compared with 7 countries in 1954. Of the 1,857 tons of magnesium metal and scrap imported, 975 tons came from Canada, 828 from Norway, 45 from the Philippines, and 9 from the United Kingdom.

Exports.—Over twice as much magnesium was exported as in 1954. A general trend toward the use of magnesium in Europe for various civilian applications was noted early in 1955.[14] Of the 7,611 tons of primary metal, alloys, and scrap exported in 1955, 3,769 tons was delivered to the Netherlands, 2,027 to West Germany, 428 to Japan, 341 to Mexico, 333 to Sweden, 138 to United Kingdom, 96 to Turkey, 71 to Belgium-Luxembourg, 66 to Yugoslavia, 62 to Venezuela, 57 each to Norway and Trinidad-Tobago, 35 to Canada, 25 to Switzerland, 22 each to Austria and Saudi Arabia, 20 to Egypt, 12 to Brazil, 6 to Nicaragua, 5 each to Guatemala and Netherland Antilles, 3 each to British Malaya and Israel, and 2 each to Arabian Peninsula States, Colombia, French West Indies, and Peru.

Canada received 116 tons of the semifabricated forms; Netherland Antilles, 28 tons; Venezuela, 18; Australia, 5; Israel, 4; Italy 3; Colombia, Cuba, and United Kingdom, 2 each; Switzerland and Indonesia, 1 each; and other countries, 54.

---

[11] Modern Metals, Boost Magnesium Prices: Vol. 11, No. 3, April 1955, p. 90.
[12] American Metal Market, Dow Increases Magnesium Price by 4 Cents per Pound: Vol. 62, No. 158, Aug. 16, 1955, p. 1.
E&MJ Metal and Mineral Markets, Magnesium: Vol. 27, No. 1, Jan. 5, 1956, p. 4.
[13] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.
[14] American Metal Market, Market for Magnesium Is Growing in Europe: Vol. 62, No. 135, July 14, 1955, p. 9.

Of the 14 tons of magnesium powder exported, 8 tons was delivered to Canada, 2 to Belgium-Luxembourg, and less than 1 ton each to France, Italy, Norway, Spain, and West Germany.

TABLE 4.—Magnesium imported for consumption and exported from the United States, 1946–50 (average) and 1951–55

[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		Semifabricated forms n. e. c.		Powder	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	905	$227,558	(1)	$1,039	5	$10,355	363	$155,643	173	$140,503	2	$1,221
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
1953	2,443	877,130	3	15,537	5	19,983	[3] 2,722	[3] 1,718,232	[3] 227	[3] 771,032	21	41,591
1954	733	337,773	6	29,767	3	14,159	[3] 3,096	[3 4] 1,766,650	[3] 161	[3] 605,251	34	44,605
1955	1,844	1,034,241	9	52,254	4	24,526	[3] 7,611	[3] 4,383,606	[3] 236	[3] 514,986	14	33,911

[1] Less than 1 ton.
[2] Data not separately classified.
[3] Due to changes in items included in each classification, data are not strictly comparable with earlier years
[4] Revised figure.

TECHNOLOGY

In 1955, research progressed both in development and use of improved magnesium alloys. A technical paper discussed the development of new magnesium alloys containing lithium and aluminum [15] at the Bureau of Mines Mississippi Valley Experiment Station, Rolla, Mo.

A favorable report was given on the tests of the magnesium alloy HK31 in missiles flying at speeds that raised their body temperatures to 700° F.[16] Methods were developed for rapidly measuring the zirconium in this and other alloys containing zirconium.[17]

Tests were begun to ascertain the possibility of the application of magnesium in equipment for use in regions of subzero temperatures. The first reports showed promising results.[18]

Improved alloying techniques and fabrication processes were developed.[19]

An automatic machine was installed in a California plant in 1955, to form one-piece jet aircraft wings. Replacing the method of rivet-

[15] Rowland, J. A., Armantrout, C. E., and Walsh, D. E., Magnesium-Rich Corner of the Magnesium-Lithium-Aluminum System: Jour. Metals (Trans., AIME), vol. 7, No. 2, Sec. 2, February 1955, pp. 355–359.
[16] Steel, Taming Supersonic Heat: Vol. 138, No. 15, Apr. 9, 1956, pp. 112, 114.
[17] Elving, Philip J., Titrimetric Determination of Zirconium in Magnesium Alloys: Anal. Chem., vol. 28, No. 2, February 1956, pp. 251–252.
[18] Metal Progress, Low-Temperature Deformation of Magnesium: Vol. 68, No. 4, October 1955, pp. 178, 180.
Light Metals Bulletin, Mechanical Properties of a Magnesium Alloy Under Biaxial Tension at Low Temperatures: Vol. 18, No. 5, Mar. 2, 1956, p. 201.
[19] Light Metals Bulletin (London), Hot-Formed Magnesium Skins Save Weight and Time: Vol. 17, No. 11, May 27, 1955, pp. 511–512.
Levy, Alan V., Thorium-Magnesium Sheet: Materials and Methods, vol. 43, No. 3, March 1956, pp. 114–117.
Bohrman, Thor H., Magnesium Tooling—Aid to Production: Am. Metal Market, vol. 62, No. 226, ov. 24, 1955, p. 9.

ing flat metal parts, the forming machine could cut the time of 1 manufacturing operation from 60 hours to 15 minutes.[20]

Improved techniques for extruding and forging magnesium alloys resulted in producing finished products with better mechanical properties.[21]

New practices of founding and heat treatment of magnesium castings resulted in increased tensile and compressive strength.[22]

New and improved protective coatings for magnesium insured better protection against fatigue and against corrosion from exposure to salt spray.[23]

Improvements leading to increased use of magnesium for cathodic protection of other metals were reported in 1955.[24]

The technology of sacrificial uses of magnesium in producing or refining other metals was described.[25]

WORLD REVIEW

In 1955 the United States reported 44 percent of the estimated total world production of primary magnesium. Increased use of the metal during 1955 in many countries was attributed to the intensive program of both fundamental and applied research that was conducted.[26]

Canada.—Although no statistics were released on the production of magnesium and magnesium products in Canada in 1955, published articles indicated that output of the metal from the two plants was at record capacity. Both plants obtained ore from their own deposits to supply their requirements for producing alloys, castings, and extruded shapes. Dominion Magnesium, Ltd., owned three dolomite deposits and its own ferrosilicon-treatment plant. Aluminum Co. of Canada employed the electrolytic method of producing magnesium and utilized granular calcined brucite as the source of the metal. Dominion Magnesium, Ltd., produced calcium, thorium, and zirconium by using magnesium as a reducing agent.[27] Seven magnesium foundries operated in Canada in 1955, but no rolling mills had been built.

---

[20] American Metal Market, Simmons Machine Builds Skin Mill for Forming One-Piece Wing Panels: Vol. 62, No. 120, June 22, 1955, p. 9.

[21] Materials and Methods, Impact Extrusion of Magnesium: Vol. 42, No. 2, August 1955, p. 125. David, C. K., Modern Impact Forging: Metals Review, vol. 29, No. 2, February 1956, p. 18.

[22] Metal Progress, Successful Founding of Magnesium Alloys: Vol. 68, No. 2, Aug. 1, 1955, pp. 156–168. Brooks, M. E., Heat Treating Magnesium: Steel, vol. 137, No. 2, July 11, 1955, pp. 88–91.

[23] Light Metal Age, Magnesium Primer: Vol. 13, No. 10, 11, October 1955, p. 36. New Protective Coating for Magnesium Alloys: Vol. 13, No. 8, August 1955, pp. 22–23.
Warren, Forrest, Magnesium Protection Methods for Missiles, Light Metal Age, vol. 13, No. 8, August 1955, pp. 14–15.
Hardouin, Maurice, Corrosion Protection of Magnesium Alloys: Metal Ind., vol. 87, No. 19, Nov. 5, 1955, pp. 385–387.
Materials and Methods, Primer for Magnesium Cuts Corrosion: Vol. 42, No. 3, September 1955, p. 160.
Bennett, J. A., The Effect of an Anodic (HAE) Coating on the Fatigue Strength of Magnesium Alloy Specimens: Light Metals Bull. (London), vol. 18, No. 5, Mar. 2, 1956, p. 201.

[24] American Metal Market, Magnesium Anodes for Ships: Vol. 62, No. 180, Sept. 16, 1955, p. 9.
Light Metals Bulletin (London), Use of Cathodic Protection in the Chemical Industry: Vol. 17, No. 11 May 27, 1955, p. 512.

[25] Wilhelm, H. A., Reduction of Uranium With Magnesium: Metal Progress, vol. 69, No. 3, March 1956, pp. 81–88.
E&MJ Metal and Mineral Markets, Ductile Cast Iron: Vol. 26, No. 51, Dec. 22, 1955, p. 7.

[26] American Metal Market, Market for Magnesium Is Growing in Europe: Vol. 62, No. 135, July 14, 1955, p. 9; Magnesium Use to Grow, Dutch Group Forecasts: Vol. 63, No. 26, Feb. 8, 1956, pp. 2, 9.

[27] American Metal Market, Dominion Magnesium Continues Miscellaneous Metals Development: Vol. 62, No. 53, Mar. 17, 1955, pp. 1, 9.

TABLE 5.—World production of magnesium metal, by countries, 1946–50 (average) and 1951–55, in short tons [1]

(Compiled by Pearl J. Thompson)

Country	1946–50 (average)	1951	1952	1953	1954	1955
Canada	[2] 459	4,409	[2] 5,500	[2] 6,600	[2] 6,600	[2] 7,700
China, Manchuria	------	(3)	(3)	(3)	(3)	(3)
France	704	963	1,200	1,194	1,268	1,670
Germany:						
East [2]	750	1,100	1,100	1,100	1,100	1,100
West [4]	------	------	------	------	154	144
Italy	248	134	1,076	1,595	1,836	3,161
Japan	------	------	------	------	23	148
Norway	------	338	338	3,853	5,183	7,441
Switzerland	99	275	331	[2] 275	------	------
U. S. S. R.[2]	20,000	35,000	45,000	55,000	45,000	55,000
United Kingdom [4]	2,623	5,512	5,071	5,936	5,577	6,054
United States	10,997	40,881	105,821	93,075	69,729	61,135
World total (estimate)	36,000	90,000	170,000	170,000	140,000	140,000

[1] This table incorporates a number of revisions of data published in previous Magnesium chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[2] Estimate.
[3] Data not available; estimate by author of chapter included in total.
[4] Primary metal and remelt alloys.

France.—Production of magnesium in France in 1955 was reported at 1,670 tons, an increase of 402 tons above 1954. Development of use techniques and new applications for the metal made notable progress during 1955.[28]

Germany, West.—In West Germany in 1955 primary magnesium was produced exclusively at the electrothermic pilot plant near Cologne. This operation was stopped before the close of the year in order to build regular commercial production facilities. Consumption of primary and secondary magnesium was reported at 16,000 tons, most of which came from the United States and Norway. One of the leading individual consumers of magnesium for structural purposes was Volkswagenwerk at Wolfsberg, which used 36 pounds of magnesium castings in each Vollkswagen engine.[29] Another company produced large quantities of magnesium die castings for oil-pump housings in automotive equipment.[30]

Italy.—Production of primary magnesium in Italy in 1955 increased 72 percent above 1954. Most of this output was exported to other European countries.

Japan.—Production of magnesium in Japan, which ceased at the close of World War II, was resumed late in 1954. Output of the metal at the Furukawa plant, sole producer, was 148 tons in 1955. The plant utilized dolomite in obtaining magnesium by thermal reduction.

Norway.—In 1955 production of primary magnesium in Norway increased 44 percent above 1954. The electrolytic plant at Herøya was the sole producer, utilizing sea water and dolomite as the source of the metal.

U. S. S. R.—Although no direct information was available on magnesium in the Union of Soviet Socialist Republics in 1955, reports

[28] Light Metals (London), Magnesium Progress in France: Vol. 18, No. 211, October 1955, pp. 336–337.
[29] Boehner, Ludwig C., Magnesium in the Volkswagen: Modern Metals, vol. 11, No. 11, December 1955, pp. 44, 46, 48.
[30] Hanawalt, J. D., Magnesium in Europe: Dow Magnesium Topics, vol. 5, No. 5, October 1955, pp. 2–5.

received from Europe indicated that magnesium production had risen to 55,000 tons and consumption was well above that of 1954.

United Kingdom.—Production of magnesium in the United Kingdom in 1955 was 477 tons above 1954. British sales of magnesium and its alloys were approximately 11,000 tons, 37 percent above 1954.[31] Magnesium basic research and use technology in the United Kingdom progressed, particularly in developing improvements in high-temperature alloys,[32] protective surface treatments,[33] fabricating techniques,[34] and joining techniques.[35] At Manchester in June 1955, the magnesium-producing industry in the United Kingdom celebrated the 21st anniversary of its establishment.[36]

---

[31] Light Metals (London), Magnesium Alloys in British Industry: Vol. 19, No. 218, May 1956, pp. 135-137.

[32] Emley, E. F., The Work of the Metallurgical Research Department of Magnesium Elektron, Ltd.: Metallurgia (Manchester), vol. 52, No. 310, August 1955, pp. 79-81.

[33] Higgins, W., Modern Concepts in the Protection of Magnesium Base Alloys: Metallurgia (Manchester), vol. 52, No. 311, September 1955, pp. 121-124.

[34] Wilkinson, R. G., The Hot Forming of Magnesium Alloys: Jour. Inst. Metals (London), vol. 3, p. 7, March 1956, pp. 217-228.

[35] Light Metals Bulletin (London), Welding of Magnesium Alloys: Vol. 18, No. 1, Jan. 6, 1956, p. 36.

[36] Light Metals (London), Magnesium Elektron Ltd., 1934-1955: Vol. 18, No. 208, July 1955, pp. 211-212.

Magnesium Compounds

By H. B. Comstock[1] and Jeannette I. Baker[2]

PRODUCTION and consumption of magnesium compounds in the United States showed pronounced upward trends in 1955. The United States supplied 10 percent of the world production of crude magnesite compared with 7 percent in 1954. Imports of refractory magnesia and periclase increased 50 percent and dead-burned dolomite 80 percent above 1954. The value of exports of magnesite and magnesias decreased approximately 15 percent below 1954. Prices of refractory grades of magnesias in 1955 showed slight increases above 1954. Research by private foundations and the refractories and steel industries resulted in the development of stronger magnesia refractories.

TABLE 1.—Salient statistics of magnesite, magnesia, and dead-burned dolomite in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Crude magnesite produced:						
Short tons	356,974	670,167	510,750	553,147	284,015	486,088
Value	[1] $2,480,954	[1] $4,506,712	$2,871,548	[1] $3,223,759	$1,391,392	$2,712,942
Average per ton	$6.95	$6.72	$5.62	$5.83	$4.90	$5.58
Caustic-calcined magnesia sold or used by producers:						
Short tons	35,834	49,981	38,055	43,020	32,254	35,751
Value [2]	$3,197,994	$4,810,379	$3,769,466	$3,991,309	$2,154,652	$2,240,612
Average per ton [3]	$89.24	$96.24	$99.05	$92.78	$66.80	$62.67
Refractory magnesia sold or used by producers:						
Short tons	295,128	432,197	386,873	399,132	288,270	418,761
Value	$11,239,550	$18,400,131	$17,255,837	$19,060,796	$13,850,712	$20,304,639
Average per ton [3]	$38.08	$42.57	$44.60	$47.76	$48.05	$48.49
Dead-burned dolomite sold or used by producers:						
Short tons	1,419,218	1,966,460	1,928,025	2,294,815	1,520,854	2,128,960
Value	$15,980,007	$26,375,313	$26,098,455	$31,455,384	$21,960,684	$31,424,587
Average per ton	$11.26	$13.41	$13.54	$13.71	$14.44	$14.76

[1] Partly estimated; most of crude is processed by mining companies, and very little enters open market.
[2] Includes speciality magnesias of high unit value.
[3] Average receipts f. o. b. mine shipping point.

DOMESTIC PRODUCTION

Magnesite.—Production of crude magnesite (consisting of crude ore, heavy-medium concentrates, and flotation concentrates) came from four places in the United States in 1955. The output increased 71 percent in quantity and 95 percent in value compared with 1954.

[1] Commodity specialist.
[2] Research assistant.

Northwest Magnesite Co., Chewelah, Stevens County, Wash., continued as the largest producer of the crude ore in the United States. An informative article relating the history and progress of quarrying and processing magnesite appeared in a Nevada periodical.[3]

Magnesia.—Output of magnesia from sea water and well brines in 1955 increased 42 percent above 1954. This was almost equal to the quantity derived from magnesite, dolomite, and brucite. In 1955 production of caustic-calcined magnesia increased 11 percent above 1954, while production of refractory magnesia increased 6 percent.

In May 1955 Kaiser Aluminum & Chemical Corp. began construction of a new refractory plant at Columbiana, Ohio, to produce basic brick from high-magnesia periclase, periclase chrome, and chrome periclase.[4]

TABLE 2.—Magnesia sold or used by producers in the United States, 1954–55, by kinds and sources

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
1954						
Caustic-calcined [2]	3,313	$180,548	28,941	$1,974,104	32,254	$2,154,652
Refractory	159,162	6,555,463	129,108	7,295,249	288,270	13,850,712
Total	162,475	6,736,011	158,049	9,269,353	320,524	16,005,364
1955						
Caustic-calcined [2]	3,881	132,275	31,870	2,108,337	35,751	2,240,612
Refractory	225,448	9,307,085	193,313	10,997,554	418,761	20,304,639
Total	229,329	9,439,360	225,183	13,105,891	454,512	22,545,251

[1] Magnesia made from a combination of dolomite and sea water is included with that from sea water.
[2] Includes specified magnesium compounds shown in table 4.

Dolomite.—Production of dead-burned dolomite in 1955 increased 40 percent in quantity and 43 percent in value above 1954. On April 16, 1955, Michigan Limestone Division, United States Steel Corp., shipped the first cargo of dolomite from its new quarry in Chippewa County, Mich. Equipment at the quarry could excavate 3 million tons of the ore annually.[5]

Brucite.—No brucite was mined in 1955.

Olivine.—The quantity of olivine produced in the United States in 1955 was 93 percent above 1954; the value showed an increase of over 50 percent. Harbison-Walker Refractories Co., of Pittsburgh, Pa., continued to be the largest producer of the ore from its quarry near Addie, N. C. For the first time Balsam Gap Co. reported considerable tonnage of olivine mined in 1955 from its quarry near Waynesville, N. C.

[3] Nevada Highways and Parks, vol. 15, No. 2, May–October 1955, pp. 28–32.
[4] American Metal Market, vol. 62, No. 62, Mar. 30, 1955, p. 9.
[5] Gillson, J. L., Industrial Minerals: Min. Cong. Jour., vol. 42, No. 2, February 1956, p. 130.
Rock Products, Opens New Dolomite Quarry: Vol. 58, June 1955, pp. 69, 77.

TABLE 3.—Dead-burned dolomite sold in and imported into the United States, 1946–50 (average) and 1951–55

Year	Sales of domestic product		Imports [1]	
	Short tons	Value	Short tons [2]	Value
1946–50 (average)	1,419,218	$15,980,007	1,292	$50,582
1951	1,966,460	26,375,313	2,719	128,207
1952	1,928,025	26,098,455	2,342	123,596
1953	2,294,815	31,455,384	3,876	259,427
1954	1,520,854	21,960,684	4,426	344,665
1955	2,128,960	31,424,587	7,993	[3] 557,554

[1] Dead-burned basic refractory material consisting chiefly of magnesia and lime.
[2] Includes weight of immediate container.
[3] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data are not comparable to years prior to 1954.

TABLE 4.—Specified magnesium compounds, produced, sold, and used by producers in the United States, 1954–55

Products [1]	Plants	Produced	Sold		Used
		Short tons	Short tons	Value	Short tons
1954					
Specified magnesias (basis, 100 percent MgO), U. S. P. and technical:					
Extra-light and light	5	3,133	3,074	$1,208,167	
Heavy	3	8,934	7,985	967,213	103
Total	[2] 6	12,067	11,059	2,175,380	103
Precipitated magnesium carbonate	8	47,435	8,122	2,120,777	37,781
Magnesium hydroxide, U. S. P. and technical (basis, 100 percent $Mg(OH)_2$)	3	[3] 46,320	5,282	[3] 289,804	40,770
1955					
Specified magnesias (basis, 100 percent MgO), U. S. P. and technical:					
Extra-light and light	6	3,126	3,602	1,445,307	
Heavy	4	16,437	15,517	1,973,244	161
Total	[2] 7	19,563	19,119	3,418,551	161
Precipitated magnesium carbonate	7	34,762	14,541	2,940,924	21,521
Magnesium hydroxide, U. S. P. and technical (basis, 100 percent $Mg(OH)_2$)	4	[3] 74,290	5,919	[3] 433,489	71,563

[1] In addition, magnesium chloride, nitrate, phosphate, acetate, silicate, and trisilicate were produced.
[2] A plant producing more than 1 grade is counted but once in arriving at total.
[3] Magnesium hydroxide produced as an intermediate compound in the manufacture of magnesia or magnesium not included.

TABLE 5.—Mines and plants producing magnesite, brucite, and other magnesium compounds in the United States, 1955

Company	Location of mine or plant	Products	Raw materials
CALIFORNIA			
Kaiser Aluminum & Chemical Corp.	Moss Landing	Caustic-calcined magnesia; refractory magnesia; magnesium hydroxide; magnesium oxide, extra-light, light, and heavy.	Sea water, dead-burned dolomite.
James McPeters	Western Mine (near Livermore).	Magnesite	
Marine Magnesium Division, 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.
Philadelphia Quartz Co. of Calif.	Alameda County	Epsom salt	Magnesite, brucite, calcined magnesia.
Westvaco Chemical Division, Food Machinery & Chemical Corp.	Newark	Caustic-calcined magnesia; refractory magnesia; magnesium chloride crystals; magnesium hydroxide.	Sea-water bitterns, dead-burned dolomite, magnesite.
ILLINOIS			
Johns-Manville Products Corp.	Waukegan	Precipitated magnesium carbonate.	Dolomite.
MICHIGAN			
Dow Chemical Co	Ludington	Magnesium chloride crystals; magnesium chloride fluxes.	Well brines.
	Midland	Epsom salt	Do.
Michigan Chemical Corp.	St. Louis	Precipitated magnesium carbonate; magnesium hydroxide; magnesium oxide, extra-light, light, and heavy.	Well brines, dead-burned dolomite.
Morton Salt Co	Manistee	Precipitated magnesium carbonate; magnesium oxide, extra-light and light.	Well brines.
The Standard Lime & Cement Co.	do	Refractory magnesia	Do.
NEVADA			
Basic, Inc	Gabbs	Brucite, magnesite, refractory magnesia.	Magnesite and brucite.
Standard Slag Co	do	Magnesite, refractory magnesia, caustic-calcined magnesia.	Magnesite.
NEW JERSEY			
J. T. Baker Chemical Co.	Phillipsburg	Magnesium chloride crystals; epsom salt; other high purity magnesium chemicals.	Magnesium carbonate.
Johns-Manville Corp	Manville	Precipitated magnesium carbonate.	Purchased magnesia.
Northwest Magnesite Co.	Cape May	Refractory magnesia	Sea water, calcined dolomite.
NEW MEXICO			
International Minerals & Chemical Corp.	Carlsbad	Magnesium oxide, heavy	Potash reject brines.

TABLE 5.—Mines and plants producing magnesite, brucite, and other magnesium compounds in the United States, 1955—Continued

Company	Location of mine or plant	Products	Raw materials
NORTH CAROLINA			
Balsam Gap Co.	Balsam Gap Mine (near Sylva).	Olivine	
Harbison-Walker Refractories Co.	Addie Mine (near Sylva).	do	
C. R. Wiseman	Wray Mine (near Burnsville).	do	
PENNSYLVANIA			
Philip Carey Mfg. Co.	Plymouth Meeting.	Precipitated magnesium carbonate; magnesium oxide, extra-light and light.	Dolomite.
Keasbey & Mattison Co.	Ambler	Precipitated magnesium carbonate; magnesium oxide, extra-light and light.	Do.
TEXAS			
Dow Chemical Co.	Freeport	Magnesium chloride, cell feed; caustic-calcined magnesia.	Sea water.
WASHINGTON			
Agro Minerals, Inc.	Tonasket	Epsom salt	Lake brine.
Northwest Magnesite Co.	Chewelah	Magnesite, caustic-calcined magnesia, refractory magnesia.	Magnesite.
Northwest Olivine Co.	Twin Sisters Quarry (near Clear Lake).	Olivine	
WEST VIRGINIA			
The Standard Lime & Cement Co.	Millville	Refractory magnesia	Dolomite.

CONSUMPTION AND USES

Demands for the magnesian ores in 1955 showed marked increases above 1954. Northwest Magnesite Co. and Basic, Inc., (formerly Basic Refractories, Inc.,) the two largest producers of magnesite, reported much greater demand for the ore in 1955 than in 1954. Requirements for dead-burned dolomite increased in 1955 in direct proportion to expanded production of iron and steel. Use of brucite from existing stocks increased 72 percent above that in 1954.

Requirements for refractory magnesia increased in 1955, both in the ferrous and nonferrous metals industries. Producers of industrial chemicals were the largest consumers of both caustic-calcined and technical and U. S. P. magnesia.

The following percentages show the uses for caustic-calcined magnesia in the United States for 1951–55:

Use	1951	1952	1953	1954	1955
Oxychloride and oxysulfate cement	24	29	41	33	34
Rayon	24	17	8	3	4
Fertilizer	13	5	2	2	1
85 percent MgO insulation	-------	11	13	14	11
Rubber (filler and catalyst)	6	4	1	1	3
Fluxes	-------	1	1	1	(1)
Refractories	6	8	-------	-------	4
Miscellaneous (including chemicals and paper industry)	27	25	34	46	43
Total	100	100	100	100	100

1 Less than 1 percent.

Technical and U. S. P. magnesia uses and percentages from 1951 to 1955 were as follows:

Use	1951	1952	1953	1954	1955
Rayon	-------	-------	45	24	16
Rubber (filler and catalyst)	41	65	29	47	27
Refractories	-------	-------	13	10	15
Medicinal	9	8	3	3	7
Uranium processing	-------	-------	-------	-------	2
Miscellaneous industrial and chemical (including neoprene compounds)	50	27	10	16	33
Total	100	100	100	100	100

PRICES

The quoted prices and net sales values for various magnesium compounds show that most prices remained steady in 1955, although wide variations were noted in the prices of some grades. The exception was the price of both dead-burned grain magnesite and caustic-calcined magnesia, which increased 2 dollars a ton, effective in November. The average price of calcined magnesia, heavy U. S. P. grade, increased from 36–38 cents per pound to 45–52 cents per pound in March 1955. Dead-burned dolomite price increases ranged from 35 to 50 cents per ton during 1955.[6]

6 Steel, vol. 136, No. 1, Jan. 3, 1955, p. 468; vol. 137, No. 26, Dec. 26, 1955, p. 98.

TABLE 6.—Prices quoted on selected magnesium compounds, carlots, 1954–55

Commodity	Unit	Container	F. o. b.	Source	January 1954	January 1955	December 1955
Magnesite:							
Caustic-calcined, oxychloride-cement grade, powdered	Short ton	Bags	Newark, Calif	(1)	$80.00	[2] $74.46	[2] $79.64
Dead-burned, grain	do	Bulk	Chewelah, Wash	(3)	38.00	38.00	[4] 40.00
Do	do	Bags	do	(3)	43.75	43.75	[4] 45.75
Periclase: Kiln-run, 90 percent	do	Bulk	Newark, Calif	(1)	62.00	59.73	57.50
Epsom salt: Tech. grade	100 lb	Bags	do	(5)	2.15	2.15	2.15
Magnesia, calcined:							
Tech. grade	Pound	Cartons	Works	(5)	0.32-.3475	0.2525-.26	0.2525-.26
Synthetic, rubber grade	do	do	do	(5)	.31	.2925-.30	.2925-.30
U. S. P.:							
Light	do	do	do	(5)	.34-.36	.35-.36	.35-.36
Heavy	do	Barrels	do	(5)	.36-.38	.36-.38	[6] .45-.52
Magnesium carbonate:							
Tech. grade	do	Bags	(7)	(5)	.095	.105	.105
U. S. P. grade	do	do	(7)	(5)	.1125	.125	.125
Magnesium chloride, powdered or flaked	Short ton	Barrels or bags	Works	(5)	50.00	50.00	50.00
Magnesium hydroxide: Medicinal grade	Pound			(5)	.265-.30	.265-.30	.265-.30

[1] Westvaco Chemical Division, Food Machinery & Chemical Corp.
[2] Average net-sales value.
[3] E&MJ Metal and Mineral Markets.
[4] Effective Nov. 3, 1955.
[5] Oil, Paint and Drug Reporter.
[6] Effective Mar. 14, 1955.
[7] Magnesium carbonate prices are quoted f. o. b. works; freight is equalized with metropolitan New York and competitive producing points.

FOREIGN TRADE [7]

Imports.—Dead-burned and grain magnesia (refractory) and periclase imported in 1955 increased 50 percent in quantity and 62 percent in value above 1954. Austria supplied 60 percent of the total compared with 68 percent in 1954. Switzerland furnished 19 percent of the 1955 total, Yugoslavia 15 percent, Canada 4 percent, and Italy 2 percent. This was the first export of magnesia from Italy to the United States since 1952.

TABLE 7.—Magnesite imported for consumption in the United States, 1953–55, by countries

[Bureau of the Census]

Country	1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
CRUDE MAGNESITE						
North America: Canada					11	$531
Grand total					11	531
LUMP CAUSTIC-CALCINED MAGNESIA						
Europe: Yugoslavia	1,413	$48,284				
Asia: India	1,141	50,608				
Grand total	2,554	98,892	(1)	(1)	(1)	(1)
GROUND CAUSTIC-CALCINED MAGNESIA						
North America: Canada					30	$2,375
Europe:						
Austria	56	$1,778	83	$2,636	88	2,815
France			27	950	33	1,440
Netherlands	16	891	16	808	16	866
United Kingdom	4	551	7	1,299	50	9,817
Yugoslavia	61	2,352	1,235	44,556	1,378	51,240
Total	137	5,572	1,368	50,249	1,565	66,178
Asia: India	22	1,300	1,070	41,570	1,955	75,179
Grand total	159	6,872	2,438	91,819	3,550	143,732
DEAD-BURNED AND GRAIN MAGNESIA AND PERICLASE						
North America: Canada	2,888	$648,422	3,584	$831,949	4,095	$945,995
Europe:						
Austria	33,026	1,634,786	46,641	2,466,428	61,460	3,672,000
Italy					1,653	87,000
Switzerland					19,933	1,265,796
Yugoslavia	3,383	185,191	17,987	859,661	15,551	757,723
Total	36,409	1,819,977	64,628	3,326,089	98,597	5,782,519
Grand total	39,297	2,468,399	68,212	4,158,038	102,692	6,728,514

1 Beginning January 1, 1954, not separately classified; included with "Ground."

7 Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the Bureau of the Census.

The imports of ground caustic-calcined magnesia in 1955 increased 46 percent in quantity and 56 percent in value, compared with 1954. Total imports of other magnesium compounds increased 22 percent above 1954.

The duty on crude magnesite in 1955, based on the Geneva Agreement of 1947, was 15/64 cent per pound, with an ad valorem of 10.1 percent. Duty on dead-burned and grain magnesite and periclase was 23/40 cent per pound, with an ad valorem of 11.7 percent, and on caustic-calcined magnesia, 15/32 cent a pound, with an ad valorem of 23.2 percent. Duty on magnesium oxide in 1955 was 2½ cents per pound, with an ad valorem of 11.6 percent.

TABLE 8.—Magnesium compounds imported for consumption in the United States, 1946–50 (average) and 1951–55

[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]		Manufactur of carbonate of magnesia	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	10	$3,245	198	$50,592	12	$868	464	$11,034	39	$10,717	1	$306
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
1953	------	------	253	72,498	319	9,878	6,782	167,478	182	66,479	15	1,500
1954	1	336	199	60,133	254	8,082	9,605	[2]226,691	33	13,086	------	------
1955	113	[2]48,598	282	[2]58,763	220	5,999	11,613	260,275	108	[2]17,369	21	5,135

[1] Includes magnesium silicofluoride or fluosilicate and calcined magnesium.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data are not comparable to those for earlier years.

Exports.—Magnesite, magnesia, and manufactures (except refractories) exported in 1955 were valued at $1,883,863 compared with $2,223,449 in 1954, a decrease of 15 percent.

TECHNOLOGY

In 1955 both producers and consumers reported development of stronger basic refractories.[8] Tests indicated that use of a new refractory, composed principally of magnesite and chrome ore, increased the ouptut of an electric steel furnace 37 percent.[9] Improved use and maintenance of high-magnesia refractories in banks and bottoms of basic electric-arc furnaces was discussed.[10] Other articles reported fuel saving and increased steel production in basic open-hearth furnaces.[11] Reports of studies of the reaction of refractories to inter-

[8] Whittemore, O. J., Jr., Special Refractories For Use Above 1,700° C.: Ind. Eng. Chem., vol. 47, No. 12, December 1955, pp. 2510–2512.
[9] Refractories Journal, No. 8, August 1955, p. 489.
[10] Bigge, H. C., Bottom Materials and Bottom Maintenance: Proc. Electric Furnace Steel Conf., Pittsburgh Meeting, Dec. 1–3, 1954, vol. 12, 1955, pp. 46–56.
Ogan, A. C., Maintenance of High-Magnesia Refractories in Banks and Bottoms: Proc. Electric Furnace Steel Conf., 1954, vol. 12, 1955, pp. 57–63.
[11] Iron Age, Capacity Gains. Fuel Savings Push All-Basic Open Hearth: Vol. 76 No. 12, Sept. 22, 1955, pp. 114–115.
Iron Age, Open Hearths, Downtime Cut: Vol. 176, No. 4, July 28, 1955, p. 23.

mittent operations of electric steel furnaces were published.[12] A report was published concerning improved techniques in the preparation of magnesia refractories.[13]

Increased interest in magnesium oxychloride and oxychloride cement indicated intensive technical studies into their properties and improved use techniques.[14]

Published articles during 1955 described improved techniques in the use of magnesium refractories in the glass industry.[15]

WORLD REVIEW

In 1955 estimated world production of crude magnesite increased approximately 9 percent above 1954. United States production increased from 7 percent of the world total in 1954 to 10 percent in 1955.

Australia.—Reports of production of crude magnesite in Australia reflected an increase of 25 percent above 1954.

Austria.—During 1955 Austria continued to lead the world in production of crude magnesite. The exports from Austria of dead-burned (refractory) and caustic-calcined magnesia showed increases for magnesite brick and dead-burned magnesia of 21 and 93 percent, respectively, over 1954.

Brazil.—Preliminary figures indicate that 947 tons of the estimated 11,000 tons of crude magnesite produced in 1955 was exported.

Canada.—Large deposits of brucite, dolomite, and magnesitic dolomite were the sources of refractory-grade magnesias in Canada in 1955. Although several small magnesite and hydromagnesite deposits in Western Canada were known, they were not worked because they were too far from the consuming industries. The production of basic refractories and basic brick, primarily for domestic consumption, was increased rapidly in Canada after World War II. The export of dead-burned refractories from Canada decreased from 7,887 tons in 1954 to 3,255 tons in 1955.[16] Imports of dead-burned and calcined magnesia amounted to 13,937 short tons, of which Yugoslavia supplied 54 percent and the United States 45 percent; the remaining 1 percent came from the United Kingdom, Netherlands, and India.[17] Canada also imported 100-percent dolomite firebrick valued at $1 million and magnesite firebrick valued at a half million dollars.[18]

---

[12] Blough, A. K., and Schrader, D. M., Effect of Intermittent Operations on Refractories Proc. Electric Furnace Steel Conf., 1954, vol. 12, 1955, pp. 84–86.

Hill, R. P., Effect of Intermittent Operations on Electric Furnace Refractories: Proc. Electric Furnace Steel Conf., 1954, vol. 12, 1955, pp. 87–88.

[13] Kriek, H. J. S., and White, J., The Dead-Burning of Magnesia: Refractories Jour., No. 2, February 1955, pp. 62–66.

[14] Newman, Edwin S., A Study of the System Magnesium Oxide-Magnesium Chloride-Water and the Heat of Formation of Magnesium Oxychloride: Nat. Bureau of Standards, Jour. Res., vol. 54, No. 6, June 1955, pp. 347–355.

Demediuk, Thaisa, Cole, W. F., and Hueber, H. V., Studies of Magnesium and Calcium Oxychlorides: Australian Jour. Chem., vol. 8, No. 2, May 1955, pp. 215–233.

Cole, W. F., and Demediuk, Thaisa, X-Ray, Thermal, and Dehydration Studies on Magnesium Oxychlorides: Australian Jour. of Chem., vol. 8, No. 2, May 1955, pp. 234–251.

Williams, Julian C., (assigned to Dow Chemical Co.), Method of Densifying Light Magnesia and of Cements Containing It: U. S. Patent 2,724,655, Nov. 22, 1955.

[15] Minshall, John B., and Hicks, James C., Performance Report of High-Magnesia Refractories in Glass Furnace Regenerators: Am. Ceram. Soc. Bull., vol. 34, No. 11, November 1955, pp. 368–371.

Siefert, A. C., and McEvoy, R. J., Basic Regenerator Refractories in a Borosilicate Glass-Wool Furnace: Am. Ceram. Soc. Bull., vol. 34, No. 10, October 1955, pp. 334–336.

[16] Dominion Bureau of Statistics, Trade of Canada: Exports: Vol. 12, No. 12, 1955, p. 151.

[17] Dominion Bureau of Statistics, Trade of Canada: Imports: Vol. 12, No. 12, December 1955, p. 145.

[18] Work cited in footnote 17, p. 135.

TABLE 9.—World production of magnesite, by countries,[1] 1946–50 (average) and 1951–55, in short tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America: United States	356,974	670,167	510,750	553,147	284,015	486,088
Total [1] [3]	520,000	940,000	840,000	880,000	790,000	900,000
South America:						
Brazil [3]	3,300	11,000	11,000	11,000	11,000	11,000
Venezuela	2,388	1,800				
Total [3]	5,688	12,800	11,000	11,000	11,000	11,000
Europe:						
Austria	394,300	732,260	818,200	895,971	925,006	1,094,412
Czechoslovakia	[3] 142,500	(4)	(4)	(4)	(4)	(4)
Germany, West	[3] 8,300					
Greece	16,251	70,392	89,939	117,879	84,327	66,980
Italy	951	1,136	1,130	2,269	3,290	4,075
Norway	1,671	1,602	1,630	2,049	915	874
Spain	8,901	15,138	13,917	16,653	30,450	28,873
Yugoslavia	53,820	99,114	41,647	135,052	119,069	129,114
Total [1] [3]	1,700,000	2,800,000	2,900,000	3,000,000	3,000,000	3,200,000
Asia:						
Cyprus (exports)	17	22	22	22		
India	64,504	131,562	99,726	103,878	78,968	[3] 83,000
Korea, Republic of		(4)	362			
Turkey	2,520	557	982	386	1,174	(4)
Total [1] [3]	160,000	300,000	330,000	340,000	420,000	550,000
Africa:						
Egypt	62	961				
Kenya	65					
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	6,861	16,330	12,072	10,824	7,792	11,610
Tanganyika (exports)	19	2,994		64	87	367
Union of South Africa	10,658	20,694	26,906	25,229	26,874	19,753
Total	17,665	40,979	38,978	36,117	34,753	31,730
Oceania:						
Australia	35,900	43,830	47,193	51,965	48,331	60,471
New Zealand	487	649	648	579	807	[3] 660
Total	36,387	44,479	47,841	52,544	49,138	[3] 61,200
World total (estimate)[1]	2,400,000	4,100,000	4,100,000	4,300,000	4,300,000	4,700,000

[1] Quantities in this table represent crude magnesite mined. In addition to countries listed, magnesite is also produced in Canada, China, Mexico, North Korea, Poland, and U. S. S. R., but data on tonnage of 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 Magnesium Compounds chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Data not available; estimate by senior author of chapter included in total.

Greece.—In 1955 production of magnesite (crude and calcined) was 66,980 tons; ⅙ was for domestic consumption, and the remaining ⅚ was exported to European countries. Known deposits of magnesite were estimated in 1951 to contain more than 1 million tons and probable deposits, more than 4 million tons.

India.—Salem Magnesite, Ltd., of Bombay, completed construction of a 100,000-ton plant to produce dead-burned magnesia, using machinery and equipment obtained from a firm in Japan under a technical assistance contract executed in July 1953. The contract stipulated that reimbursement would be made from shipments of the product to Japan over a period of 3 years.

TABLE 10.—Exports of caustic-calcined magnesia from Austria, by countries of destination, 1951–55, in short tons [1]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
North America: United States	557	300	82	98	64
South America: Argentina	46	33	5	160	214
Europe:					
Belgium-Luxembourg	213	265	181	197	148
Bulgaria		65	147	44	71
Czechoslovakia	3,777	3,502	3,067	3,275	4,359
Denmark	295	77	18	82	142
France	3,159	2,946	3,090	3,297	3,785
Germany:					
East	5,969	5,299	3,421	424	364
West	48,661	48,605	64,440	70,202	67,142
Hungary	969	1,520	63	437	781
Italy	2,824	2,079	2,441	2,851	3,766
Netherlands	736	153	50	98	33
Norway		50	44	55	20
Rumania	8		109		
Sweden	17	17	55	83	127
Switzerland	1,401	1,339	1,341	1,436	2,022
Trieste		17			
United Kingdom	195	260	776	1,384	1,391
Oceania: Australia			8		
Other countries			39	79	23
Total	68,827	66,527	79,377	84,202	84,452

[1] Compiled from Customs Returns of Austria.

TABLE 11.—Exports of refractory magnesia from Austria, by countries of destination, 1951–55, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
North America: United States	4,575	9,005	7,335	28,741	63,477
South America:					
Argentina	758	728	987	1,439	3,264
Brazil			196	14	
Chile	661	1,586	19	175	239
Peru	1,321		45	1,033	1,305
Europe:					
Belgium-Luxembourg	1,782	3,132	1,628	779	1,041
Bulgaria			3,300	2	17
Czechoslovakia	29	56	429	348	463
Denmark	448	481	331	236	618
Finland	3,323	843	475	512	475
France	12,451	14,795	12,368	9,065	11,671
Germany:					
East	96	5,364	3,537	52	29
West	17,525	23,752	21,854	18,409	44,874
Greece	187	106	37	83	77
Hungary	69	127	32	7,748	4,378
Italy	7,588	13,095	10,993	4,986	6,640
Netherlands	3,772	316	245	138	109
Norway	121	52	192	132	324
Poland	4,107	3,043	5,035	5,460	
Rumania	623	1,145	5,917	438	
Spain			14	8	21
Sweden	971	1,682	783	832	801
Switzerland	23,650	3,495	559	688	1,457
Trieste	110			6	
United Kingdom	1	545	1,283	2,227	22,508
Yugoslavia	7,820	5,868	709	134	138
Asia:					
India	110		742	1,310	571
Japan	24		176		1,126
Turkey	8	77	41	19	60
Other countries	178	661	632	1,904	1,925
Total	92,308	89,954	79,894	86,918	167,608

[1] Compiled from Customs Returns of Austria.
[2] This table incorporates a number of revisions of data published in the previous Magnesium Compounds chapter.

TABLE 12.—Exports of magnesite brick from Austria, by countries of destination, 1951–55, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
South America:					
Argentina	1,383	691	801	3,430	8,892
Chile	109	75	229	60	639
Europe:					
Belgium-Luxembourg	8,193	9,946	11,361	7,715	9,636
Bulgaria		154	288		151
Czechoslovakia	967	1,513	510	550	22
Denmark	3,126	2,451	4,347	3,641	3,516
Finland	1,786	2,039	4,153	3,180	3,157
France	24,437	30,359	37,947	26,346	36,562
Germany:					
East	1,658	2,661	2,712	1,661	815
West	27,320	31,211	31,095	38,742	46,843
Greece	604	692	714	786	1,218
Hungary	4,452	5,320	4,405	245	137
Italy	12,215	19,134	18,231	11,896	21,248
Netherlands	2,867	3,398	3,787	2,987	3,610
Norway	658	643	1,096	921	1,404
Poland	4,905	7,786	15,558	11,662	3,573
Rumania	1,102	4,405	4,974	5,860	
Spain			563	515	302
Sweden	10,258	10,839	12,785	10,899	13,049
Switzerland	1,761	2,077	1,595	1,197	1,933
United Kingdom	29	1,645	1,195	848	2,344
Yugoslavia	3,028	8,324	8,643	5,386	1,484
Asia: Turkey	709	1,828	2,355	602	1,597
Africa:					
Belgian Congo	55	21	132	410	329
British South Africa		1,499	2,515	1,101	
Oceania: Australia			20	115	4,110
Other countries	3,913	2,480	2,471	4,032	8,209
Total	115,535	151,191	174,482	144,787	174,780

[1] Compiled from Customs Returns of Austria.
[2] This table incorporates a number of revisions of data published in the previous Magnesium Compounds chapter.

Italy.—Production of crude magnesite in Italy in 1955 rose 24 percent above 1954. About 75 percent of this ore was dead-burned and shipped to the United States.

Japan.—Japan produced 864,786 tons of dolomite concentrate in 1955 and 12,125 tons of refractory magnesia from sea water.

TABLE 13.—Exports of magnesite from Greece, by countries of destination, 1951–55, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
France		2,362	1,323	4,850	5,098
Germany:					
East					298
West	661	13,272	11,401	3,847	982
Italy		2,315	551	2,320	1,654
United Kingdom	3,815	579	1,880	2,315	1,598
Other countries	16,096	82	1,323	827	2,425
Total	20,572	18,610	16,478	14,159	12,055

[1] Compiled from Customs Returns of Greece.
[2] This table incorporates a number of revisions of data published in the previous Magnesium Compounds chapter.

TABLE 14.—Exports of calcined magnesia from Greece, by countries of destination, 1951–55, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
France				1,039	1,064
Germany, West	10,351	8,953	14,370	23,679	15,710
Italy				24	
Netherlands	11,465	11,990	1,687	13,027	20,771
United Kingdom			661	2,389	3,146
United States	99	4,079			
Other countries	3,148	283	506	38	111
Total	25,063	25,305	17,224	40,196	40,802

[1] Compiled from Customs Returns of Greece.
[2] This table incorporates a number of revisions of data published in the previous Magnesium Compounds chapter.

Netherlands.—In the Netherlands the processing, use, and sale of raw and dead-burned magnesite imported mainly from Greece, Yugoslavia, and Austria progressed steadily after World War II. Exports of calcined magnesia from the Netherlands in 1955 increased 7 percent above 1954.

TABLE 15.—Exports of refractory magnesia from the Netherlands, by countries of destination, 1951–55, in short tons [1]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
Belgium-Luxembourg	431	507	444	503	386
Czechoslovakia	76	64			
Denmark	1,286	1,293	995	825	695
Egypt	116	65	57		
Finland	1,139	728	713	540	784
France	471	96	71	190	131
Germany, West	8,197	10,551	9,177	9,197	10,546
Netherlands Antilles		136			
New Zealand		62			
Norway	618	499	424	470	333
Portugal	57	108	65	99	84
Saar				202	142
Sweden	1,518	1,160	990	975	960
Union of South Africa	144	217	136	127	177
United Kingdom	2,627	2,232	3,211	3,746	3,727
Other countries	2,446	109	126	140	233
Total	19,126	17,827	16,409	17,014	18,198

[1] Compiled from Customs Returns of the Netherlands.

Norway.—Production of magnesite in Norway in 1955 was 874 tons, a slight decrease from 1954. Production of olivine increased 9 percent above 1954. Domestic iron and steel foundries consumed the olivine.

Peru.—Peruvian exports of magnesium sulfate in 1955 mounted to 503,727 tons compared with 70 tons in 1954. In July Harbison-Walker Refractories Co. reported the purchase of a tract of land in Lima on which to construct a plant immediately for producing fireclay, silica, and basic refractories. The plant was planned to supply all refractories requirements of the Peruvian industries, including steel production, smelting of copper and other metals, and the manufacture of Portland cement and glass. Harbison-Walker owned the principal interest in the new company, known as Refractories Peruanos, S. A.[19]

Rhodesia and Nyasaland, Federation of.—The combined magnesite production in these countries in 1955 was 11,610 tons, a 49-percent increase above 1954. All of this ore was exported to the Union of South Africa.

Spain.—Spain reported a slight decrease in production of both magnesite and dolomite in 1955.

Tanganyika.—Tanganyika produced and exported 367 tons of magnesite in 1955 compared with 87 tons in 1954.

Union of South Africa.—Production of magnesite in 1955 decreased 27 percent below 1954. Imports from Rhodesia and Nyasaland, larger than this drop in production, indicated that actual consumption increased.

United Kingdom.—Dolomite was mined in several areas. The chemical and metallurgical industries imported magnesite. Research was continued to develop improved refractories for the iron and steel industry.[20]

Yugoslavia.—Production of magnesite in 1955 increased 8 percent above 1954. Increasing quantities of domestic supplies of magnesite and chromite were used to produce chrome-magnesite refractories and chrome-magnesite brick in the new plant at Kraljevo.[21] Exports of dead-burned magnesite to the United States in 1955 increased 23 percent above 1954 and to Canada 73 percent. Exports of both raw and dead-burned magnesite to West Germany decreased sharply in 1955.

---

[19] American Metal Market, vol. 62, No. 138, July 19, 1955, p. 1.
[20] White, J., Refractories in Great Britain, A Survey of Recent Trends: Iron and Coal Trades Rev., vol. 170, Nos. 4, 5, June 24, 1955, pp. 1453–1460.
[21] Commercial Information (Beograd. Yugoslavia), Magnohrom Produces Highly Refractory Materials: Vol. 8, No. 7, July 1955, pp. 29–32.

Manganese

By Gilbert L. DeHuff [1] and Teresa Fratta [2]

CONSUMPTION of manganese ore in 1955, although not as high as that in the record year 1953, nevertheless exceeded 2 million short tons. This demand was a factor contributing to the rise in price from the 80-cent low in effect at the beginning of the year to approximately $1.15 per long-ton unit of manganese, c. i. f. United States ports, duty extra, at year's end. The supply situation during the year was favorable, with imports of manganese ore containing 35 percent or more manganese still above 2 million short tons and domestic production of such ore continuing to increase under the markets provided by Government purchases.

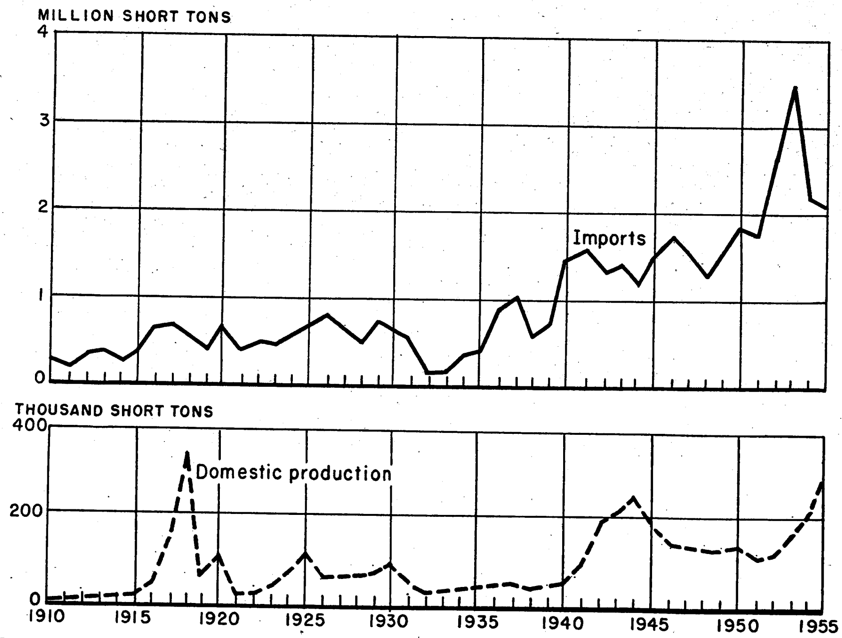

FIGURE 1.—General imports and domestic production (shipments) of manganese ore, 1910–55.

[1] Commodity specialist.
[2] Statistical clerk.

TABLE 1.—Salient statistics of manganese in the United States, 1946–50 (average) and 1951–55, gross weight in short tons

	1946–50 (average)	1951	1952	1953	1954	1955
Manganese ore (35 percent or more Mn):						
Production (shipments):						
Metallurgical ore	122,702	95,255	100,999	139,960	191,376	275,544
Battery ore	10,364	9,752	14,380	17,576	14,694	11,711
Miscellaneous ore	324				58	
Total shipments [1]	133,390	105,007	115,379	157,536	206,128	287,255
General imports	1,585,429	1,767,580	2,668,780	3,500,986	[2] 2,165,694	2,088,427
Consumption	1,420,937	1,892,609	1,809,189	2,195,742	1,740,648	2,109,623
Ferromanganese:						
Domestic production	610,248	791,260	758,721	907,533	718,721	869,977
Imports for consumption	77,324	119,764	64,095	126,518	56,772	65,672
Exports	10,004	633	1,453	1,112	1,732	1,789
Consumption	645,349	883,841	796,826	931,401	716,910	934,451
Spiegeleisen:						
Domestic production	95,835	77,017	58,666	97,729	(3)	(3)
Imports for consumption	2,138		44	785		
Exports	1,646	85	34			
Consumption	97,446	80,556	69,029	73,512	52,082	69,564

[1] Shipments are used as the measure of manganese production for compiling United States mineral production value. They are taken at the point that the material is considered to be in marketable form from the consumer's standpoint and include without duplication the following beneficiated products made from domestic ores: Concentrates, nodules, synthetic battery ore, and synthetic miscellaneous ore

[2] Revised figure.

[3] Bureau of Mines not at liberty to publish.

DOMESTIC PRODUCTION

The year was a significant one for the domestic manganese-mining industry, with production of ore containing 35 percent or more manganese amounting to 287,000 short tons, compared with 206,000 tons in 1954. In addition, deliveries of manganese ore and low-grade manganese ore to GSA depots at Wenden, Ariz., and Deming, N. Mex., filled the quota of 6 million recoverable long-ton units of manganese for each, with the result that the Wenden depot closed on April 29 and that at Deming on November 30. Defense Minerals Exploration Administration continued to participate in manganese-exploration projects to the extent of 75 percent of approved costs, repayable only out of production. For manganese, 3 new contracts were made during the year, and 1 certificate of discovery or development was issued.

The Anaconda Co. production of 58-percent manganese nodules from Butte, Mont., carbonate ores, and Manganese, Inc.'s production of 49-percent manganese nodules from Three Kids, Nev., oxide ores provided more than half of the 276,000 short tons of metallurgical ore shipped in 1955. Most of the remainder was sold to the Government under the General Services Administration (GSA) "carlot" purchase program for small producers; Virginia, Arkansas, and Tennessee were the principal contributing States, in that order. First shipments of metallurgical nodules containing more than 60 percent manganese were made in January by Manganese Chemicals Corp. under contract to GSA. These were produced, with high-purity manganese carbonate, at Riverton, Minn., from low-grade Cuyuna-range material by means of the ammonium carbamate leach process. A small tonnage of synthetic battery ore was also made and shipped.

Battery concentrate containing 35 percent or more manganese was produced at Philipsburg, Mont., by Trout Mining Division of Ameri-

TABLE 2.—Manganiferous raw materials shipped by producers in the United States, 1946–50 (average) and 1951–55, in short tons

Year	Metallurgical ore				Battery ore (35 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
1946–50 (average)	122,702	101,740	1,067,747	213,492	10,364	324	932
1951	95,255	106,203	1,065,788	267,751	9,752		
1952	100,999	106,307	902,711	215,255	14,380		
1953	139,960	272,738	966,652	293,758	17,576		
1954	191,376	61,692	496,505	214,931	14,694	58	135
1955	[1] 275,544	161,946	749,343	213,370	[1] 11,711	(1)	347

[1] Small tonnages of synthetic miscellaneous and synthetic battery ore included with metallurgical.

can Machine & Metals, Inc. Low-grade Nevada and Arizona ores were among the manganese ores used in producing synthetic battery ore at Henderson, Nev. In the latter part of the year ownership of this plant passed from Western Electrochemical Co. to American Potash & Chemical Corp.

TABLE 3.—Metallurgical manganese ore shipped in the United States, 1946–50 (average) and 1951–55, by States, in short tons

State	1946–50 (average)	1951	1952	1953	1954	1955
Alabama	27					
Arizona	164	173	203			1,396
Arkansas	1,246	3,718	2,246	6,123	13,728	23,744
California	63		3,589	720	393	3,136
Montana	119,830	91,080	90,772	102,878	44,735	94,762
Nevada	226	58	105	18,368		101,070
New Mexico	669	226	2,360			1,390
Oregon				46		
South Carolina	16					
Tennessee	77		126	2,625	11,823	15,895
Texas			56			
Utah	24		95			
Virginia	75		1,011	8,454	22,678	32,654
Washington	285		436			
Total	122,702	95,255	100,999	[1] 139,960	[2] 191,376	[3] 275,544

[1] Includes small tonnages from Arizona, Missouri, and Washington.
[2] Includes tonnages from Georgia, Missouri, and Nevada.
[3] Includes small tonnages from Georgia and Minnesota.

Commercial shipments of low-grade manganese ores containing 10 to 35 percent manganese were made from Georgia, Minnesota, Montana, and New Mexico, while manganiferous iron ore (5 to 10 percent manganese) was shipped from Minnesota only. Manganiferous zinc residuum was produced from New Jersey zinc ore.

As of December 31, 1955, total deliveries of manganese ore and low-grade manganese ores at the various GSA depots, since opening, expressed in long-ton units of recoverable manganese, were as follows: Butte-Philipsburg, 2,037,000; Deming, 6,250,580 (completed); and Wenden, 6,108,316 (completed). Total deliveries on the "carlot" program totaled 5,332,000 long-ton units of contained manganese. Final registration date for participation in the "carlot" and Butte-

Philipsburg programs was extended to June 30, 1956, and had also been so extended for Deming. Specifications and prices remained unchanged throughout the year.

TABLE 4.—Ferruginous manganese ore shipped in the United States, 1946–50 (average) and 1951–55, by States, in short tons

State	1946–50 (average)	1951	1952	1953	1954	1955
Arizona	12	224				
Arkansas	3,427	1,429	896			
California	205		56	534		
Colorado	7		76			
Georgia						347
Michigan	390				15,361	
Minnesota	3,938	14,728	31,502	201,090	7,552	115,285
Montana	4,790	7,598	9,357	5,598	5,266	6,341
Nevada	9,640	1,250	7,947	25,064	12,870	
New Mexico	73,307	79,605	52,934		20,546	40,320
Oregon				271		
Utah	4,948	1,369	3,397	5,155	97	
Virginia	2,007					
Washington			142			
Total	102,671	106,203	106,307	[1] 272,738	[2] 61,827	162,293

[1] Includes tonnages from New Mexico, North Carolina, and Wyoming.
[2] Includes small tonnages from California and Tennessee.

TABLE 5.—Manganiferous iron ore shipped in the United States, 1946–50 (average) and 1951–55, by States, in short tons

State	1946–50 (average)	1951	1952	1953	1954	1955
Michigan	23,524	69,626	22,095	76,251		
Minnesota	1,030,906	995,923	880,616	890,401	496,505	749,343
New Mexico	13,102	239				
Utah	215					
Total	1,067,747	1,065,788	902,711	966,652	496,505	749,343

Mines in New Mexico and Arizona made substantial shipments of manganese ore containing 35 percent or more manganese to the above named GSA depots, with lesser quantities coming from California and Nevada and small tonnages from Montana, Idaho, Utah, and Colorado. The total quantity of this grade delivered was more than twice that in the previous year. These shipments are not included in production (shipment) figures and will not be included until shipment is made from the depots. These ores doubtless will lose their identity by being blended with the low-grade ores at the depots or with concentrate made from them. Arizona was by far the largest shipper of low-grade manganese ores to these depots, followed by Montana, New Mexico, and California. Other States sending low-grade ores were Utah, Nevada, Minnesota, and Oregon, in that order. These low-grade ores also will not be included in production figures until shipment is made from the depots.

CONSUMPTION AND STOCKS

Consumption of manganese ore increased 21 percent over the previous year, bringing the 1955 figure close to the record high of 1953.

As in 1954, domestic sources supplied 2 percent and foreign sources 98 percent of the total manganese ore consumed compared with 4 and 96 percent, respectively, in 1953, 5 and 95 percent in 1952, and 7 and 93 percent in each of the years 1951 and 1950. The manufacture of dry-cell batteries consumed 2 percent of the total, chemicals consumed 1 percent, and the metal industries consumed the remaining 97 percent. Industrial stocks of ore decreased slightly to 1.4 million short tons.

TABLE 6.—Manganese and manganiferous ores shipped[1] in the United States in 1955, by States

	Metallurgical		Battery		Miscellaneous		Total		
	Short tons		Short tons		Short tons		Short tons		
	Gross weight	Manganese content	Gross weight	Manganese content	Gross weight	Manganese content	Gross weight	Manganese content	Value
Manganese ore:[2]									
Arizona	1,396	547	[3] 48	[3] 29			1,444	576	(4)
Arkansas	23,744	11,685					23,744	11,685	$1,727,286
California	3,136	1,338					3,136	1,338	270,519
Montana	94,762	54,538	11,264	5,224			106,026	59,762	(4)
Nevada	101,070	49,340	[5] 399	[5] 232			101,469	49,572	(4)
New Mexico	1,390	535					1,390	535	(4)
Tennessee	15,895	6,531					15,895	6,531	1,280,102
Virginia	32,654	14,517					32,654	14,517	2,779,337
Total	[6] 275,544	[6] 139,816	11,711	5,485			[6] 287,255	[6] 145,301	[6] 21,650,794
Ferruginous manganese ore:[7]									
Georgia					347	66	347	66	(4)
Minnesota	115,285	15,160					115,285	15,160	(4)
Montana	6,341	1,458					6,341	1,458	(4)
New Mexico	40,320	4,355					40,320	4,355	(4)
Total	161,946	20,973			347	66	162,293	21,039	(8)
Manganiferous iron ore:[9]									
Minnesota	749,343	44,175					749,343	44,175	(4)
Total	749,343	44,175					749,343	44,175	(8)

[1] Shipments are used as the measure of manganese production for compiling United States mineral production value. They are taken at the point that the material is considered to be in marketable form from the consumer's standpoint, and include without duplication the following beneficiated products made from domestic ores: Concentrates, nodules, synthetic battery ore, and synthetic miscellaneous ore.
[2] Containing 35 percent or more manganese (natural).
[3] Prorated portion of synthetic battery ore produced in Nevada from low-grade Arizona ore.
[4] Included in total.
[5] Prorated portion of synthetic battery ore produced in Nevada from low-grade Nevada ore.
[6] Includes metallurgical ore from Georgia and Minnesota, plus synthetic miscellaneous ore and small tonnage of synthetic battery ore produced in Minnesota from low-grade Minnesota ore.
[7] Containing 10 to 35 percent manganese (natural).
[8] Combined value for ferruginous manganese ore plus manganiferous iron ore equals $5,128,255.
[9] Containing 5 to 10 percent manganese (natural).

The consumption in 1955 of manganese as ferroalloys and directly charged ore per short ton of open-hearth, bessemer, and electric steel produced was 12.8 pounds compared with 12.7 pounds in 1954. Of the 12.8 pounds, 11.45 pounds was in the form of ferromanganese, 1.1 pound was in the form of silicomanganese, 0.2 pound was spiegeleisen, and 0.05 pound was ore and manganese metal. 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 manufacture 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 companies that produce castings only is also considered, the total pounds of manganese consumed per short ton of steel in 1955 becomes 13.3, of which 11.8 represents ferromanganese, 1.2 silicomanganese, 0.2 spiegeleisen, and 0.1 ore, metal, and briquets.

Electrolytic Manganese and Manganese Metal.—Consumption of electrolytic manganese in 1955 more than doubled that in 1954. The electrolytic metal was produced by Electro Manganese Corp. in two plants at Knoxville, Tenn., and by Electro Metallurgical Co., Division of Union Carbide & Carbon Corp. at Marietta, Ohio. Both companies also produced nitrided electrolytic manganese, used for introducing nitrogen into steel. Electro Metallurgical Co. continued to make manganese metal in electric furnaces.

TABLE 7.—Manganiferous raw materials available for consumption in the United States in 1955

	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 mine shipments	287, 255	50. 58	375, 663	13. 17	749, 343	5. 90
Imports for consumption	2, 262, 633	46. 28	171, 462	20. 59		
Total available for consumption	2, 549, 888	46. 76	547, 125	15. 50	749, 343	5. 90

TABLE 8.—Consumption of manganese ore and manganese alloys in the United States, 1954–55, and stocks Dec. 31, 1955, gross weight in short tons

Category of use and form in which consumed	Quantity consumed 1954	Quantity consumed 1955	Stocks Dec. 31, 1955 [1] (including bonded warehouses)
Manganese alloys and manganese metal:			
Manganese ore:			
Domestic	33, 610	42, 469	6, 513
Foreign	1, 604, 180	1, 975, 130	1, 311, 996
Total manganese ore	1, 637, 790	2, 017, 599	1, 318, 509
Ferromanganese, silicomanganese, and manganese metal			64, 101
Spiegeleisen			4, 759
Steel ingots and steel castings: [2]			
Manganese ore:			
Domestic		11	6
Foreign	7	10	
Total manganese ore	7	21	6
Ferromanganese:			
High-carbon	619, 951	798, 660	121, 460
Medium-carbon }	49, 750	72, 079	15, 129
Low-carbon }			
Total ferromanganese	669, 701	870, 739	136, 589
Spiegeleisen	41, 500	60, 481	26, 318
Silicomanganese	68, 502	95, 432	17, 770
Manganese briquets		64	
Manganese metal	996	3, 341	508

See footnotes at end of table.

TABLE 8.—Consumption of manganese ore and manganese alloys in the United States, 1954–55, and stocks Dec. 31, 1955, gross weight in short tons—Con.

Category of use and form in which consumed	Quantity consumed		Stocks Dec. 31, 1955 [1] (including bonded warehouses)
	1954	1955	
Steel castings: [3]			
Manganese ore:			
Domestic	7	114	4
Foreign	193	88	200
Total manganese ore	200	202	204
Ferromanganese:			
High-carbon	20,021	23,516	6,913
Medium-carbon }			
Low-carbon }	3,445	3,414	1,057
Total ferromanganese	23,466	26,930	7,970
Spiegeleisen	2,636	2,936	846
Silicomanganese	6,961	9,148	2,241
Manganese briquets	1,351	1,426	262
Manganese metal	326	234	130
Pig iron:			
Manganese ore:			
Domestic	1,807	1,964	4
Foreign	47,458	26,394	15,123
Total manganese ore	49,265	28,358	15,127
Dry cells:			
Manganese ore:			
Domestic	2,893	1,628	111
Foreign	28,142	32,705	22,737
Total manganese ore	31,035	34,333	22,848
Chemicals:			
Manganese ore:			
Domestic	292	27	----------
Foreign	22,059	29,083	5,351
Total manganese ore	22,351	29,110	5,351
Miscellaneous products:			
Ferromanganese:			
High-carbon	[4] 19,816	[4] 31,849	[4] 6,116
Medium-carbon }			
Low-carbon }	[4] 3,927	[4] 4,933	[4] 1,369
Total ferromanganese	[4] 23,743	[4] 36,782	[4] 7,485
Spiegeleisen	[4] 7,946	[4] 6,147	[4] 2,034
Silicomanganese	[4] 4,796	[4] 7,403	[4] 1,116
Manganese briquets	[4] 13,632	[4] 12,204	[4] 3,197
Manganese metal	[4] 617	[4] 922	[4] 191
Grand total:			
Manganese ore:			
Domestic	38,609	46,213	6,638
Foreign	1,702,039	2,063,410	1,355,407
Total manganese ore	[5] 1,740,648	[5] 2,109,623	[6] 1,362,045
Ferromanganese:			
High-carbon	659,788	854,025	}
Medium-carbon }			152,044
Low-carbon }	57,122	80,426	}
Total ferromanganese	716,910	934,451	[7] 152,044
Spiegeleisen	52,082	69,564	33,957
Silicomanganese	80,259	111,983	[7] 21,127
Manganese briquets	14,983	13,694	[7] 3,459
Manganese metal	1,939	4,497	[7] 829
Producers stocks of ferromanganese, silicomanganese, and manganese metal	----------	----------	64,101

[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] Obtained by sampling.
[5] 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.
[6] Excludes small tonnages of dealers' stocks.
[7] Excludes producers' stocks.

Ferromanganese.—Production of ferromanganese in the United States was 870,000 short tons in 1955, compared with 719,000 short tons in 1954. The following plants were active producers during the year: The Anaconda 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, Niagara Falls, N. Y., Portland, Oreg., and Sheffield, Ala.; E. J. Lavino & Co., Reusens, Va., and Sheridan, Pa.; Ohio Ferro-Alloys Corp., Philo, Ohio; Pioche Manganese Co., Henderson, Nev.; Tennessee Products & Chemical Corp., Chattanooga, Tenn.; Tenn-Tex Alloy & Chemical Corp., Houston, Tex.; and United States Steel Corp., Ensley, Ala., and Clairton and Duquesne, Pa. The quantity made in blast furnaces was 2¼ times that in electric furnaces. Shipments of ferromanganese from producing furnaces increased 25 percent in quantity and 24 percent in value from 1954. Manganese ore consumed in manufacturing ferromanganese, silicomanganese, and manganese briquets totaled 1,972,000 short tons in

TABLE 9.—Ferromanganese imported into and made from domestic and imported ores in the United States, 1954–55

	1954		1955	
	Gross weight (short tons)	Mn content (short tons)	Gross weight (short tons)	Mn content (short tons)
Ferromanganese: [1]				
Made in United States:				
From domestic ore [2]	28,035	22,048	27,583	22,016
From imported ore [2]	690,686	517,316	842,394	648,149
Total domestic production	718,721	539,364	869,977	670,165
Imported	56,772	44,744	65,672	52,650
Total ferromanganese	775,493	584,108	935,649	722,815
Open-hearth, bessemer, and electric [3] furnace steel produced	88,311,652		117,036,085	

[1] Number of domestic plants making ferromanganese: 1954, 19; 1955, 18.
[2] Estimated.
[3] Includes crucible.

TABLE 10.—Ferromanganese produced in the United States and metalliferous materials consumed in its manufacture,[1] 1946–50 (average) and 1951–55

Year	Ferromanganese produced			Materials consumed (short tons)			Manganese ore used per ton of ferromanganese [1] 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		
1946–50 (average)	610,248	78.15	476,909	1,106,708	97,874	2,928	1.974
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
1953	907,533	76.74	696,436	1,829,382	75,594	31,562	2.099
1954	718,721	75.04	539,364	1,412,030	31,351	8,404	2.008
1955	869,977	77.03	670,165	[1] 1,924,643	[1] 46,936	1,594	[1] 2.022

[1] For 1955, includes ore used in manufacture of silicomanganese and manganese briquets.

1955, of which 2 percent was of domestic origin and 98 percent foreign; recovery of manganese from ore was 83.1 percent.

Silicomanganese.—Consumption of silicomanganese in 1955 was 12.0 percent that of ferromanganese, compared with 11.2 percent in 1954 and 12.2 percent in 1953.

TABLE 11.—Manganese ore used in manufacture of ferromanganese [1] in the United States, 1951–55, by source of ore

Source of ore	1951		1952		1953		1954		1955 [1]	
	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	110, 607	58. 34	83, 614	56. 95	75, 594	57. 48	31, 351	57. 53	46, 936	58. 01
Foreign:										
Africa	641, 013	44. 36	510, 452	45. 59	637, 934	45. 85	397, 153	45. 51	586, 602	47. 21
Brazil	146, 108	40. 83	118, 842	40. 03	192, 280	40. 20	123, 234	40. 23	138, 276	41. 07
Chile	8, 484	47. 15	12, 586	47. 21	36, 456	43. 95	10, 516	43. 44	24, 707	44. 12
Cuba	103, 263	39. 50	136, 436	39. 82	172, 700	39. 89	144, 870	39, 85	253, 271	40. 25
India	449, 780	48. 03	477, 428	46. 03	716, 568	44. 51	637, 475	46. 10	817, 710	45. 31
Indonesia	801	46. 94	8, 291	43. 77	6, 763	44. 48	6, 988	44. 86	9, 198	45. 34
Mexico	40, 402	40. 81	51, 571	40. 84	42, 675	41. 99	54, 969	42. 00	60, 889	44. 00
New Caledonia	---	---	12, 092	46. 35	40	47. 50	4, 943	46. 83	2, 179	45. 57
Philippines	5, 232	44. 76	7, 064	41. 19	8, 586	41. 52	591	44. 50	105	39. 05
Turkey	9, 505	42. 64	16, 053	39. 90	8, 382	45. 76	8, 200	45. 73	11, 176	46. 41
U. S. S. R	10, 097	46. 01	---	---	508	45. 87	---	---	---	---
Other	2, 128	39. 66	13, 803	37. 36	6, 490	47. 63	23, 091	48. 28	20, 530	45. 46
Grand total	1, 527, 420	45. 71	1, 448, 232	45. 07	1, 904, 976	44. 56	1, 443, 381	44. 91	1, 971, 579	45. 18

[1] For 1955, includes silicomanganese and manganese briquets.

TABLE 12.—Ferromanganese shipped from furnaces in the United States, 1946–50 (average) and 1951–55

Year	Short tons	Value	Year	Short tons	Value
1946–50 (average)	611, 850	$86, 792, 374	1953	900, 110	$185, 192, 588
1951	795, 745	122, 346, 198	1954	707, 415	139, 157, 801
1952	738, 088	133, 996, 006	1955	886, 886	172, 863, 154

Thirteen plants produced silicomanganese in 1955, namely: The Anaconda Co., Anaconda, Mont.; Electro Metallurgical Co., Division of Union Carbide & Carbon Corp., Alloy, W. Va., Ashtabula, Ohio, Marietta, Ohio, Niagara Falls, N. Y., and Sheffield, Ala.; Globe Metallurgical Corp., Beverly, Ohio; Ohio Ferro-Alloys Corp., Philo, Ohio; Pioche Manganese Co., Henderson, Nev.; Pittsburgh Metallurgical Co., Calvert City, Ky. and Charleston, S. C.; Tennessee Products & Chemical Corp., Chattanooga, Tenn.; and Vanadium Corp. of America, Niagara Falls, N. Y.

Spiegeleisen.—Three companies produced spiegeleisen at three plants in 1955: Inland Steel Co., East Chicago, Ind.; New Jersey Zinc Co., Palmerton, Pa.; and United States Steel Corp., Ensley, Ala.

Manganiferous Pig Iron.—Pig-iron furnaces used 1,257,000 short tons of manganese-bearing ores containing (natural) over 5 percent manganese in 1955. Of this total, 721,000 tons was of domestic origin and 536,000 tons foreign. Of the domestic ore used, 697,000 tons contained (natural) 5 to 10 percent manganese, 22,000 tons contained 10 to 35 percent manganese, and 2,000 tons contained more than 35 percent manganese. Of the foreign ore used, 408,000 tons contained (natural) 5 to 10 percent manganese, 102,000 tons contained (natural) 10 to 35 percent manganese, and 26,000 tons contained 35 percent or more manganese.

Battery and Miscellaneous Industries.—Manufacturers of dry-cell batteries used 34,000 short tons of manganese ore during 1955, or 10 percent more than in 1954. Of the total, 1,600 tons was of domestic origin—a somewhat lower portion than the previous year. Chemical plants used 29,000 tons, of which only 27 tons was of domestic origin. All of the above ore contained (natural) over 35 percent manganese.

TABLE 13.—Spiegeleisen produced and shipped in the United States, 1946–50 (average) and 1951–55

Year	Produced (short tons)	Shipped from furnaces		Year	Produced (short tons)	Shipped from furnaces	
		Short tons	Value			Short tons	Value
1946–50 (average)	95,835	93,502	$4,176,766	1953	97,729	67,247	$5,144,470
1951	77,017	79,168	5,368,989	1954–55	(1)	(1)	(1)
1952	58,666	67,129	4,730,631				

[1] Bureau of Mines not at liberty to publish.

TABLE 14.—Foreign ferruginous manganese ore and manganiferous iron ore consumed in the United States, 1952–55, in short tons

Source of ore	Ferruginous manganese ore				Manganiferous iron ore			
	1952	1953	1954	1955	1952	1953	1954	1955
Brazil	361							
Canada							408,467	408,292
Egypt	[1] 153,531	[1] 130,116	128,102	102,070				
Greece			1,033					
India			56					
Total	153,892	130,116	129,191	102,070			408,467	408,292

[1] Includes 1,048 short tons in 1952 and 626 short tons in 1953 from other unidentified sources in Africa.

PRICES

Manganese Ore.—Government prices for domestically mined manganese ore meeting specifications and regulations continued to be calculated on the basis of $2.30 per long dry-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, opened the year at 80 to 82 cents per long-ton unit of manganese, c. i. f. United States ports, duty extra. Prices then gradually increased to close the year at $1.12 to $1.17 nominal. Although strengthening demand was a factor, much of the increase was due to higher ocean freight rates. Long-term contracts for ore from various sources were quoted at the beginning of the year as nominal at 80 to 82 cents and at the end of the year nominal at 94 to 96 cents, c. i. f. United States ports, duty extra. Prices for chemical grade ore, f. o. b. Philadelphia, as quoted by E&MJ Metal and Mineral Markets were unchanged throughout the year at $96 per ton, minimum 84 percent manganese dioxide, carlots, in drums; $90.50 in burlap bags. Duty remained at one-fourth cent per pound of contained manganese, with continuing exceptions that ore from Cuba and the Republic of the Philippines was exempt from duty and ore from the U. S. S. R. and certain neighboring countries was dutiable at 1 cent per pound of contained manganese.

Manganese Alloys.—The average value, f. o. b. producers' furnaces, for ferromanganese shipped during 1955 was $194.91 per short ton, compared with $196.71 in 1954. The price of ferromanganese was held at 9.5 cents per pound of alloy until December, when it rose to 10.25 cents per pound. According to Iron Age, the selling price of ferromanganese in carlots at eastern centers averaged 9.56 cents per pound for the year. The quoted price for spiegeleisen of 19- to 21-percent content, as given by Iron Age, averaged $86.45 per gross ton for the year.

Manganese Metal.—Electrolytic manganese metal was quoted at the end of the year by E&MJ Metal and Mineral Markets at 30 cents per pound in carlots and 32 cents per pound for ton lots. A premium of 0.75 cent per pound applied to hydrogen-removed metal.

FOREIGN TRADE [3]

Imports of manganese ore in 1955 were somewhat lower than in 1954; however, the average grade (46.4 percent manganese) was an improvement over the 46.1-percent manganese of 1954, 44.9-percent of 1953, and 45.2-percent of 1952. Although imports from India were lower than in the previous year, that country continued to be the leading supplier, with 34 percent of the total ore imported in 1955. India, Cuba, Union of South Africa, and Gold Coast, in that order of importance, with the last three countries closely grouped, supplied 70 percent of total United States imports for the year; Belgian Congo and Brazil, in equal proportions, provided 16 percent.

Import data in table 15 include receipts of ore, classified as Battery and Chemical grade, totaling 86,004 short tons in 1955, averaging 54.6 percent manganese or 86.4 percent manganese dioxide. Of this quantity 58,061 short tons came from Gold Coast, 21,766 from French Morocco, 4,693 from Cuba, 1,264 from Chile, and 220 from India. Imports for consumption of Battery and Chemical grade totaled 83,640 short tons valued at $4,163,342, or $49.78 per short ton f. o. b. foreign ports. Of the total, Gold Coast supplied 52,250 short tons valued at $2,834,186; French Morocco, 25,213 tons at $1,079,527; Cuba, 4,693 tons at $223,650; Chile, 1,264 tons at $17,300; and India, 220 tons at $8,679.

Imports for consumption of ferromanganese in 1955 increased 16 percent over 1954; the value increased 10 percent. Ferromanganese was exported at approximately the same level. Exports of manganese ore and concentrates (10 percent or more manganese) totaled 6,279 short tons valued at $612,390.

[3] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, 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, 1954–55, 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			
	1954	1955	1954	1955	1954	1955	1954	1955	1954	1955
North America:										
Cuba	261,539	271,733	113,574	117,312	261,539	271,733	113,574	117,312	$8,844,121	$7,217,124
Mexico	89,573	71,514	38,960	31,937	122,501	112,375	52,808	49,236	3,539,633	2,949,369
Total	351,112	343,247	152,534	149,249	384,040	384,108	166,382	166,548	12,383,754	10,166,493
South America:										
Argentina		4,725		2,079		4,725		2,079		142,200
Brazil	103,655	164,049	46,453	69,869	100,064	138,120	45,260	60,061	3,397,212	4,365,605
Chile	18,559	8,311	8,096	3,750	18,503	35,632	8,150	16,621	577,610	1,429,923
Peru	4,126	5,559	1,789	2,438	4,233	6,734	1,872	2,985	90,635	142,223
Total	126,340	182,644	56,338	78,136	122,800	185,211	55,282	81,746	4,065,457	6,079,951
Europe:										
France	24		14		24		14		15,594	
Greece	4,688	2,969	2,264	1,425	12,497	1,997	5,438	960	410,852	70,658
Portugal	3,360		1,636			6,590		3,192		308,917
Turkey	3,869	17,791	1,893	8,446	13,441	27,107	6,128	12,721	501,429	947,203
Total	11,941	20,760	5,807	9,871	25,962	35,694	11,580	16,873	927,875	1,326,778
Asia:										
Burma						528		297		46,025
India	868,291	699,645	400,064	327,221	952,554	821,030	437,108	382,271	30,364,032	22,335,249
Indonesia	3,902	4,389	1,842	2,097	4,981	4,411	2,332	2,084	[3] 116,990	91,192
Philippines	1,848	1,120	887	538	1,848	1,120	887	538	69,008	37,000
Portuguese Asia	28,780	10,051	12,570	4,185	28,780		12,570		889,685	
Total	902,821	715,205	415,363	334,041	988,163	827,089	452,897	385,190	[3] 31,439,715	22,509,466
Africa:										
Angola	46,269	62,621	22,639	29,553	46,890	41,926	22,978	19,239	2,367,538	1,188,593
Belgian Congo	161,206	164,355	80,924	83,008	159,067	131,981	79,854	66,655	[3] 6,481,160	4,664,142
British East Africa	1,094		547		1,094		547		36,629	
Federation of Rhodesia and Nyasaland	1,033	5,427	516	2,729	1,033	5,427	516	2,729	45,178	226,624

French Morocco	73,558	99,193	39,032	49,815	60,363	114,999	31,334	59,423	2,987,503	4,299,778
Gold Coast	232,277	232,488	115,085	117,971	193,558	301,182	97,250	146,575	9,110,108	13,967,280
Union of South Africa	[3] 242,342	252,092	[3] 101,633	109,536	[3] 239,985	223,613	[3] 100,987	96,459	5,182,522	5,046,432
Total	[3] 757,779	816,176	[3] 360,376	392,612	[3] 701,990	819,128	[3] 333,466	391,080	[3] 26,210,638	29,392,849
Oceania:										
Australia	9,733		4,794		9,733		4,794		423,662	
British Western Pacific Islands	5,968	10,395	2,858	5,298	5,968	10,395	2,858	5,298	196,016	322,885
French Pacific Islands					4,945	1,008	2,355	416	140,040	22,672
Total	15,701	10,395	7,652	5,298	20,646	11,403	10,007	5,714	759,718	345,557
Grand total	[3] 2,165,694	2,088,427	[3] 998,070	969,207	[3] 2,243,601	2,262,633	[3] 1,029,614	1,047,151	[3] 75,787,157	69,821,094

[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; excludes imports for manufacture in bond and export.

[3] Revised figure.

TABLE 16.—Ferromanganese imported for consumption in the United States, 1953–55, by countries

[U. S. Department of Commerce]

Country	1953			1954			1955		
	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
North America:									
Canada	341	286	$94,221	1,737	1,315	$339,226	1,142	926	$311,889
Mexico	89	70	16,075				160	122	21,533
Total	430	356	110,296	1,737	1,315	339,226	1,302	1,048	333,422
South America: Chile				336	264	40,500	4,959	3,910	613,356
Europe:									
France	21,052	16,827	4,464,421	18,194	14,508	3,246,162	20,184	16,267	3,525,982
Germany, West	51,856	38,894	9,358,900	15,726	11,794	2,808,175	128	113	57,041
Norway	29,832	24,604	9,223,263	17,180	14,078	3,815,696	24,062	19,771	5,155,635
Yugoslavia	112	81	16,380	524	406	67,604	2,232	1,722	308,014
Total	102,852	80,406	23,062,964	51,624	40,786	9,937,637	46,606	37,873	9,046,672
Asia: Japan	23,236	17,445	4,007,749	3,075	2,379	585,467	12,805	9,819	2,028,917
Grand total	126,518	98,207	27,181,009	56,772	44,744	10,902,830	65,672	52,650	12,022,367

TABLE 17.—Spiegeleisen[1] imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Short tons	Value	Year	Short tons	Value
1946–50 (average)	2,138	$115,598	1953	785	$63,149
1951			1954		
1952	44	3,658	1955		

[1] Exclusive of spiegeleisen containing not more than 1 percent carbon.

TABLE 18.—Ferromanganese exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Gross weight (short tons)	Value	Year	Gross weight (short tons)	Value
1946–50 (average)	10,004	$1,536,729	1953	1,112	$389,064
1951	633	206,614	1954	1,732	614,544
1952	1,453	474,686	1955	1,789	642,806

TECHNOLOGY

From sintered Artillery Peak flotation concentrates, containing 40 percent manganese and 20 percent combined silica plus alumina after sintering, standard ferromanganese was produced at the Boulder City, Nev., Electrometallurgical Experiment Station of the Federal Bureau of Mines, using a carbon-lined, deep-shaft, single-phase electric furnace with single 3-inch electrode, operated at approximately 2,000 amperes and 22 volts. Maximum manganese recovery obtained in producing ferromanganese having 78- to 80-percent manganese content and less than 1 percent silicon was 89.5 percent.

An acid-ferrous sulfate leach process for mixed carbonate-oxide ores was investigated in the station's laboratory, using raw material from the Cuyuna range of Minnesota. In this process sulfuric acid dissolves the manganese and iron of the carbonate minerals; the contained ferrous iron of the leach liquor then becomes a solvent for the manganese contained as oxides. Extraction of 90 percent manganese was obtained.

Laboratory investigation of percolation leaching of low-grade western wad ores was pursued at the Bureau's Southwest Experiment Station, Tucson, Ariz. Upward percolation leaching with sulfurous acid extracted approximately 95 percent of the manganese content of a 5-percent-manganese wad ore from Arizona. Using sulfur dioxide, similar extractions were obtained from other low-grade wad ores, whose manganese content ranged from 4 to 12 percent.

The Federal Bureau of Mines hydrometallurgical work at the Eastern Experiment Station, College Park, Md., in cooperation with the American Iron and Steel Institute, on recovery of manganese from open-hearth slags was described in considerable detail in two reports of investigations.[4] Mixtures of slag and limestone in proper proportions were fired in an oxidizing atmosphere to produce a clinker; reduction of the manganese oxides in the clinker with hydrogen formed manganous oxide, which was, in turn, dissolved by an ammoniacal solution of ammonium carbonate. Distillation of approximately 30 percent of the ammonia precipitated the manganese as carbonate. In the pilot plant calcination of this carbonate produced a sintered oxide containing 66 percent Mn, or 92 percent Mn_3O_4, having good manganese-iron and manganese-phosphorus ratios and indicated over-all manganese recoveries of 65 to 80 percent. The product could be expected to command a premium price.

At the Bureau of Mines, Northwest Electrodevelopment Experiment Station, Albany, Oreg., limonite from Scappose, Oreg., deposits was smelted with off-grade, highly siliceous manganese ores from various northwestern deposits to obtain high-manganese pig irons suitable for gray-iron-foundry use.[5]

Results were published of concentration tests on several low-grade manganese ores from California and Nevada mines.[6]

A satisfactory solution of the casting and fabrication problems of high-damping manganese-copper alloys was discovered by Bureau work at the Mississippi Valley Experiment Station, Rolla, Mo., to depend primarily upon mold design, appropriate deoxidizing treatment in casting, and proper control of casting temperature.[7] Comparative data were obtained on the rolling of titanium-manganese alloy into ¾-inch plate.[8]

A report of diamond drilling and surface trenching of the Littleton Ridge deposit in the southern district of Aroostook County, Maine,

[4] Heindl, R. A., Ruppert, J. A., Skow, M. L., and Conley, J. E., Manganese From Steel-Plant Slags by a Lime-Clinkering and Carbonate-Leaching Process: Part I, Laboratory Development: Bureau of Mines Rept. of Investigations 5124, 1955, 98 pp; and Part II, Pilot-Plant Development: Bureau of Mines Rept. of Investigations 5142, 1955, 80 pp.

[5] Walsted, John P., Special Pig Irons for the Pacific Northwest: Bureau of Mines Rept. of Investigations 5120, 1955, 14 pp.

[6] Engel, A. L., Heinen, H. J., Morrice, Edward, and Shedd, E. S., Concentration Tests of Selected California-Nevada Manganese Ores: Bureau of Mines Rept. of Investigations 5163, 1955, 12 pp.

[7] Rowland, J. A., Armantrout, C. E., and Walsh, D. F., Casting and Fabrication of High-Damping Manganese-Copper Alloys: Bureau of Mines Rept. of Investigations 5127, 1955, 20 pp.

[8] Huber, R. W., Petersen, V. C., and Wiley, R. C., The Fabrication of Arc-Melted Ingots of Titanium and Titanium-Manganese Alloys Into Plate: Bureau of Mines Rept. of Investigations 5117, 1955, 35 pp.

disclosed the interbedded siliceous manganiferous carbonate and chlorite-sericite slates to be complexly folded and faulted. A composite sample of drill core analyzing 6.9 percent manganese and 18.0 percent iron showed reasonably good extractions of manganese when leached with nitric, sulfuric, or hydrochloric acid; however, an excessive quantity of acid was consumed in dissolving the iron content. This was contrary to experience obtained in acid leaching of materials from other Aroostook manganese-iron deposits. Investigation of two other manganese occurrences in the southern district was also described.[9]

Exploration for manganese in a portion of the Philipsburg district, Montana, was reported. Although a lead-zinc ore shoot was found, results were negative insofar as discovery of manganese ore was concerned.[10]

In September GSA signed a $202,100 contract (increased to $252,000 in 1956) with Ores Beneficiation, Inc., for constructing and operating a 300-pound-per-hour pilot plant at Joplin, Mo., to test the Bruce Williams process for recovering manganese from slags and other low-grade and refractory raw materials. The manganiferous material is ground to a minimum fineness of 100-mesh, mixed with ammonium salts, and roasted at about 850° F. Manganic manganese is converted by ammonium sulfates or sulfites to manganese sulfate, and the manganous manganese is converted simultaneously by ammonium chloride to the chloride, without appreciably solubilizing iron or phosphorus. In applying the process to manganese silicates ammonium fluoride and/or ammonium bifluoride is added. The calcine is leached with water, and addition of ammonia and carbon dioxide or of ammonium carbonate precipitates manganese carbonate, which can be reduced to MnO_2 by calcination. Except for chemically destroyed ammonia, the process is cyclic.[11]

The Udy electric furnace process of Stratmat, Ltd., a subsidiary of Strategic Materials Corp., received preliminary testing in a 250-kv.-a. furnace at the Department of Mines and Technical Surveys, Ottawa, Canada. Results were deemed favorable to the extent that plans were made for constructing a pilot plant having a capacity of 50 tons of ore a day.[12] In the process planned for the pilot plant, electric furnaces of special design are employed in either 2- or 3-stage smelting operations. The products of the first furnace are iron metal and a high-manganese slag, the phosphorus of the charge coming down with the metal. The molten slag is charged to the second furnace, where is made either a final high-carbon ferromanganese or an intermediate product silicomanganese or ferrosilicomanganese. The third furnace is used to add this silicomanganese to high-manganese slag from the first furnace. The silicon of the silicomanganese reduces manganese of the slag feed to produce either medium-carbon or low-carbon ferromanganese, which commands higher prices than does the high-carbon or standard grade.

Studies of the new low-nickel austenitic stainless steels, Type 201 (17 Cr–4 Ni–6 Mn)–202 (18 Cr–5 Ni–8 Mn), as compared with the

[9] Eilertsen, N. A., Investigation of the Littleton Ridge Manganese Deposit and Vicinity, Southern District, Aroostook County, Maine: Bureau of Mines Rept. of Investigations 5104, 1955, 39 pp.
[10] McNabb, J. S. Jr., Manganese Exploration in the Philipsburg District, Granite County, Mont.: Bureau of Mines Rept. of Investigations 5173, 1955, 25 pp.
[11] Stringham, William S. and Summers, Glenn N., (assigned to Bruce Williams), Method for Beneficiating Manganese Ores: U. S. Patents 2,724,645 and 2,724,646, Nov. 22, 1955.
[12] Buck, W. Keith, Manganese in Canada, 1955 (Prelim.): Canada Department of Mines and Technical Surveys, Ottawa, March 1956, 7 pp.

previously recognized austenitic stainless or Type 301 (17 Cr–7 Ni)–302 (18 Cr–8 Ni), were made by the Materials Advisory Board, National Academy of Sciences, and by the American Iron and Steel Institute. Specifications of the 201–202 types include a maximum nitrogen content of 0.25 percent; those for the 301–302 types put maximum manganese content at 2.00 percent. During World War II a 17–4–4 stainless having 0.10 to 0.15 percent nitrogen was developed and utilized for certain applications, but it was prone to crack during forming operations. Later investigations showed that raising the manganese content to 6 percent overcame this difficulty and gave a steel having mechanical properties similar to those of 301. In 1951 a directive of the National Production Authority prohibited more than 1 percent nickel in stainless steels for many industrial applications. As a result, a new alloy containing approximately 16 percent chromium, 16 percent manganese, maximum 1 percent nickel, and maximum 0.25 percent nitrogen came into use for railroad-car and truck bodies. The composition of this steel has not been standardized. Subsequent lifting of the restricting directive, but continued shortage of nickel coupled with growing appreciation of the new alloys, has led to increasing substitution of 201–202 for the older 300 series types. The Materials Advisory Board reported that 201 could be substituted for virtually 100 percent of the Type 301 uses; 202 for probably 80 percent of the Type 302 uses.[13]

WORLD REVIEW

Angola.—Production of 35,000 short tons of manganese ore in 1955 was at the same rate as for 1954, but the grade was 10 percent lower at 38 percent manganese. Exports in 1955 totaled 45,000 short tons, distributed as follows: United States, 31,000; West Germany, 6,800; Norway, 4,500; and Sweden, 2,200. In 1954 and 1953 virtually all exports went to the United States.[14]

TABLE 19.—World production of manganese ore, by countries,[1] 1946–50 (average) and 1951–55, in short tons [2]

[Compiled by Pearl J. Thompson]

Country [1]	Mn (percent)	1946–50 (average)	1951	1952	1953	1954	1955
North America:							
Canada (shipments)		45					
Cuba	36–50+	77,590	169,856	277,426	389,356	296,801	346,680
Mexico	30+	43,956	87,292	157,403	269,863	277,996	97,326
United States (shipments)	35+	133,394	105,007	115,379	157,536	206,128	287,255
Total		254,985	362,155	550,208	816,755	780,925	731,261
South America:							
Argentina	30–40	2,616	1,323	2,535	5,512	1,323	5,512
Brazil	38–50	205,492	224,366	274,732	255,058	179,157	178,699
Chile	40–50	28,185	47,437	59,356	60,207	58,400	[3] 58,400
Peru	40+	171	1,043	1,221	[3] 3,500	3,123	3,801
Total		236,464	274,169	337,844	324,277	242,003	[3] 246,412

See footnotes at end of table.

[13] American Iron and Steel Institute, Contributions to the Metallurgy of Steel: No. 47, May 1955, 10 pp. Bennett, Edmund V., Staff Study on Low-Nickel Austenitic Stainless Steels: Nat. Acad. Sci., Materials Advisory Board, June 10, 1955, 30 pp.

[14] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 5, May 1956, pp. 13–14.

TABLE 19.—World production of manganese ore, by countries,[1] 1946–50 (average) and 1951–55, in short tons[2]—Continued

Country [1]	Mn (percent)	1946–50 (average)	1951	1952	1953	1954	1955
Europe:							
Greece	35+	305	17,842	21,656	15,577	18,697	27,148
Hungary (concentrates) [3]	35–48	37,300	44,000	44,000	44,000	44,000	60,600
Italy	30	22,906	31,479	45,484	44,157	53,843	62,371
Portugal	35+	2,196	8,394	12,197	13,918	10,627	4,351
Rumania	35	[3] 50,200	(4)	(4)	(4)	(4)	[3] 391,000
Spain	30+	23,857	22,917	31,408	36,044	39,511	46,839
Sweden	40	100,000	5,500	50,700	49,600	8,800	[3] 8,800
U. S. S. R.[3]	41+	2,000,000	2,800,000	2,800,000	[5] 3,900,000	[5] 4,400,000	[5] 4,400,000
Yugoslavia	30+	[3] 11,000	4,600	4,600	5,200	5,000	4,900
Total [1] [3]	-------	2,248,000	3,000,000	3,200,000	4,400,000	4,900,000	5,000,000
Asia:							
Burma	35+	----------	[3] 2,200	7,280	9,610	4,160	342
India	40+	617,923	1,447,463	1,637,738	2,130,511	1,583,511	1,702,757
Indonesia	35–49	----------	----------	8,634	20,310	16,442	38,810
Iran [6]	36–46	2,989	4,379	3,583	[3] 4,400	8,800	[3] 7,700
Japan	32–40	81,261	203,942	228,593	214,286	180,155	209,634
Korea, Republic of	30–48	(4)	2,477	8,175	3,371	1,744	3,838
Malaya	30	[7] 15	[7] 215	----------	----------	----------	----------
Philippines	35–51	18,760	24,629	22,737	23,708	10,354	13,131
Portuguese India	32–50+	11,614	94,162	122,429	166,227	116,756	[7] 154,528
Turkey	30–50	15,716	55,685	88,745	99,038	54,925	55,228
Total [1] [3]	-------	754,000	1,857,000	2,161,000	2,721,000	2,043,000	2,274,000
Africa:							
Angola	48	6,814	50,918	60,731	72,603	34,865	34,853
Belgian Congo	50	15,847	78,203	141,071	238,831	424,320	508,972
French Morocco	35–50	201,747	410,252	469,932	473,304	441,413	453,396
Gold Coast (exports) [8]	48	769,870	902,812	889,491	835,510	515,475	604,330
Rhodesia and Nyasaland, Federation of:							
Northern Rhodesia	30+	----------	1,411	4,397	7,984	18,951	19,411
Southern Rhodesia	-------	39	----------	1,580	----------	18	1,330
South-West Africa	-------	[9] 1,095	7,231	29,219	40,654	34,066	41,880
Spanish Morocco	50	154	1,237	4,007	1,181	856	1,262
Tunisia	35–40	6	----------	----------	----------	----------	----------
Union of South Africa	40+	495,735	836,510	964,121	912,333	772,862	649,171
Total	-------	1,491,307	2,288,574	2,564,549	2,582,400	2,242,826	2,314,605
Oceania:							
Australia	-------	7,744	8,924	7,917	36,897	31,587	53,039
Fiji	-------	[10] 153	707	2,251	2,448	11,087	8,444
New Caledonia	45+	1,724	22,195	18,450	6,163	----------	----------
New Zealand	-------	429	450	357	324	268	[3] 275
Papua	-------	68	45	----------	47	----------	17
Total	-------	10,118	32,321	28,975	45,879	42,942	61,775
World total (estimate)[1]	-------	5,000,000	7,800,000	8,800,000	10,900,000	10,250,000	10,600,000

[1] In addition to countries listed, Bulgaria, China, and North Korea have produced manganese ore; data of output are not available, but estimates for them are included in the totals. Czechoslovakia and Egypt report production of manganese ore, but because the manganese content averages less than 30 percent and these ores are essentially ferruginous manganese ores, the output is not included in this table. Egypt produced the following tonnages: 1946–50 (average), 77,326; 1951, 171,259; 1952, 230,564; 1953, 307,331; 1954, 195,694; and 1955, 235,036; occasionally a small tonnage contains more than 35 percent manganese.

[2] This table incorporates a number of revisions of data published in previous Manganese chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.

[3] Estimate.

[4] Data not yet available; estimate by author of chapter included in total.

[5] 1953, 1954, and 1955 production estimated for ore of 35 percent or more manganese content.

[6] Year ended March 20 of year following that stated.

[7] Exports.

[8] Dry weight.

[9] Average for 1 year only, as 1950 was the first year of commercial production.

[10] Average for 1948–50.

Belgian Congo.—The 45,000 short-ton-per-month washing plant of Beceka Manganese was inaugurated at the company Kisenge mine January 27, 1955. All ore mined during the year (502,000 short tons) was processed in the plant to produce 353,000 short tons of marketable product averaging 50 percent manganese. The deposit, consisting of manganese oxides replacing metamorphic schists, forms prominent bosses above the plain and was mined by open-pit methods, using power equipment. Because of barren patches, mining operations were selective, the higher grade ore averaging approximately 47 percent manganese. Polianite and a nonbarium variety of hollandite are the principal manganese oxides. Diamond drilling had indicated ore to a depth of 100 meters below the surface, and reserves were believed to be at least 10 million tons. The Kasekalesa mine of SUDKAT produced 7,900 short tons of ore containing 50 percent manganese in 1955.[15] Exports of manganese ore from Belgian Congo for the year totaled 302,000 short tons, of which 209,000 went to the United States, 45,000 to Belgium, 40,000 to West Germany, and small quantities to Italy, France, and Sweden. Virtually all exports passed through the Angolan port of Lobito, involving a rail haul of approximately 900 miles.[16]

Bolivia.—Discoveries of manganese ore, with samples running 50 percent manganese, were reported in the Department of Beni.[17]

Brazil.—Production of ferromanganese for 1955 was 10,000 short tons; silicomanganese, 3,000 short tons; and spiegeleisen, 700 short tons.[18] It was reported that construction of a new ferroalloy plant with a capacity of 16,000 short tons of ferrosilicon and ferromanganese was planned for Minas Gerais.[19] The Uruguayan National Council of Government decreed that United States Steel Corp's wholly owned Uruguayan subsidiary could have a depot in Uruguay, near Nueva Palmira on the Uruguay River, for transshipment of manganese ore and other raw materials free of all duties and internal taxes. This was part of the corporation project to export the Urucum manganese ores of Brazil to the United States via the Paraguay River.[20] An important discovery of Metallurgical grade manganese ore, plus considerable Battery grade, was acquired by Brazilian interests near Urandi in the south central part of Bahia State.[21] Industria e Commercio de Minerios, S. A. (Icomi), in which Bethlehem Steel. Corp. has substantial interest, continued to develop its manganese deposits in the Serra do Navio district, Territory of Amapa.

Canada.—Stratmat, Ltd., a Canadian subsidiary of Strategic Materials Corp., drilled 45 holes totalling 18,860 feet during the year at its Woodstock, New Brunswick, manganese-iron deposits and submitted this prospective low-grade ore to preliminary metallurgical testing by the Udy electric-furnace process (see Technology). Electro Metallurgical Co., Division of Union Carbide Canada, Ltd., produced high- and low-carbon ferromanganese and silicomanganese in electric furnaces at its Welland, Ontario, plant. Manganese alloys also were

---

[15] U. S. Consulate, State Department Dispatch 1: Elisabethville, Belgian Congo, July 18, 1956, p. 9. State Department Dispatch 21: Elisabethville, Belgian Congo, Nov. 12, 1955, 14 pp.
Polinard, E., Les Richesses minèrales du Congo belge: Encyclopédie du Congo Belge, vol. 2, eds. Bieleveld, Brussels, 1952, pp. 554–556.

[16] U. S. Consulate, State Department Dispatch 10: Elisabethville, Belgian Congo, Sept. 22, 1956, p. 10.

[17] U. S. Embassy, State Department Dispatch 103: La Paz, Bolivia, Sept. 1, 1955, p. 5.

[18] U. S. Embassy, State Department Dispatch 51: Rio de Janeiro, Brazil, July 11, 1956, p. 2.

[19] American Metal Market, vol. 62, No. 153, Aug. 9, 1955, p. 2.

[20] U. S. Embassy, State Department Dispatch 195: Montevideo, Uruguay, Dec. 7, 1955, 1 p.

[21] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 6, December 1955, p. 18.

made from Metallurgical-grade ore by Chromium Mining & Smelting Corp., Ltd., at Sault Ste. Marie, Ontario, and silvery pig iron was produced from low-grade manganiferous ores by Canadian Furnace Co., Ltd., at Port Colborne, Ontario.[22]

Chile.—Fabricia Nacional de Carburo y Metalurgia, Chile's principal consumer of manganese ore, reported consumption of 27,000 short tons of ore and production of 10,000 tons of standard ferromanganese plus 3,500 tons of silicomanganese in 1955. Although some of these alloys went to the domestic steel industry, most were exported to the United States, and small tonnages went to various countries in Europe and South America. FNCM obtained much of its ore from Manganesos de Atacama, whose new 5,000-ton-per-year ferromanganese plant was still under construction at year end.[23]

Cuba.—Of a total of 347,000 short tons of manganese ore produced in 1955, 336,000 tons was of Metallurgical grade, averaging 44 percent manganese; 11,000 tons was of Chemical grade, averaging 84 percent manganese dioxide.[24]

Egypt.—Production of Chemical-grade ore, reported to contain 90 percent manganese dioxide, totaled 8,000 short tons in 1955. Ferruginous manganese ore totaled 227,000 short tons averaging 28 percent manganese.[25]

French Morocco.—1955 mine production of metallurgical manganese ore totaled 409,000 short tons, of which the Imini mine of Sociètè Anonyme Cherifienne d'Études Minières accounted for 248,000 short tons averaging 50 percent manganese. Approximately 92 percent of the 1955 production of metallurgical ore came from the Imini, Bou Arfa, and Tiouine mines. Ore from the Bou Arfa mine, in Eastern Morocco, totaled 78,000 short tons, of which 73,000 tons was low-grade (25–30 percent Mn) and the remainder high-grade (43–50 percent Mn). The sintering plant of SACEM at Sidi Marouf processed 178,000 short tons of Imini-mine high-grade ore to produce 144,000 short tons of sinter having a manganese content of 56 percent. The sintering plant, of Sociètè Anonyme des Mines de Bou Arfa treated 22,000 short tons of low-grade ore to obtain 14,000 short tons of sinter with a manganese content of 36 percent. Production of chemical ore in French Morocco for the year was 44,000 short tons, almost all of which came from the Imini mine.[26]

Gold Coast.—Exports of manganese ore, in 1955 were 604,000 short tons, of which 599,000 tons contained more than 30 percent manganese. The United States received 320,000; United Kingdom, 140,000; Norway, 83,000; France, 26,000; and Italy, 17,000 tons. Small shipments were sent to Netherlands, Belgium-Luxemburg, India, and Austria.[27]

India.—The manganese-mining industry of India employed 90,000 workers in 1955.[28] Shivrajpur Syndicate, one of India's leading pro-

[22] Buck, W. Keith, Manganese in Canada, 1955 (Prelim.): Canada Department of Mines and Technical Surveys, Ottawa, March 1956, 7 pp.
[23] U. S. Embassy, State Department Dispatch 848: Santiago, Chile, May 16, 1956, pp. 2–4. State Department Dispatch 69: Santiago, Chile, July 25, 1956, p. 13.
[24] U. S. Embassy, State Department Dispatch 839: Habana, Cuba, May 23, 1956, p. 1.
[25] U. S. Embassy, State Department Dispatch 1105: Cairo, Egypt, Apr. 28, 1956, pp. 1–2.
[26] U. S. Consulate General, State Department Dispatch 26: Casablanca, French Morocco, Aug. 1, 1956, pp. 15–17.
[27] U. S. Consulate General, State Department Dispatch 181: Accra, Gold Coast, Jan. 10, 1957, 1 p. State Department Dispatch 173: Accra, Gold Coast, Mar 3, 1956, 2 pp.
[28] U. S. Embassy, State Department Dispatch 215: New Delhi, India, Aug. 20, 1956, p. 1.

ducers of manganese ore, beneficiated ore containing 35 to 40 percent manganese, at the rate of 500 tons per month, to a shipping product containing 46 to 48 percent manganese. The company, which exported most of its production to the United States on the basis of firm forward contracts, complained of high rail and sea freight rates.[29] A resolution for nationalization of manganese mines received general support in the Indian Upper House of Parliament but was withdrawn as impracticable under existing circumstances.[30] Six industrial projects were licensed for the manufacture of approximately 106,000 tons of ferromanganese per year. Indian consumption of ferromanagnese has been about 17,000 tons per year, or approximately the same as 1955 production.[31]

Indonesia.—Exports of managanese ore for the first 11 months of the year totaled 40,000 short tons, most of which went to Europe. None of the ore was concentrated, and there was no appreciable home consumption.[32]

Italy.—Besides manganese ore, production of which is shown in table 19, Italy also produces ferruginous manganese ore containing 15 percent manganese and 27 percent iron. Production of this item totaled 42,000 short tons in 1953, 30,000 in 1954, and 37,000 in 1955. Italian production of manganese ore and ferruginous manganese ore is for home consumption, which also required the import of 41,000 and 102,000 short tons of such ores in 1953 and 1954, respectively. Of the 1954 imports, India supplied 44,000 tons; U. S. S. R., 23,000 and Union of South Africa, 16,000.[33] The Monte Argentario mine of Ferromin in Grosseto Province, the only producer of ferruginous manganese ore, was reported to be approaching exhaustion. Ferromin mines accounted for 95 percent of the manganese ore (29 percent Mn) produced in 1954. The reported lack of encouragement from results of continued exploration suggests that Italy's expanding steel and ferroalloy industry will become more dependent upon imports. In 1954 Italy produced 4 short tons of manganese metal, 2,000 of "refined ferromanganese," 34,000 of "carbon ferromanganese," 11,000 of silicomanganese, 12,000 of spiegeleisen, and 3,000 of silicospiegeleisen; imported 120 short tons of metal, 1,300 of spiegeleisen, and 900 of ferromanganese; and exported 1,100 short tons of ferromanganese, and 170 of ferrosilicomanganese.[34]

Jamaica.—Eastern Jamaica has scattered deposits of manganese. Most important was the Marshall Hall deposit in Portland assaying approximately 75 percent manganese dioxide. The extent of the deposit was undetermined. Discovery of a new body of good chemical grade ore was also reported.[35]

Japan.—Imports of manganese ore in 1955, at 193,000 short tons, approached production rather closely. Chief supplier was India, with 138,000 short tons, followed by U. S. S. R., 22,000; Philippines, 15,000; Indonesia, 6,500; Korean Republic, 6,200; Goa, 3,700; Southern Rhodesia, 1,100; Peru, 250; and New Caledonia, 250. Since little development work was done on manganese deposits, it is ex-

[29] U. S. Consul, State Department Dispatch 627: Bombay, India, May 4, 1955, 2 pp.
[30] U. S. Embassy, State Department Dispatch 1144: New Delhi, India, Apr. 21, 1955, p. 7.
[31] U. S. Embassy, State Department Dispatch 1127: New Delhi, India, Apr. 19, 1955, p. 8.
[32] U. S. Embassy, State Department Dispatch 39: Surabaya, Indonesia, Mar. 14, 1956, p. 1.
[33] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 1, January 1956, p. 16.
[34] U. S. Embassy, State Department Dispatch 1531: Rome, Italy, Mar. 6, 1956, p. 16.
[35] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 16.

pected that Japan will continue to depend heavily on imports. Barter agreements included manganese ore. Some 600 short tons of manganese metal was produced in 1955. All was consumed domestically and most went to the manufacture of nonferrous alloys.[36]

Jordan.—Reserves of the Wadi Dana manganese deposit were estimated to be approximately 200,000 tons running from 43 to 50 percent manganese, with an average copper content of 2 percent.[37]

Mexico.—Prices for manganese ore in April 1955 were reported to be $0.67 per long-ton unit, middle of bridge El Paso, United States duty extra, for ore containing 42 percent manganese. For each percent above this grade, $0.01 premium was applied; for each percent below there was a penalty of $0.015.[38] Exports of manganese ore in 1955 contained 40,000 short tons of elemental manganese, all going to the United States.[39] Lack of enough motive power on the railways adversely affected movement of manganese ore.[40] The ore at the San Francisco mine of Cia Minera Autlan, discovered in 1951 near Autlan, Jalisco, occurs as a 3- to 6-foot-thick, nearly flat-lying sedimentary deposit in rhyolite tuff, cut by faults, most of which are of small displacement. The principal manganese minerals are braunite and pyrolusite. Some barite is found, and hematite occurs as filling of small faults. A modified longwall retreat system of mining was used.[41] The company was engaged in erecting a 1,200-ton-per-day heavy-medium mill at the mine. Shipment is made to eastern United States ports by trucking over 100 miles of dirt road to the port of Manzanillo.

Peru.—The output of manganese ore, never large, has come from high altitudes far from the coast in the Departments of Junin and Puno. Production from Puno ceased in 1953 when pockets of Chemical-grade ore containing more than 50 percent manganese were exhausted at the Rosello mine. Ore, which after hand-cobbing averages 44–46 percent manganese with little iron or silica but occasionally with 1 or 2 percent of zinc, was mined by Minas Gren Bretana from surface "gloryholes" near Azulcocha on the Pachacayo-Mauricocha road. Except for small regular shipments to Cerro de Pasco at Oroya, all ore was sold for export principally to the United States. The ore was trucked to the railroad for shipment via Callao.[42] The freight rate for manganese ores and concentrates in bulk was increased from US$10 to US$12 a ton, according to the 1955 contract between shippers and West Coast of South America Northbound Conference Lines.[43]

Philippines.—By the end of 1954 all manganese mines had suspended operations. General Base Metals was the only operator to resume mining in the first half of 1955 and was reported to have cut its operating costs by emphasis on mechanization.[44] It was the principal producer for the year, the only others being Palawan Manganese Mines, Inc., and Laur Manganese Co. Exports in 1955 totaled

---

36 U. S. Embassy, State Department Dispatch 948: Tokyo, Japan, Apr. 17, 1956, p. 2.
37 U. S. Embassy, State Department Dispatch 384: Amman, Jordan, May 1, 1956, p. 55.
38 U. S. Consulate, State Department Dispatch 117: Ciudad Juarez, Mexico, Apr. 15, 1955, 1 p.
39 Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 6, June 1956, p. 19.
40 U. S. Embassy, State Department Dispatch 1185: Mexico, D. F., Mexico, Apr. 24, 1956, p. 6.
41 Llamas, Francisco, Manganese Deposits of Autlan: XXth Internat. Geol. Cong., Symposium on Manganese Deposits, Mexico City, September 1956, unpublished paper.
42 U. S. Embassy, State Department Dispatch 42: Lima, Peru, July 18, 1956, p. 11.
43 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 6, June 1955, p. 23.
44 Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 6, December 1955, pp. 18–19.

14,000 short tons, with 13,000 to Japan and the remainder to the United States.[45]

Portuguese India.—Exports of manganese ore from Goa in 1955 increased 35 percent over those of the previous year to 155,000 short tons. West Germany took 55,000; the United States, 50,000; France, 29,000; Sweden, 11,000; Italy, 5,600; and Austria, 3,900 tons. The mining of iron and manganese ores was Goa's most important economic activity.[46]

Rhodesia and Nyasaland, Federation of.—In September 1955 Rhodesian Vanadium Corp., wholly owned subsidiary of Vanadium Corp. of America, purchased the Bahati mine near Fort Roseberry in northeastern Northern Rhodesia for a price reported to be approximately $1 million. Plans call for production to be increased by mid-1956 from the prepurchase 400 tons per month to 2,000 tons per month of ore averaging between 48 and 50 percent manganese. The ore will not be concentrated at the plant but will be taken by truck across Belgian Congo territory to railhead at Mufilira, Northern Rhodesia.[47] Mineral Search of Africa, a subsidiary of Rio Tinto Co., was reported to have discovered large manganese deposits near the Belgian Congo border near Chiwefwe, some 70 miles southeast of N'dola.[48] Manganese-ore exports of the Federation in 1955 totaled 19,000 short tons, of which 17,000 tons went to the United States, 1,000 tons to the United Kingdom, and the remainder to Netherlands and West Germany.[49]

Thailand.—High-grade pyrolusite ore, analyzing 98.05 percent manganese dioxide, was reported to have been discovered in Thailand.[50]

Union of South Africa.—The chairman of South African Manganese, Ltd., reported to shareholders that the large reduction in profits for the fiscal year ended June 30, 1955, compared with the 2 previous years, was due partly to lower export prices but chiefly to the acute shortage of railway trucks. Tonnage exported was almost 50 percent less than in the previous year. Although some improvement in the railway situation was noted in the latter part of calendar 1955, no real improvement was expected before late 1957. Because of this situation and because of congestion on the Natal railway system, loading of the company ore for export was diverted from Durban to Port Elizabeth. The company geophysical and geological program for prospecting the Kuruman district continued throughout the year. Manganese ore from one of the new developments was mined, and consideration was given to opening a second property.[51] Some South African manganese ore was exported through the Mozambique port of Lourenço, Marques.[52]

U. S. S. R.—A transaction was completed whereby a Japanese firm will acquire 6,500 tons of Soviet manganese ore in exchange for wire rod. Price was reported to be US$30 per ton c. i. f. Japan and

[45] U. S. Embassy, State Department Dispatch 1306: Manila, P. I., May 15, 1956, pp. 32-33.
[46] U. S. Consul, State Department Dispatch 488: Bombay, India, Feb. 1, 1957, pp. 3-4.
[47] U. S. Consulate General, State Department Dispatch 169: Salisbury, Southern Rhodesia, Dec. 13, 1955, 2 pp.
[48] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, pp. 23-24.
[49] U. S. Consulate General, State Department Dispatch 261: Johannesburg, Union of South Africa, May 14, 1956, p. 3 of encl. 3.
[50] South African Mining and Engineering Journal, vol. 66, Part I, No. 3261, Aug. 13, 1955, p. 981.
[51] South African Mining and Engineering Journal, vol. 66, No. 3277, Dec. 3, 1955, pp. 546-547.
[52] U. S. Consulate General, State Department Dispatch 190: Johannesburg, Union of South Africa, June 3, 1955, 1 p.

grade about 48 percent manganese. Negotiations for 10,000 tons by another Japanese firm also were reported.[53]

United Kingdom.—Imports of manganese ore in the first half of 1955 amounted to 222,000 short tons. Of this quantity, 69,500 tons came from the U. S. S. R.; 64,500 tons from India; 64,500 tons from Gold Coast; 21,000 tons from Union of South Africa; and 2,600 tons from other sources.[54]

---

[53] Metal Bulletin (London), No. 3967, Feb. 8, 1955, p. 20.
[54] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, p. 24.

Mercury

By J. W. Pennington[1] and Gertrude N. Greenspoon[2]

RECORD peaks in peacetime consumption and average price were the outstanding features of the domestic mercury industry in 1955. Other features included a moderate but continued increase in production, sharply reduced domestic imports, and abnormally low industrial stocks.

Mercury consumption of 57,200 flasks in 1955 exceeded that of 1954 by 34 percent. The increase was due chiefly to the installation of a new chlorine and caustic soda plant using mercury cells at Muscle Shoals, Ala.

An average price of $290.35 a flask surpassed the previous high set in 1954 by $25.96 a flask. Quotations ranged from a high of $323–$325 a flask in March to a low of $253–$255 a flask in mid-August. In the last quarter prices strengthened and at the year's close were $280–$284 a flask.

Mine production continued the upward trend of the last 5 years and rose 2 percent over 1954 to 19,000 flasks. High prices and strong demand raised the number of producing properties to 98 from the 71 operating in 1954 and were largely responsible for the increased production. Of the total production 94 percent came from 18 mines. California furnished 52 percent of the output, Nevada 30 percent, Idaho and Oregon each 6 percent, and Alaska, Arizona, and Texas the remainder.

Imports of mercury for consumption fell sharply in the last quarter of 1954 and continued at a reduced rate in 1955. As a result, annual imports were the smallest since 1947 and 69 percent less than in 1954. Drastic reductions occurred in imports from Italy and Spain, which totaled only 629 and 5,458 flasks, respectively. Mercury obtained from Yugoslavia remained about the same at 3,807 flasks, whereas metal from Mexico increased 15 percent to 10,250 flasks.

A substantial increase in consumption coupled with a large decrease in imports and only a moderate increase in mine output resulted in the smallest industrial stocks in several years. Inventories fell below normal levels and totaled only 10,028 flasks at the end of the year compared with 22,486 flasks at the beginning.

Even though exports and reexports are customarily small, those in 1955 were less than usual. Compared with the preceding year, exports declined from 890 flasks to 451 and reexports fell from 1,436 flasks to 267. Export restrictions imposed by the Bureau of Foreign Commerce were largely responsible for these reductions.

[1] Commodity specialist.
[2] Statistical assistant

TABLE 1.—Salient statistics of the mercury industry in the United States, 1946–50 (average) and 1951–55

(Flasks of 76 pounds)

	1946–50 (average)	1951	1952	1953	1954	1955
Production	15,489	7,293	12,547	14,337	18,543	18,955
Number of producing mines	29	47	39	49	71	98
Average price per flask: New York	$83.84	$210.13	$199.10	$193.03	$264.39	$290.35
Imports for consumption	43,615	47,860	71,855	83,393	64,957	20,354
Exports	668	241	400	546	890	451
Consumption	40,492	56,848	42,556	52,259	42,796	57,185

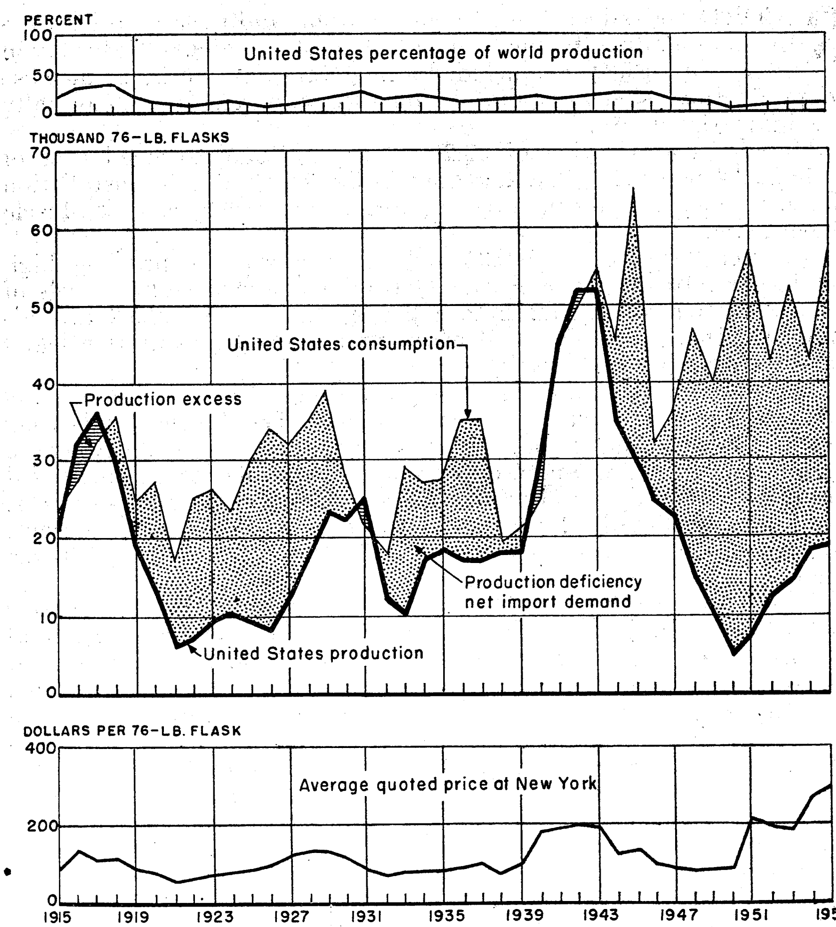

FIGURE 1.—Trends in production, consumption, and price of mercury, 1915–55.

Government assistance initiated in 1954 to strengthen the current and future supply situation was continued in 1955. Under provisions of the Defense Production Act of 1950, as amended, the Defense Minerals Exploration Administration (DMEA) of the Department of the Interior entered in contracts for the exploration of mercury deposits. Also available was the guaranteed-price program of General Services Administration (GSA), which will remain in effect until December 31, 1957. The GSA program is described under Prices.

World production rose in 1955 to 196,000 flasks, an increase of 14,000 over 1954. Mexican output more than doubled, Spanish and Yugoslav production increased slightly, that of Italy decreased, and the Philippines became a producer of mercury for the first time.

DEFENSE MINERALS EXPLORATION ADMINISTRATION

Under the provisions of the Defense Production Act of 1950, as amended, DMEA granted exploration assistance, amounting to 75 percent of the costs, to approved mercury-exploration projects. The chapters on Mercury in 1952, 1953, and 1954 listed contracts from the beginning of the program to the end of 1954. Some of them have been terminated and others completed. Those in force in 1955, including those executed during the year, are shown in table 2.

TABLE 2.—DMEA contracts involving mercury during 1955, by States

State and contractor	Property	County	Contract: Date	Contract: Total amount [1]
ALASKA				
Moneta Porcupine Mines, Ltd	Red Top	Bristol Bay district.	Aug. 18, 1955	$118, 720
ARIZONA				
Ord Mercury Mines	Ord	Gila	Nov. 10, 1952	28, 000
CALIFORNIA				
California Quicksilver Mines, Inc	Abbott	Lake	Sept. 15, 1951	88, 940
New Idria Mining & Chemical Co	New Idria	San Benito	Apr. 4, 1955	129, 331
Hugh M. Simmons	Granada	Napa	June 28, 1955	17, 800
L. A. Smith & B. C. Austin	Altoona	Trinity	June 27, 1955	95, 260
Frank Vollmer	Oceanic	San Luis Obispo.	Feb. 28, 1955	6, 639
NEVADA				
C. A. Coppin	Red Bird	Pershing	July 5, 1955	17, 180
OREGON				
Roba & Westfall	Roba & Westfall	Grant	June 2, 1953	20, 140
TEXAS				
Amerimex Mining Co	Fresno	Presidio	Dec. 18, 1952	80, 000

[1] Government participation was 75 percent in exploration projects for mercury in 1955.

DOMESTIC PRODUCTION [3]

Mine production of mercury in the United States increased in 1955 for the fifth consecutive year and exceeded that in 1954 by 2 percent. The output (19,000 flasks) was at the highest annual rate since 1947. Substantial increases in primary metal were reported in Arizona, Idaho, Nevada, and Oregon, whereas production in Alaska and California declined. High prices enabled more facilities to operate and were chiefly responsible for the larger production. Reduction of output in Alaska resulted from a fire which forced closure of the Red Devil mine facilities, and the lower production in California apparently resulted from the treatment of lower grade ore.

Although production in California in 1955 was 12 percent less than in 1954, the State retained its rank as the leading mercury producer in the United States; it contributed, however, only 52 percent of the total compared with 61 percent in 1954 and 85 to 58 percent in 1950 to 1953, inclusive. The 1955 percentage was the lowest since 1949, when, for the first time in many years, California supplied less than half of the country's total output. Nevada was in its customary second place, with 30 percent; Idaho regained third place, and Oregon ranked fourth. Output in Alaska—the third largest producer in 1954—was at a considerably reduced rate in 1955; the entire year was spent in rebuilding the plant at the Red Devil mine, which was destroyed by fire in October 1954. Texas produced for the first time since 1953.

TABLE 3.—Mercury produced in the United States, 1952–55, by States

Year and State	Producing mines	Flasks of 76 pounds	Value [1]
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
1953:			
Alaska	2	40	7,721
California	28	9,290	1,793,249
Idaho and Texas	2	1,105	213,298
Nevada	12	3,254	628,120
Oregon	5	648	125,083
Total	49	14,337	2,767,471
1954:			
Alaska	2	1,046	$276,552
Arizona	3	163	43,096
California	35	11,262	2,977,560
Idaho	1	609	161,013
Nevada	21	4,974	1,315,076
Oregon	9	489	129,287
Total	71	18,543	4,902,584
1955:			
Alaska and Texas	4	690	200,342
Arizona	4	477	138,497
California	48	9,875	2,867,206
Idaho	2	1,107	321,417
Nevada	33	5,750	1,669,512
Oregon	7	1,056	306,610
Total	98	18,955	5,503,584

[1] Value calculated at average price at New York.

[3] Census data exclude production in Alaska and operations where value of production and expenditures are less than $500.

TABLE 4.—Mercury produced in the United States, 1910–55, by States, in flasks of 76 pounds

Year	Alaska	Arizona	Arkansas	California	Idaho	Nevada	Oregon	Texas	Utah	Washington	Other [1]	Total
1910				16,985		69		3,276				20,330
1911				18,612		69		2,295				20,976
1912				20,254		2,516		1,964				24,734
1913		224		15,386		1,623		2,714				19,947
1914		11		11,154		2,062		3,103				16,330
1915		(2)		14,095		2,296	(2)	4,359			6	20,756
1916		5		20,768		2,169	299	6,223		74		29,538
1917		39		23,623	5	984	383	10,649				35,683
1918				22,366	21	1,030	693	8,340				32,450
1919				15,005		746	429	4,953				21,133
1920				9,719		82	24	3,391				13,216
1921				3,015	1	(2)	(2)	(2)			3,240	6,256
1922				3,360		(2)	2	(2)			2,929	6,291
1923				5,375	(2)	(2)	(2)	(2)			2,458	7,833
1924		(2)		7,861	(2)	(2)	(2)	(2)			2,091	9,952
1925		30		7,514	(2)	532		(2)			977	9,053
1926	(2)	(2)		5,651	6	194		(2)		482	1,208	7,541
1927	(2)	(2)		5,672		419	2,055	(2)		559	2,423	11,128
1928		(2)		6,977		2,867	3,710	(2)		(2)	4,316	17,870
1929	(2)	(2)		10,139		4,764	3,657	(2)		1,397	3,725	23,682
1930	(2)	(2)		11,451		3,282	2,919	(2)		1,079	2,822	21,553
1931	(2)	(2)	(2)	13,448		2,217	5,011	(2)		560	3,711	24,947
1932	(2)	(2)	(2)	5,172		474	2,523	(2)		407	4,046	12,622
1933			(2)	3,930		387	1,342	(2)	(2)	(2)	4,010	9,669
1934		(2)	488	7,808		300	3,460	(2)		330	3,059	15,445
1935		(2)	304	9,271		190	3,456	(2)		106	4,191	17,518
1936		(2)	(2)	8,693		211	4,126	(2)	25	(2)	3,514	16,569
1937		37	(2)	9,743		198	4,264	(2)		(2)	2,266	16,508
1938	(2)		(2)	12,277		336	4,610	(2)		(2)	768	17,991
1939		(2)	364	11,127	(2)	828	4,592	(2)			1,722	18,633
1940	162	740	1,159	18,629	(2)	5,924	9,043	(2)	53	(2)	2,067	37,777
1941	(2)	873	2,012	25,714	(2)	4,238	9,032	(2)	19	(2)	3,033	44,921
1942	(2)	701	2,392	29,906	(2)	5,201	6,935	(2)	(2)	(2)	5,711	50,846
1943	786	541	1,532	33,812	4,261	4,577	4,651	1,769				51,929
1944	(2)	548	191	28,052	(2)	2,460	3,159	1,095			2,183	37,688
1945	(2)	(2)	(2)	21,199	627	4,338	2,500	(2)			2,099	30,763
1946	699	95	11	17,782	868	4,567	1,326					25,348
1947	127			17,165	886	3,881	1,185					23,244
1948	100			11,188	543	1,206	1,351					14,388
1949	100			4,493		4,170	1,167					9,930
1950				3,850		680	5					4,535
1951		(2)		4,282	357	1,400	1,177	(2)			77	7,293
1952	28			7,241	887	3,523	868					12,547
1953	40			9,290	(2)	3,254	648	(2)			1,105	14,337
1954	1,046	163		11,262	609	4,974	489					18,543
1955	(2)	477		9,875	1,107	5,750	1,056	(2)			690	18,955

1 Includes States shown as "(2)".
2 Included with "Other." Bureau of Mines not at liberty to publish separately.

A total of 98 mines, compared with 71 in 1954, contributed to production in 1955; 18 properties, each producing 100 flasks or more, supplied 94 percent of the total output. The largest producers were as follows:

State	*County*	*Mine*
Arizona	Maricopa	Pine Mountain.
California	Lake	Abbott,
		Sulphur Bank.
	San Benito	New Idria (including San Carlos).
		North Star.
	San Luis Obispo	La Libertad.
	San Mateo	Farm Hill No. 2.
	Santa Clara	Guadalupe.
		New Almaden mine and dumps.
	Sonoma	Buckman Group.
		Mount Jackson (including Great Eastern).
Idaho	Valley	Hermes.
	Washington	Idaho-Almaden.

State	*County*	*Mine*
Nevada	Humboldt	Cordero.
Oregon	Douglas	Bonanza.
	Jefferson	Horse Heaven.
Texas	Brewster	Maggie Group.
	Presidio	Fresno.

Of the leading producers, new properties or those producing for the first time in several years were the Pine Mountain, Sulphur Bank, Farm Hill No. 2, Idaho-Almaden, Horse Heaven, and Maggie Group mines.

TABLE 5.—Mercury produced in the United States, 1946–50 (average) and 1951–55, by quarters, in flasks of 76 pounds

Quarter	1946–50 (average)	1951	1952	1953	1954	1955
First	4,018	880	3,050	3,530	4,170	4,050
Second	3,754	1,400	3,000	3,790	4,700	4,860
Third	} 7,592	{ 1,600	3,320	3,040	5,160	4,720
Fourth		3,270	3,130	3,970	4,470	5,200
Total: Preliminary	15,364	7,150	12,500	14,330	18,500	18,830
Final	15,489	7,293	12,547	14,337	18,543	18,955

The grade of mercury ore treated in the United States dropped 1.7 pounds to 6.4 pounds per ton in 1955 and was the lowest since 1943. This reflects the higher prices, which permitted economical processing of lower grade materials.

TABLE 6.—Mercury ore treated and mercury produced therefrom in the United States, 1927–55 [1]

(Until 1954 excludes some material from old dumps)

Year	Ore treated (short tons)	Mercury produced: Flasks of 76 pounds	Mercury produced: Pounds per ton of 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	1942	733,360	49,066	5.1
1928	142,131	14,841	7.9	1943	613,111	50,761	6.3
1929	248,314	19,461	6.0	1944	300,385	37,333	9.4
1930	288,503	18,719	4.9	1945	209,009	29,754	10.8
1931	260,471	22,625	6.6	1946	157,469	24,929	12.0
1932	108,118	11,770	8.3	1947	139,311	22,823	12.5
1933	78,089	8,381	8.2	1948	103,220	13,891	10.2
1934	126,931	13,778	8.2	1949	71,977	9,745	10.3
1935	135,100	15,280	8.6	1950	35,115	4,312	9.3
1936	141,962	14,007	7.5	1951	81,067	6,934	6.5
1937	186,578	16,316	6.6	1952	135,197	12,500	7.0
1938	199,954	17,816	6.8	1953	138,090	14,262	7.8
1939	191,892	18,505	7.3	1954	174,083	18,524	8.1
1940	449,940	37,264	6.3	1955	222,740	18,819	6.4
1941	652,141	43,873	5.1				

[1] Excludes mercury produced from placer operations and from clean-up activity at furnaces and other plants.

Secondary.—Production of secondary mercury was 10,030 flasks in 1955 compared with 6,100 flasks in 1954, the first year for which complete data are available. Over half of the total output of secondary mercury was in the first quarter of 1955 owing to scrapping of a plant that used a process involving mercury.

TABLE 7.—Production of secondary mercury [1] in the United States, 1951–55, in flasks of 76 pounds

Year:	Quantity
1951	2,000
1952	2,500
1953	2,800
1954	6,100
1955	10,030

[1] Until 1954 covers only that metal produced from scrap that could not be excluded because its identity as such was lost following sale.

CONSUMPTION AND USES

Mercury was consumed at a new peacetime record rate in 1955; it rose 34 percent above 1954 and was 1 percent more than in 1951, the previous peacetime peak. The high rate of consumption was due largely to installation of a chlorine and caustic soda plant, using mercury cells, at Muscle Shoals, Ala., in the first half of the year. As stated in previous chapters of this series, the use of mercury for new chlorine installations is not dissipative. If such plants are dismantled the mercury recovered is considered as secondary or scrap in production and consumption data.

TABLE 8.—Mercury consumed [1] in the United States, 1946–50 (average) and 1951–55, in flasks of 76 pounds

Use	1946–50 (average)	1951	1952	1953	1954	1955
Pharmaceuticals	3,993	2,761	1,395	1,858	1,846	1,578
Dental preparations	1,067	[2] 803	[2] 1,027	[2] 1,117	[2] 1,409	[2] 1,177
Fulminate for munitions and blasting caps	417	494	337	39	106	90
Agriculture (includes insecticides, fungicides, and bactericides for industrial purposes)	4,994	7,737	5,886	6,936	7,651	7,399
Antifouling paint	1,513	2,500	1,178	655	512	724
Electrolytic preparation of chlorine and caustic soda	823	1,543	2,507	2,380	2,137	3,108
Catalysts	3,383	2,635	1,048	826	594	729
Electrical apparatus	7,299	[2] 10,250	[2] 8,018	[2] 9,630	[2] 10,833	[2] 9,268
Industrial and control instruments	5,211	[2] 6,158	[2] 6,412	[2] 5,546	[2] 5,185	[2] 5,628
Amalgamation	147	154	151	200	203	217
General laboratory	407	524	629	1,241	1,129	976
Redistilled	6,201	[2] 8,776	[2] 7,547	[2] 7,784	[2] 9,281	[2] 9,583
Other	5,037	12,513	6,421	14,047	1,910	16,708
Total	40,492	56,848	42,556	52,259	42,796	57,185

[1] Until 1954 included only such small quantities of secondary metal as were not separately identifiable.
[2] A breakdown of the "redistilled" classification showed ranges of 53 to 43 percent for instruments, 22 to 5 percent for dental preparations, 37 to 10 percent for electrical apparatus, and 21 to 9 percent for miscellaneous uses in the period 1946–54, compared with 45 percent for instruments, 9 percent for dental preparations, 37 percent for electrical apparatus, and 9 percent for miscellaneous uses in 1955.

TABLE 9.—Mercury consumed [1] in the United States, 1946–50 (average) and 1951–55, by quarters, in flasks of 76 pounds

Quarter	1946–50 (average)	1951	1952	1953	1954	1955
First	9,360	16,000	10,100	12,700	11,500	19,500
Second	10,240	11,600	9,500	13,200	11,300	17,900
Third	8,980	7,400	13,200	11,000	9,000	8,300
Fourth	11,660	21,600	10,200	15,500	9,500	11,600
Total: Preliminary	40,240	56,600	43,000	52,400	41,300	57,300
Final	40,492	56,848	42,556	52,259	42,796	57,185

[1] Until 1954 included only such small quantities of secondary metal as were not separately identifiable.

Most mercury uses took less metal in 1955 than in 1954; dental preparations, pharmaceuticals, and electrical apparatus decreased 16, 15, and 14 percent, respectively; agricultural use, which includes insecticides, fungicides, and bactericides for industrial purposes, consumed 3 percent less than in 1954. On the other hand, 45 percent more mercury was required to replace metal losses 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 greater capacity. Consumption of mercury for the manufacture of industrial and control instruments rose 9 percent.

STOCKS

Consumers' and dealers' stocks of mercury declined 59 percent in 1955 and were below those normally held by industry. The drop was due in part to withdrawal of metal held for a chlorine and caustic soda plant installation, completed in 1952 but not put into operation until early 1955.

TABLE 10.—Stocks of mercury in hands of producers and of consumers and dealers, 1951–55, in flasks of 76 pounds

End of year	Producers	Consumers and dealers	Total
1951	1,072	29,100	30,172
1952	685	33,700	34,385
1953	1,121	25,900	27,021
1954	186	22,300	22,486
1955	928	9,100	10,028

Stocks held by domestic producers usually represent only a small part of the total for the entire industry. These stocks rose substantially in 1955 but continued small in relation to most earlier years except for 1952 and 1954. The rise in producers' inventories was due in part to the reluctance of consumers to purchase the metal at current prices.

In addition to the metal shown in table 10, noteworthy quantities of mercury are held in the National Stockpile, but data on such quantities may not be disclosed.

PRICES

The annual average mercury quotation during 1955 was $290.35 a flask; it established a new peak and exceeded the previous high of 1954 by 10 percent. At the beginning of the year prices ranged from $322–$324 a flask. After an increase to $323–$325 a flask in March, pressure for supplies lessened, and quotations declined gradually and without interruption to a range of $253–$255 a flask in mid-August. Following this, the price rose to $280–$284 a flask in November and continued at that level for the remainder of the year. Weekly price changes are given in table 12.

TABLE 11.—Average monthly prices per flask (76 pounds) of mercury at New York and London, and excess of New York price over London price, 1953–55

Month	1953			1954			1955		
	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	$212.96	$199.01	$13.95	$187.36	$175.19	$12.17	$322.00	$304.63	$17.37
February	205.09	199.44	5.65	188.00	180.38	7.62	322.00	304.63	17.37
March	198.12	199.20	[3] 1.08	200.44	193.25	7.19	321.56	305.24	16.32
April	195.89	199.27	[3] 3.38	220.23	222.63	[3] 2.40	315.85	304.12	11.73
May	195.00	198.87	[3] 3.87	248.80	244.86	3.94	302.92	301.96	.96
June	191.92	198.07	[3] 6.15	275.00	258.57	16.43	283.27	301.30	[3] 18.03
July	190.46	198.20	[3] 7.74	286.92	279.65	7.27	264.92	300.77	[3] 35.85
August	188.31	198.18	[3] 9.87	290.00	281.29	8.71	253.89	280.75	[3] 26.86
September	185.20	193.15	[3] 7.95	311.00	289.88	21.12	263.40	259.15	4.25
October	183.42	178.31	5.11	325.00	304.20	20.80	275.56	258.61	16.95
November	184.09	173.57	10.52	320.33	307.74	12.59	279.39	253.79	25.60
December	185.92	173.54	12.38	319.54	306.61	12.93	279.42	200.81	78.61
Average	193.03	192.49	.54	264.39	255.33	9.06	290.35	280.22	10.13

[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.

TABLE 12.—Weekly prices per flask (76 pounds) of mercury at New York, in 1955 [1]

Week ended—	Price range	Week ended—	Price range
Jan. 5	$322–$324	July 6	$275–$277
12	322– 324	13	270– 272
19	322– 324	20	262– 264
26	322– 324	27	259– 261
Feb. 2	322– 324	Aug. 3	255– 257
9	322– 324	10	253– 255
16	322– 324	17	253– 255
23	322– 324	24	254– 256
Mar. 2	323– 325	31	255– 257
9	323– 325	Sept. 7	255– 257
16	323– 325	14	260– 265
23	320– 323	21	265– 270
30	320– 323	28	270– 275
Apr. 6	317– 320	Oct. 5	274– 278
13	317– 320	12	275– 280
20	315– 318	19	275– 280
27	315– 318	26	276– 281
May 4	313– 316	Nov. 2	278– 283
11	307– 310	9	279– 283
18	302– 305	16	279– 283
25	300– 302	23	280– 284
June 1	295– 298	30	280– 284
8	288– 291	Dec. 7	280– 284
15	285– 288	14	280– 284
22	281– 283	21	280– 284
29	278– 280	28	280– 284

[1] E&MJ Metal and Mineral Markets.

The guaranteed-purchase price program announced by GSA in July 1954 was continued in 1955. This program provided for purchasing a maximum of 125,000 flasks of domestic mercury and 75,000 flasks of Mexican metal at $225 a flask and was scheduled to end December 31, 1957, even if such quantities were not obtained. An import duty of $19 a flask is included in the price for Mexican mercury. As only 5 flasks of mercury have been purchased since the inception of the program, it is apparent that the program will expire before the allotted quantities of metal are obtained.

The average annual London price in dollars was $280.22 a flask and also established a new peak; it was 10 percent greater than in 1954 and only slightly under the 1943 and 1944 averages, when prices were controlled. The quotation was £110 (equivalent to $308.00) a flask when the year began; it fluctuated between £106 ($296.80) and £110 through April. From May to mid-August the price was £108 ($302.40). For one week in August, mercury was quoted at a range of £94–£95 ($263.20–$266.00). The price declined the last week of the month to £90–£95 ($252.00–$266.00), then advanced to £92–£94 15s. ($257.60–$265.30) during September; it dropped to £91 10s. ($256.20) in October, and the downward trend continued through November and December. At the year end the price was quoted at £89 10s. ($250.60).

FOREIGN TRADE [4]

Imports of mercury for consumption in 1955 were 20,354 flasks—69 percent less than the quantity received in 1954 and the smallest since 1947. Receipts from all producing countries except Mexico and Yugoslavia were substantially less than in 1954; supplies from Yugoslavia were 2 percent less and those from Mexico 15 percent over 1954.

Tariff.—A duty of 25 cents a pound ($19 a flask) on imports of mercury has been in effect since 1922.

Exports of mercury, relatively insignificant, were little more than half the 1954 quantity. Exports to all destinations except Canada continued to require licenses throughout 1955, but in the last quarter of the year were no longer subject to quantity control.

Reexports of mercury were also relatively insignificant and in 1955 totaled only 267 flasks compared with 1,436 flasks in 1954.

General imports (imports for immediate consumption plus entries into bonded warehouses) afford a better measure of material actually entering the country during a calendar period than do imports for consumption (imports for immediate consumption plus withdrawals from bonded warehouses for consumption).

Imports of various mercury compounds are generally negligible and in 1955 were 42 percent less than those received in 1954. Of the total of 20,298 pounds (34,900 in 1954) of mercuric chloride, mercurous chloride, oxide (red precipitate), and other mercury preparations imported in 1955, 15,000 came from Canada, 2,716 from the United Kingdom, 1,660 from Yugoslavia, 772 from Spain, and 150 from India; 110 pounds of vermillion reds from Italy.

[4] Figures on United States imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 13.—Mercury imported for consumption in the United States, 1946–50 (average) and 1951–55, in flasks [1]

[U. S. Department of Commerce]

	1946–50 (average)		1951		1952		1953		1954		1955	
	Flasks	Value	Flasks	Value	Flasks	Value	Flasks	Value	Flasks	Value	Flasks	Value
North America:												
Canada	33	$2, 504	660	$125, 906	20	$7, 398	171	$33, 217	115	$31, 221	114	$36, 500
Honduras			10	2, 140								
Mexico	3, 440	204, 028	5, 109	843, 523	7, 941	1, 302, 837	13, 298	2, 079, 096	8, 887	1, 729, 601	10, 250	2, 545, 925
Total	3, 473	206, 532	5, 779	971, 569	7, 961	1, 310, 235	13, 469	2, 112, 313	9, 002	1, 760, 822	10, 364	2, 582, 425
South America:												
Bolivia			19	1, 744								
Chile	128	9, 096										
Peru							6	875			95	26, 276
Total	128	9, 096	19	1, 744			6	875			95	26, 276
Europe:												
Czechoslovakia	40	1, 984										
Denmark	60	4, 021										
Germany			250	39, 904								
Italy	22, 351	1, 455, 994	21, 868	2, 875, 681	26, 276	5, 033, 235	36, 120	5, 938, 004	22, 180	3, 393, 759	629	178, 487
Netherlands	115	6, 458	350	21, 700	100	18, 979	50	8, 959				
Spain	12, 747	609, 812	11, 954	1, 573, 982	27, 102	4, 404, 675	28, 049	4, 549, 115	29, 884	4, 875, 352	5, 458	1, 302, 234
Sweden	212	12, 888	680	107, 370								
Switzerland			204	23, 450								
United Kingdom	160	9, 920	47	3, 285	1	261	(2)	36			1	314
Yugoslavia	2, 272	119, 233	6, 459	952, 924	10, 365	1, 771, 052	5, 649	951, 008	3, 891	753, 724	3, 807	1, 059, 260
Total	37, 957	2, 220, 310	41, 812	5, 598, 296	63, 844	11, 228, 202	69, 868	11, 447, 122	55, 955	9, 022, 835	9, 895	2, 540, 295
Asia:												
India							25	3, 666				
Japan	2, 057	121, 071	250	14, 980			25	4, 600				
Total	2, 057	121, 071	250	14, 980			50	8, 266				
Africa: French Morocco					50	8, 250						
Grand total	43, 615	2, 557, 009	47, 860	6, 586, 589	71, 855	12, 546, 687	83, 393	13, 568, 576	64, 957	[3] 10, 783, 657	20, 354	5, 148, 996

[1] Flask = 76 pounds.
[2] Less than 1 flask.
[3] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to other years.

TABLE 14.—Mercury imported (general imports) into the United States, in 1955, by months

[U. S. Department of Commerce]

Month	Flasks of 76 pounds	Month	Flasks of 76 pounds
January	973	August	1,018
February	1,330	September	1,023
March	1,670	October	3,574
April	1,394	November	3,043
May	1,103	December	2,102
June	1,697		
July	1,721	Total	20,648

TABLE 15.—Mercury imported (general imports) into the United States, 1946–50 (average) and 1951–55, in flasks of 76 pounds

[U. S. Department of Commerce]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	37	660	20	171	115	114
Honduras		10				
Mexico	4,009	4,989	7,971	13,637	9,374	10,310
Total	4,046	5,659	7,991	13,808	9,489	10,424
South America:						
Bolivia		19				
Chile	134					
Peru				6		95
Total	134	19		6		95
Europe:						
Denmark	60					
Germany		250				
Italy	23,899	17,633	26,025	37,827	21,858	579
Netherlands	165		100	50		
Spain	13,300	13,707	24,333	28,303	29,859	5,524
Sweden	227	680				
Switzerland		204				
Turkey					54	
United Kingdom	10	(1)	1	(1)		1
Yugoslavia	2,585	6,525	10,186	5,765	4,057	4,025
Total	40,246	38,999	60,645	71,945	55,828	10,129
Asia: Japan	2,085	250		25		
Africa: French Morocco			50			
Grand total	46,511	44,927	68,686	85,784	65,317	20,648

[1] Less than 1 flask.

Exports.—Of the 451 flasks exported (890 in 1954), 106 (100) went to Canada, 66 (none) to Japan, 56 (51) to Venezuela, 54 (6) to Colombia, 35 (8) to Cuba, 30 (651) to Brazil, 29 (none) to Korea, and the remainder in lots of less than 20 flasks to 13 other countries.

Reexports were 267 flasks in 1955 (1,436 in 1954). Of the total, 256 (1,057) went to Canada, and 11 (8) to Venezuela.

TABLE 16.—Mercury exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Pounds	Flasks of 76 pounds	Value	Year	Pounds	Flasks of 76 pounds	Value
1946–50 (average)	50, 786	668	$67, 899	1953	41, 497	546	$105, 975
1951	18, 311	241	57, 502	1954	67, 628	890	183, 417
1952	30, 369	400	85, 974	1955	34, 301	451	155, 433

TABLE 17.—Mercury reexported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Pounds	Flasks of 76 pounds	Value	Year	Pounds	Flasks of 76 pounds	Value
1946–50 (average)	122, 915	1, 617	$112, 572	1953	69, 640	916	$157, 880
1951	51, 326	675	111, 274	1954	109, 147	1, 436	257, 342
1952	19, 689	259	46, 721	1955	20, 274	267	77, 664

TECHNOLOGY

The mercury deposits of the central Kuskokwim region of Alaska were described in a Geological Survey report.[5] Mercury, the chief mineral product of the district, occurs as cinnabar commonly associated with stibnite. Description of the geography, geology, and mineral resources of about 10,000 square miles in Southeastern Alaska were included in the publication.

A Bureau of Mines bulletin [6] containing information on the history, organization, mining, metallurgy, and other pertinent phases of the mercury industry was released.

Thermal conductivity measurements to 540° C. on high-purity mercury showed that the conductivity increased with temperature.[7] Similar results were obtained with the sodium-potassium alloys, whereas liquid sodium and potassium exhibit normal behavior. Results indicated direct relationship between phenomena of electrical and thermal transfer in ideal liquid systems.

The results obtained in studying the thermal diffusion of a series of liquid metals were found to be consistent with the existing theory that separations depend on the activation energy $\Delta U \pm / V$ of the components.[8]

A newly designed isoteriscope was used to measure the vapor pressure of mercury in the region 250° to 360° C. Values obtained agreed with those of other investigations but were more self-consistent than any data previously reported.[9]

---

[5] Cady, W. M., Wallace, R. E., Hoare, J. M., and Webber, J. E., The Central Kuskokwim Region, Alaska: Geol. Survey Prof. Paper 268, 1955, 132 pp.

[6] Meyer, Helena M., Mercury (a chapter from Mineral Facts and Problems): Bureau of Mines Bull. 556, 1955, 10 pp.

[7] Ewing, C. T., Seebold, R. E., Grond, J. A., and Miller, R. R., Thermal Conductivity of Mercury and Two Sodium-Potassium Alloys: Jour. Phys. Chem., vol. 59, No. 6, June 1955, pp. 524–528.

[8] Winter, F. R., and Drickomer, H. G., Thermal Diffusion in Liquid Metals: Jour. Phys. Chem., vol. 59, No. 12, December 1955, pp. 1229–1230.

[9] Spedding, F. H., and Dye, J. L., The Vapor Pressure of Mercury at 250°–360°: Jour. Phys. Chem., vol. 59, No. 7, July 1955, pp. 581–583.

The low volumetric change on melting and the high rate of self-diffusion of mercury make it an ideal pattern material. These two fundamental physical properties permit the manufacture of large and complex castings. Other advantages of mercury patterns as well as descriptions and applications of the frozen-mercury process were noted.[10]

Production of chlorine and caustic soda in mercury cells continues to expand. In a recent article[11] the construction and operations of mercury cells were described. Also included was a comparison of the mercury and diaphragm cells, with a discussion on the production of chlorine without caustic soda.

Another publication[12] presented the effects of certain impurities in the mercury cell operations. Vanadium, molybdenum, chromium, and titanium were the most harmful; magnesium and aluminum may interfere; and calcium, barium, iron, nickel, copper, zinc, lead, arsenic, and manganese have no influence when they are in low concentrations and not mixed with other metals.

Cost-capacity data for electrolytic chlorine plants show that multiple-unit installations of cells and rectifiers influence overall plant costs.[13]

Planned expansions in chlorine production with mercury cells, together with leading chlorine producers, were announced.[14]

By means of electrolysis with a mercury cathode, microgram quantities of copper, lead, cadmium, zinc, iron, cobalt, and nickel can be separated from at least 0.5 normal vanadium solutions.[15] The electrodeposited metals can be separated into major groups of passive and nonpassive metals and separations within the nonpassive group are possible.

The general behavior of amalgams during anodic decomposition by discharge through a resistance at constant applied potential, under intermittent constant current, or under constant anode potential, showed that amalgams of cadmium and thallium can be completely decomposed.[16] Bismuth, cobalt and nickel cannot be anodically oxidized without decomposing mercury.

In the photosensitized decomposition of ammonia at room temperature using mercury—6($3P_1$)—under both flow and static conditions, nitrogen and hydrogen were produced.[17]

Visible light irradiations of suspended red mercuric sulfide in distilled water containing oxygen induces formation of hydrogen peroxide, with no apparent change in the mercuric sulfide.[18]

---

[10] Kramer, Irvin R., Frozen-Mercury Process Increases Scope of Investment Casting: Tool Eng., vol. 34, No. 5, May 1955, pp. 106–108.
Kramer, Irvin R., and von Ludwig, Davidler, Large Intricate Shapes Made by Investment Casting: Materials and Methods, vol. 41, No. 4, April 1955, pp. 106–109.

[11] Platzer, Norbert, European Designs of Electrolytic Cells for Chlorine and Caustic: Chem. Eng. Prog., vol. 51, No. 7, July 1955, pp. 305–312.

[12] Angel, G. H. and others, Influence of Impurities in the Electrolyte in Chlorine-Caustic Electrolysis by the Mercury Cell Process: Electro-Chem. Soc. Jour., vol. 102, No. 3, March 1955, pp. 124–130, vol. 102, No. 5, May 1955, pp. 246–251.

[13] Schofield, Bryce P., How Plant Costs Vary With Size: Chem. Eng., vol. 62, No. 10, October 1955, p. 185.

[14] Chemical and Engineering News, New Chlorine Program Likely: Vol. 33, No. 38, Sept. 19, 1955, p. 3974.

[15] Schmidt, William E., and Bricker, Clark E., Separations With a Mercury Electrode: Electro-Chem. Soc. Jour., vol. 102, No. 11, November 1955, pp. 623–630.

[16] Porter, John T., II, and Cooke, A. Donald, The Electrolytic Decomposition of Dilute Amalgams: Jour. Am. Chem. Soc. vol. 77, No. 6, Mar. 20, 1955, pp. 1481–1486.

[17] McDonald, C. C., and Gunning, H. E., Decomposition of Ammonia Photosensitized by Mercury 6 ($3P_1$) Atoms: Jour. Chem. Phys., vol. 23, No. 3, March 1955, pp. 532–541.

[18] Grossweiner, L. I., Photochemical Production of Hydrogen Peroxide Catalyzed by Mercuric Sulfide: Jour. Phys. Chem., vol. 59, No. 8, August 1955, pp. 742–746.

Berberet and Clark [19] reported the results of a study of phenomena related to the metastable 6^3 Po mercury atoms in a cell containing nitrogen in saturated mercury vapor at 22° C. and irradiated with resonance emissions from a cool mercury arc.

The angular distribution of the fluorescence radiation from the 411–KEV excited state in $mercury^{198}$ was measured [20] and found to agree with the theoretical expectation for the excitation of a state with spin 2 from a ground state with spin 0.

A large mercury-pool cathode in a stirred solution increased the sensitivity of polarographic methods and permitted determination of trace components.[21] Polograms of solution in the micromolar range were obtained because of the low-changing current of the electrode.

To overcome the effect of cell resistance on the polarographic current at a stationary electrode, an electromechanical method of instantaneous resistance compensation has been developed.[22] The system can also be used with dropping or rotating electrodes.

Half-wave potentials for dissolving tin depend on the electrolyte and the concentration of the amalgam in acid, neutral, and alkaline solutions with dropping amalgam electrodes.[23]

Complexes of mercury (II) and ethylenediamine are reversibly reduced in alkaline solution to free mercury at the dropping mercury electrode.[24]

To develop a high-temperature-reference electrode,[25] potential of the silver, silver chloride and mercury, mercurous chloride electrode combinations were measured in hydrochloric acid. Hydrolytic decomposition of calomel was indicated at low acid concentrations and high temperatures when acid concentration was varied from 0.01 to 1.0 N and temperature from 25° to 263° C.

The thickness of halide films was calculated from the results of a study on the formations and properties of insoluble films on liquid mercury surfaces with convection mercury electrodes in halide solutions.[26]

The development of a new mercury lamp that can be operated on existing incandescent street-lighting circuits with little additional control equipment has been announced.[27] The lamp requires about 430 watts and has a rated output of 20,000 lumens.

Although possibly twice as much electric energy is used to heat incandescent lamps in the United States, mercury now provides more artificial light than tungsten. Mercury lamps are 2 to 3 times as

---

[19] Berberet, J. A., and Clark, K. C., Resonance Irradiation of Mercury Vapor in Nitrogen: Phys. Rev., vol. 100, No. 2, Oct. 15, 1955, pp. 506-516.

[20] Metzger, Franz R., Angular Distribution of the Resonance Fluorescence Radiation from the 411-KEV Excited State of Hg^{198}: Phys. Rev., vol. 97, No. 5, Mar. 1, 1955, pp. 1258-1260.

[21] Rosie, Douglas J., and Cooke, W. Donald, Polarography With a Mercury-Pool Cathode in Stirred Solutions: Anal. Chem., vol. 27, No. 9, September 1955, pp. 1360-1363.

[22] Nicholson, M. M., Effect of Cell Circuit Resistance in Polarography With Stationary and Dropping Electrodes: Anal. Chem., vol. 27, No. 9, September 1955, pp. 1364-1365.

[23] Cooper, W. Charles, The Polarographic Behavior of Dropping Amalgam Electrodes: Jour. Am. Chem. Soc., vol. 77, No. 8, Apr. 20, 1955, pp. 2074-2076.

[24] Watters, James I., and Mason, John G., Investigation of the Complexes of Mercury (II) With Ethylenediamine, Using the Mercury Electrode: Jour. Am. Chem. Soc., vol. 78, No. 2, Jan. 20, 1956, pp. 285-289.

[25] Lietzke, M. H., and Vaugen, J. V., The Behavior of the Silver, Silver Chloride and the Mercury, Mercurous Chloride Electrodes at High Temperatures: Jour. Am. Chem. Soc., vol. 77, No. 4, Feb. 20, 1955, pp. 876-878.

[26] Kolthoff, I. M., and Jordan, Joseph, Halide Films at the Convection Mercury Electrode: Jour. Am. Chem. Soc., vol. 77, No. 12, June 20, 1955, pp. 3215-3216.

[27] Electrical World, New Mercury Street Lamp Works on 6.6-amp Series: Vol. 143, No. 23, June 6, 1955, p. 55.

efficient as tungsten lamps. Future applications of mercury lamps in home, industry, and special lighting seem assured.[28]

Comparison of mercury with filament lamps reveals that each has advantages and disadvantages. Mercury lamps are less flexible than filament or fluorescent systems but are highly economical for certain applications, such as high, hard-to-light areas where maintenance costs for other systems would be a deterrent.[29]

A low-pressure, water-cooled mercury arc lamp that produces intrinsic mercury lines and a weak background continuum at high operating currents has been developed.[30] It should be particularly useful for making polarization measurements of Raman lines.

Other new developments and applications were described in several articles that were published during the year.[31]

Microamounts of mercury in soil and biological materials are rapidly determined by a method requiring only standard laboratory equipment. Common metallic ions do not interfere, and high accuracy is possible.[32]

A rapid and volumetric method[33] for determining mercury consists of converting the mercury into neutral mercury (II) oxide, which is held in solution by complexing it with a small quantity of acetamide or a large quantity of urea. The mercury is estimated by acidmetric determination of the alkali liberated when potassium iodide or sodium thiosulfate is added to this mercury (II) oxide complex.

To control the quantity of mercury deposited on tin-copper bodies, a rapid, quantitative method of mercury assay was developed.[34] It consisted of tumbling weighed samples in mercury, heating under a vacuum, and weighing. The loss in weight represented mercury in tin amalgam.

Of all procedures for the separation and determination of silver, mercury, and copper, the dithizone method appears most rapid.[35] Use is made of the complexing of copper by ethylenediaminetetraacetic acid, the effect of chloride on the extraction of silver, and the decomposition of the dithizonates of mercury and copper by 6N hydrochloric acid. A complete analysis can be made in 2 hours.

By determining the absorbance of the mercury–202 hyperfine component of the 2537–A resonance line of mercury by mercury vapor,

---

[28] Buttolph, L. J., Mercury Lamps—Light Made to Order: Gen. Elec. Rev., vol. 58, No. 2 ,March 1955 pp. 27–31.

[29] Tugman, J. L., Does it Really Pay to Swing Over to Modern Mercury Lighting?: Power, vol. 99, No. 3, March 1955, pp. 86–87.

[30] Shull, E. R., High-Current Mercury Arc Raman Source: Jour. Opt. Soc. America, vol. 45, No. 8, August 1955, pp. 670–671.

[31] Electrical Engineering, 1,000-Watt Short-Arc Mercury-Xenon Lamp for the U. S. Navy: Vol. 74, No. 9, September 1955, p. 813.

Thulin, A., A Simple 500 M c/s Oscillator for Use With Electrodeless Mercury-198 Lamps: Jour. Sci. Instr., vol. 32, No. 7, July 1955, pp. 257–258.

Kech, N. E., and Oglesher, W. A., Operation of Mercury Vapor on Series Street-Lighting Circuits: Illum. Eng., vol. 50, No. 3, March 1955, pp. 115–121; discussion, pp. 121–122.

Rost, H. O., Mercury Vapor Lamp As a Circuit Component: Illum. Eng., vol. 50, No. 6, June 1955, pp. 302–306.

Seegal, S. M., Study of High-Intensity Light Sources: Illum. Eng., vol. 50, No. 5, May 1955, pp. 259–262.

Noel, E. B., and Martt, E. C., Effect of Operating Variables on Mercury Lamp Performance (abs.): Illum. Eng., vol. 50, No. 9, September 1955, pp. 452–455.

[32] Polley, Dorothy, and Miller, V. L., Rapid Microprocedure for Determination of Mercury in Biological and Mineral Materials: Anal. Chem., vol. 27, No. 7, July 1955, pp. 1162–1164.

[33] Palit, Santi R., and Somayajulu, G. R., Volumetric Determination of Mercury and the Use of Mercury Salts or Primary Acidmetric Standards: Anal. Chem., vol. 27, No. 8, August 1955, pp. 1331–1333.

[34] Kerr, George T., Macut, Sylvester S., and Neely, Carl C., Estimation of Metallic Mercury on the Surface of Tinned Copper: Anal. Chem., vol. 27, No. 2, February 1955, pp. 294–295.

[35] Friedelberg, Harold, Separation and Determination of Microgram Quantities of Silver, Mercury, and Copper With Dithizone: Anal. Chem., vol. 27, No. 2, February 1955, pp. 305–306.

the quantity of the isotope present in the vapor can be determined.[36] Results agree within 2 percent with values obtained by mass spectrometric methods. Freedom from contamination of previous samples and use of smaller samples are advantages over the mass spectrometer.

Simple technique[37] was described for the complete conversion of milligram quantities of elemental mercury to dimethylmercury and for mass spectrometric analysis of isotope abundance ratios.

WORLD REVIEW

World production of mercury in 1955 was at the highest annual rate since 1943 and totaled 196,000 flasks. It exceeded the 1954 output by 14,000 flasks and represented the seventh consecutive year of increased production.

Of the principal mercury-producing countries, Spain, United States, and Yugoslavia made slight increases. Mexican output of 29,878 flasks was more than double that of 1954 and was largely responsible for the increased world production. Italian production decreased slightly to 53,520 flasks.

In other mercury-producing countries, output was reported for the first time in the Philippines; production in Chile and Turkey increased, whereas that in Japan dropped.

TABLE 18.—World production of mercury, by countries [1], 1946–50 (average) and 1951–55, in flasks of 34.5 kilograms (76 pounds)[2]

[Compiled by Augusta W. Jann]

Country [1]	1946-50 (average)	1951	1952	1953	1954	1955
North America:						
Honduras	----------	11	----------	----------	----------	----------
Mexico	7,031	8,064	8,732	11,643	14,755	29,878
United States	15,489	7,293	12,547	14,337	18,543	18,955
South America:						
Bolivia (exports)	(3)	19	----------	----------	----------	----------
Chile	561	114	173	100	243	526
Peru	1	----------	----------	----------	77	(4)
Europe:						
Austria	9	26	15	22	27	16
Czechoslovakia	789	[5] 725	[5] 725	[5] 725	(4)	(4)
Italy	48,165	53,839	55,869	51,373	54,477	53,520
Spain	40,838	44,480	39,135	43,541	43,135	[5] 45,000
U. S. S. R. (estimate) [6]	11,020	11,600	11,600	12,300	(4)	(4)
Yugoslavia	11,286	14,649	14,620	14,272	14,446	14,591
Asia:						
China	702	[5] 4,000	[5] 4,000	[5] 5,000	(4)	(4)
Japan	1,691	1,847	3,083	6,406	10,269	4,968
Philippines	----------	----------	----------	----------	----------	635
Taiwan	----------	----------	----------	----------	44	(4)
Turkey	25	----------	----------	----------	261	841
Africa:						
Algeria	236	----------	----------	----------	----------	----------
Union of South Africa	153	----------	----------	----------	----------	----------
World total (estimate)	138,000	147,000	151,000	160,000	182,000	196,000

[1] Rumania and other countries may also produce a negligible amount of mercury, but production data are not available.
[2] This table incorporates a number of revisions of data published in previous Mercury chapters. Data do not add to totals shown owing to rounding where estimates are included in the total.
[3] Less than 0.5 flask.
[4] Data not available; estimate by author of chapter included in total.
[5] Estimate.
[6] According to the 42d annual issue of Metal Statistics (Metallgesellschaft), except 1954 and 1955.

[36] Osborn, K. R., and Gunning, H. E., Determination of Hg^{202} and Other Mercury Isotopes in Samples of Mercury Vapor by Mercury Resonance Radiation Absorbiometry: Jour. Opt. Soc. America, vol. 45, No. 7, August 1955, pp. 552–555.
[37] Dibeler, Vernon H., Isotope Analysis Using Dimethylmercury: Anal. Chem., vol. 27, No. 12, December 1955, pp. 1958–1959.

TABLE 19.—Production of mercury in Italy, Mexico, United States and Yugoslavia in 1955, by months, in flasks of 76 pounds [1]

Month	Italy	Mexico	United States	Yugoslavia
January	4,264	2,437	1,380	1,102
February	4,902	7,136	1,250	1,073
March	4,438	3,336	1,420	1,364
April	4,554	2,031	1,400	1,160
May	4,119	1,653	1,490	1,422
June	3,336	2,901	1,970	1,276
July	3,481	2,060	1,790	986
August	4,903	2,292	1,650	1,189
September	5,019	1,305	1,280	870
October	4,728	1,740	1,740	1,189
November	4,932	1,769	1,730	1,393
December	4,844	1,218	1,730	1,567
Total	53,520	29,878	[2] 18,955	14,591

[1] Sources: Bolletin mensile di statistica, Italy; Boletin de minas y petroleo, Mexico; and Indeks, Yugoslavia.
[2] Monthly data not adjusted to final figures.

Italy.—The world's largest producer continued to be Italy, even though the mercury output declined to 53,520 flasks in 1955 from 54,477 flasks in 1954. Most of the production came from the Monte Amiata deposits in Siena and Grosseto Provinces about 75 miles north of Rome. An excise tax of $51.20 a flask on metallic mercury and 58 cents a pound on metal in ore and concentrate was in effect during the year. It was reported that production facilities in Italy had been expanded by the installation of two Gould rotary-type plants.

TABLE 20.—Exports of mercury from Italy, 1951–55, by countries of destination, in flasks of 76 pounds [1] [2]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
Australia	-	-	-	-	165
Austria	-	-	41	470	368
Belgium-Luxembourg	-	-	400	-	299
Brazil	261	-	-	-	310
Canada	-	-	-	400	473
Czechoslovakia	-	174	1,392	177	1,433
Finland	-	-	596	511	232
France	2,234	319	3,336	5,628	3,014
Germany:					
East	-	-	-	-	348
West	435	145	3,887	15,232	12,473
Hungary	-	-	583	-	270
India and Pakistan	2,408	-	-	-	-
Indonesia	-	-	-	-	339
Netherlands	203	348	493	818	595
Norway	-	-	464	145	-
Poland	2,176	580	2,814	749	1,738
Rumania	299	339	-	-	325
Sweden	-	-	9	302	177
Switzerland	296	-	99	249	67
United Kingdom	2,901	3,713	8,499	16,207	3,951
United States	16,070	27,761	32,025	20,227	-
Other countries	217	386	506	803	1,346
Total	27,500	33,765	55,144	61,918	27,923

[1] Compiled from Customs Returns of Italy.
[2] This table incorporates a number of revisions of data published in the previous Mercury chapter.

Mexico.—Output of Mexican metal in 1955 totaled 29,878 flasks, which was more than double the 14,755 flasks produced in 1954. This substantial increase in production enabled Mexico to replace the United States as the world's third largest mercury producer.

Expansion of existing and installation of new operations contributed to the large metal production. A new 100-ton flotation plant was put in operation at the Mina la Marina property at Huitzuco, Guerrero. This plant not only increased capacity but also permitted the processing of lower grade materials. The Cia Minera Julieta, S. A., started mercury production at its El Tanque mine, treating 1.5-percent mercury ore in a 10-retort plant.

In an effort to control exports of mercury the Mexican Government ordered that an import license must be obtained from the country of destination before a Mexican export permit would be issued. As shown in table 21, the United States continues to receive most of the Mexican metal.

TABLE 21.—Exports of mercury from Mexico, 1951–55, by countries of destination, in flasks of 76 pounds [1]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
Canada		22	100	193	2,060
United States	6,500	8,653	15,629	11,469	14,251
Germany			110	294	460
Netherlands	236	151	50	517	339
United Kingdom				4,790	5,284
Japan	335		236	605	1,575
Other countries	634	676	234	596	267
Total	7,705	9,502	16,359	18,464	24,236

[1] Compiled from Customs Returns of Mexico.

Philippines.—The first mercury-producing mine in the Philippines began operations in August 1955. Exploration and development of mercury deposits near Tagburos Barrio, about 8 miles north of Puerto Princesa, Palawan Island, and the construction of a Gould rotary-type plant were completed by the Palawan Quicksilver Mines, Inc. Ore reserves were stated to be 135,000 tons averaging about 8 pounds of mercury per ton. Both surface and underground mining methods will be used, although surface operations would supply enough ore for the plant. Daily capacity of the plant is 100 tons of ore, and annual production is estimated at 2,500 to 3,000 flasks. After a breaking-in period the operations produced 530 flasks during the last quarter of 1955. Another mercury deposit about 3 miles from Tagburos is being investigated, with favorable results.

Spain.—The expected increase in Spanish production of mercury failed to materialize, and the 1955 output (45,000 flasks) was virtually the same as the 43,135 flasks in 1954. As almost the entire production came from the famous Almaden mine, where facilities were expanded in 1953, it is indicated that the grade of ore treated has decreased since 1953.

Installation of a new mercury plant in Castaras, Province of Granada, was authorized by the Government and is scheduled for operation near the end of 1956.

TABLE 22.—Exports of mercury from Spain, 1951–55, by countries of destination, in flasks of 76 pounds [1] [2]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
Australia	827	50	105	1,392	195
Austria	-----	58	-----	-----	64
Belgium-Luxembourg	116	6	38	-----	123
Brazil	148	20	367	777	1,437
Canada	-----	-----	-----	-----	1,501
Finland	104	-----	-----	1,001	297
France	6,411	3,765	3,415	4,226	7,629
Germany	4,554	1,804	2,606	1,460	4,214
Japan	1,076	377	1,761	901	927
Netherlands	986	1,308	441	1,016	896
Norway	551	200	290	145	150
Portugal	162	801	96	345	159
Sweden	2,176	203	320	640	1,236
Switzerland	5,416	3,878	2,451	751	1,159
United Kingdom	15,516	4,566	6,701	6,315	4,203
United States	9,857	27,160	24,972	24,217	7,835
Other countries	643	57	105	348	220
Total	48,543	44,253	43,668	43,534	32,245

[1] Compiled from Customs Returns of Spain.
[2] This table incorporates a number of revisions of data published in the previous Mercury chapter.

United Kingdom.—Consumption of mercury in the United Kingdom—the second largest user in the world—may be gaged by imports minus reexports although this calculation makes no allowance for industry and Government stocks which are not available.

	1951	1952	1953	1954	1955
Imports	18,800	9,200	21,300	29,500	12,900
Reexports	6,100	3,600	2,500	6,600	3,300
Apparent consumption	12,700	5,600	18,800	22,900	9,600

Reexports of mercury in 1954 and 1955, in flasks of 76 pounds, were as follows:

Destination:	*1954*	*1955*
Canada	55	775
Venezuela	101	65
Austria	230	-----
Belgium	465	89
Denmark	215	150
Finland	622	193
Germany (West)	224	-----
Hungary	415	-----
Netherlands	115	22
Norway	842	12
Poland	1,973	350
Sweden	118	516
Indonesia	15	354
Federation of Rhodesia and Nyasaland	104	133
Union of South Africa	285	86
Australia	364	214
Other	430	300
Total	6,573	3,259

Yugoslavia.—The 1955 production of 14,591 flasks of mercury was virtually unchanged from the annual Yugoslav output for the last 5 years. Most of the mercury is obtained from the Idria mine in the Province of Slovenia (formerly Gorizia).

Exports of mercury for 1951–55 are shown in table 23.

TABLE 23.—Exports of mercury from Yugoslavia, 1951–55, by countries of destination, in flasks of 76 pounds [1]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
Austria	4	356	360	366	577
Belgium-Luxembourg	5	791	347	330	90
Brazil				95	
Canada					200
Denmark		1	10		
Finland			35		
France	16	731	300	585	510
Germany, West	13	971	2,289	3,874	1,662
Greece		10			
Netherlands	11	450	300		236
Sweden	1	485	336	260	40
Switzerland	8	565	195	977	4,967
United Kingdom	12	697	2,666	1,001	175
United States	60	8,906	5,972	4,353	4,753
Other countries			6		
Total	130	13,963	12,816	11,841	13,210

[1] Compiled from Customs Returns of Yugoslavia.

Mica

By Milford L. Skow[1] and Gertrude E. Tucker[2]

NEW PEAKS were reached for the quantity and value of total crude domestic mica sold or used in the United States in 1955. The tonnage increased about 18 percent and the value 32 percent over the corresponding figures for 1954. Although sales of sheet mica in 1955 were only 96 percent of those in 1954, their value was 41 percent greater because of increased sales to the Government. Sales of scrap and flake mica were the highest on record. Compared with 1954, the consumption of sheet mica increased 31 percent, and consumption of scrap mica (as indicated by the quantity of ground mica sold) increased 33 percent. Total imports were up 85 percent, but total exports were virtually unchanged.

TABLE 1.—Salient statistics of the mica industry in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Domestic mica sold or used by producers:						
Total sheet mica: [1]						
Pounds	571,462	594,884	697,989	849,394	[2] 668,788	642,113
Value	$127,606	$160,322	$908,135	$2,153,584	$2,393,041	$3,370,397
Average per pound	$0.22	$0.27	$1.30	$2.54	[2] $3.58	$5.25
Scrap and flake mica:						
Short tons	51,554	71,871	75,236	73,259	81,073	95,432
Value	$1,153,419	$1,884,087	$1,954,286	$1,823,840	$1,733,772	$2,058,035
Average per ton	$22.37	$26.21	$25.97	$24.90	$21.39	$21.57
Total sheet, scrap, and flake mica:						
Short tons	51,840	72,168	75,585	73,684	[2] 81,407	95,754
Value	$1,281,025	$2,044,409	$2,862,421	$3,977,424	$4,126,813	$5,428,432
Ground mica:						
Short tons	63,988	70,122	74,806	73,072	80,072	106,185
Value	$3,102,603	$3,842,628	$4,278,103	$4,192,420	$4,889,122	$6,557,639
Consumption of splittings:						
Pounds	8,788,267	13,379,295	10,220,671	10,346,159	6,732,719	8,997,674
Value	$6,593,720	$11,760,617	$9,729,099	$7,902,232	$4,132,418	$4,388,416
Imports for consumption short tons	14,961	18,917	13,048	10,989	8,924	16,490
Exports do	1,419	1,894	2,472	2,402	3,328	3,314

[1] Includes small quantities of splittings in certain years.
[2] Revised figure.

GOVERNMENT MICA PROGRAMS

DEFENSE MINERALS EXPLORATION ADMINISTRATION

From the beginning of the exploration program in 1951 through December 31, 1955, 215 exploration contracts for strategic mica were executed. Of these, 182 were canceled or terminated, and 33 were still in force on December 31, 1955. The total value of the 176

[1] Commodity specialist.
[2] Statistical assistant.

457676—58——51

terminated contracts was $1,007,117, of which the Government advanced $651,921. Certificates of discovery or development were issued on 49 of these contracts having a total value of $356,728.

TABLE 2.—Defense Minerals Exploration Administration mica contracts in force during 1955 by States, counties, and mines

State and operator	Property	County	Contract[1]	
			Total value	Status, Dec. 31, 1955
ALABAMA				
Dixie Mines, Inc	Liberty	Randolph	$3,616	In force.
GEORGIA				
Beam, J. R	Bennett	Cherokee	8,316	Do.
Teague, Alex	Old Denson	Pickens	2,994	Terminated.
Tralyta Mining Co	Lake Tralyta	Union	5,716	Do.
Phillips, C. R	J. H. Reynolds	Upson	[2] 6,650	Do.
Schwab, E. H	Duke	do	5,524	In force.
MONTANA				
Barham, Daniel T	Thumper Lode and Thumper Lode No. 2.	Gallatin	14,000	Do.
NEW HAMPSHIRE				
Robinson, Henry Lee	Chandler Mills	Sullivan	1,500	Terminated.
NORTH CAROLINA				
Branch Mining Co	Branch	Avery	3,240	In force.
C & D Mining Co	C & D	do	4,624	Do.
Pancake Miners	Pancake	do	4,940	Terminated.
Phillips, John, et al	Little Hawk	do	5,340	Do.
Smith, Howard	Howard Smith	do	8,064	In force.
Smith, Sam G	Doe Hill	do	3,376	Do.
Smith, Sam, Jr., et al	Benfield	do	4,413	Do.
Vance, Joe C	Crab Orchard	do	3,264	Terminated.
Do	Joe	do	3,613	In force.
Vance, T. B	Shuffle Vance	do	5,310	Do.
Watson, Elbert	Ben Aldridge	do	3,112	Terminated.
Boone, R. L	Cliff Blanton	Cleveland	[2] 5,650	In force.
Burns-Spangler Construction Co	Lee Cornwell	do	[2] 6,700	Terminated.
Crotts, W. C	W. C. Crotts	do	3,664	Do.
Keller Mining Co	Royster	do	5,364	Do.
Rudasill, R. L	Rudasill	do	3,500	Do.
Wise, Dave, et al	Toney	do	3,100	Do.
Beam Mining Co	Beam	Gaston	600	Do.
Crowder, Ernest	Lingerfeldt	do	4,356	Do.
Buchanan Minerals, Inc	Dream	Jackson	7,200	In force.
Hensley, Charlie E	Betty's Creek No. 3	do	[2] 5,350	Terminated.
Hooper, Roscoe, et al	Old Sheep Mountain	do	[2] 9,900	Do.
White, Alvin, et al	Coward	do	4,940	In force.
Crowder, Ernest	Hoyle Cline	Lincoln	4,946	Terminated.
Bauer Mining Co	Baird Cove	Macon	[2] 9,100	Do.
Carolina Mining Co	Zeb Angel	do	5,276	In force.
Fouts, Roy H	Sol Jacobs (Winecoff)	do	5,348	Terminated.
Phillips, Sam, et al	Mudcut	do	10,838	Do.
Ward, A	Elmore	do	5,064	Do.
Do	Harris	do	6,500	In force.
Boone, Howard, et al	Marsh Putnam	Mitchell	5,292	Terminated.
Boone, Jeter, et al	Doc Thomas	do	5,748	Do.
Buchanan, Zeb, et al	R. B. Phillips	do	4,016	Do.
Burleson & Keller	McKinney Cove	do	4,688	Do.
Cooper, Tom, et al	Old Burleson	do	4,916	Do.
De Groat, et al	Azaline	do	3,264	Do.
Ellis & Carpenter	Rube Sparks	do	3,688	Do.
Erby Mining Co	J. K. Buchanan	do	6,525	Do.
Flynt, W. S	Jasper Smith	do	4,604	Do.
Freeman, Paul	Hesby Edwards	do	4,464	In force.
Greene, Bill H., et al	Bill Greene	do	3,616	Terminated.
Greene, W. A	Branch	do	4,116	In force.
Grindstaff, Roy, et al	John Conley	do	4,488	Do.
Grindstaff, Walter, et al	Walter Grindstaff	do	5,264	Terminated.

See footnotes at end of table.

TABLE 2.—Defense Minerals Exploration Administration mica contracts in force during 1955 by States, countries, and mines—Continued

State and operator	Property	County	Contract[1]	
			Total value	Status, Dec. 31, 1955
NORTH CAROLINA—continued				
Huskins, Ed, et al	Randolph	Mitchell	$5,616	In force.
Huskins, P., et al	J. W. Boone	do	4,016	Do.
Jarrett, John	Jarrett	do	4,538	Terminated.
Do	Ralph Jarrett	do	5,316	Do.
Jarrett, John, et al	Fred Robinson	do	4,220	In force.
McKinney & Young	Woody Hill	do	4,688	Terminated.
Mine Creek Mica Mines	Geo. Howell No. 2	do	7,624	Do.
Pittman, Audy	Wiseman No. 2	do	6,316	Do.
Phillips, C. R	Willis	do	4,304	In force.
Phillips, C. R., et al	Arnold Young	do	3,364	Terminated.
Do	Sparks	do	4,316	Do.
Do	Sugar Dave	do	5,816	Do.
Phillips, Horace	Horace Phillips	do	6,616	Do.
Phillips, John	Queen	do	5,744	In force.
Richmond, Thomas, et al	Black Bull	do	4,464	Do.
Sparks, E. K	E. K. Sparks	do	7,716	Terminated.
Biggerstaff, John L	Dyeus	Rutherford	9,288	In force.
Martin, W. A	Martin	do	4,880	Terminated.
Mines & Mining, Inc	Farlow Gap	Transylvania	5,136	In force.
Beam, J. R., et al	Little Ray	Yancey	3,950	Do.
Do	Willie Shanty	do	5,824	Do.
Boone, Ed	Goog Rock	do	10,940	Do.
Brown, C. L., et al	Fox	do	5,788	Do.
Buchanan & Snyder	Jim Riddle	do	4,764	Do.
Chrisawn, W. B	R. S. Westall	do	[2] 3,363	Terminated.
Cook Mining Co	Charles Robinson	do	[2] 12,470	Do.
Garland, A. T., et al	Lowhern	do	7,556	Do.
Grindstaff, Walter, et al	Hughes & Gouge	do	4,464	Do.
Nonmetallic Minerals Corp	Irby Cut	do	5,428	Do.
Phillips, John	Laws	do	5,096	In force.
Do	S. D. McKinney	do	5,840	Terminated.
Rock Mining Co	Rock	do	3,938	Do.
South Toe Mining Co	Carson Rock	do	4,900	Do.
Twiggs, H. J	Sam Huskins	do	[2] 5,200	Do.
Young & Burleson	Ruby (Shaft)	do	4,350	Do.
VIRGINIA				
Baltzley, W. D., & Mavos	Baltzley, No. 3	Powhatan	6,250	Do.

[1] Government participation, 75 percent, except where otherwise noted.
[2] Government participation, 90 percent.

EMERGENCY PROCUREMENT SERVICE

Purchases at the General Services Administration 3 mica-purchasing depots during 1955 yielded 234,182 pounds of full-trimmed muscovite block mica (over 0.007 inch thick), comprising 157,363 pounds of ruby and 76,819 pounds of nonruby. Good Stained or better qualities constituted about 40 percent of the ruby and 56 percent of the nonruby; Stained quality made up about 42 percent of the ruby and 33 percent of the nonruby. About 76 percent of the ruby block mica and 88 percent of the nonruby were obtained at the Spruce Pine, N. C., depot. A small yield of ruby film mica also was reported by this depot.

The total quantity of Stained or better qualities of full-trimmed muscovite block obtained by the Government from domestic purchases in 1955 was equivalent to 9 percent of the total 1955 fabrication of block and film of these qualities, irrespective of grades.

TABLE 3.—Yield of full-trimmed muscovite ruby and nonruby block mica from domestic purchases by GSA, 1955, by quality, grade, and depot, in pounds

Depot and grade	Ruby				Nonruby			
	Good Stained or better	Stained	Heavy Stained	Total	Good Stained or better	Stained	Heavy Stained	Total
Spruce Pine, N. C.:								
2 and larger	385.47	143.82	232.94	762.23	242.59	52.80	10.59	305.98
3	636.48	242.57	264.04	1,143.09	597.69	134.89	22.01	754.59
4	1,465.43	654.80	489.12	2,609.35	1,436.31	395.17	70.41	1,901.89
5	7,780.25	3,723.10	1,891.59	13,394.94	6,471.12	1,911.06	422.50	8,804.68
5½	7,614.82	4,657.58	2,149.24	14,421.64	5,646.33	2,393.36	710.86	8,750.55
6	39,230.63	33,949.66	13,619.75	86,800.04	26,469.74	15,900.86	4,472.29	46,842.89
Total	57,113.08	43,371.53	18,646.68	119,131.29	40,863.78	20,788.14	5,708.66	67,360.58
Franklin, N. H.:								
2 and larger	5.56	254.27	280.62	540.45				
3	23.48	306.67	211.18	541.33				
4	73.90	406.95	172.60	653.45			.02	.02
5	674.62	2,244.53	823.64	3,742.79	.03	.12	.11	.26
5½	599.45	2,161.55	941.23	3,702.23	.06	.27	.23	.56
6	3,455.82	11,889.87	4,725.94	20,071.63	.91	2.72	.78	4.41
Total	4,832.83	17,263.84	7,155.21	29,251.88	1.00	3.11	1.14	5.25
Custer, S. Dak.:								
2 and larger	.06	12.63	15.40	28.09	16.31	24.84	14.25	55.40
3	1.00	36.81	50.13	87.94	42.44	57.25	35.28	134.97
4	3.88	142.28	175.56	321.72	152.81	216.41	114.94	484.16
5	40.78	689.41	743.94	1,474.13	555.63	958.66	456.76	1,971.05
5½	52.84	710.53	627.91	1,391.28	414.02	799.08	385.47	1,598.57
6	346.78	3,168.34	2,161.94	5,677.06	1,225.84	2,606.12	1,376.66	5,208.62
Total	445.34	4,760.00	3,774.88	8,980.22	2,407.05	4,662.36	2,383.36	9,452.77
Grand total	62,391.25	65,395.37	29,576.77	157,363.39	43,271.83	25,453.61	8,093.16	76,818.60

TABLE 4.—Yield of byproducts from domestic purchases of ruby and nonruby mica by GSA, 1955, by depots, in pounds

Depot	Ruby			Nonruby		
	Miscellaneous full-trimmed [1]	Punch	Scrap	Miscellaneous full-trimmed [1]	Punch	Scrap
Spruce Pine, N. C	8,551	74,810	952,670	7,518	44,522	654,496
Franklin, N. H	19,785	69,786	367,208	(2)		(2)
Custer, S. Dak	3,118	5,701	85,928	23,963	2,448	184,694
Total	31,454	150,297	1,405,806	31,481	46,970	839,190

[1] Includes thins and block of lower than Heavy-Stained qualities.
[2] Less than 0.5 pound.

TABLE 5.—Yield of full-trimmed muscovite ruby film mica from domestic purchases by GSA at Spruce Pine, N. C., depot, 1955, by grades, in pounds

Grade	Ruby	Grade	Ruby
2 and larger	3.66	5½	334.74
3	16.48	6	1,736.23
4	58.10		
5	261.97	Total	[1] 2,422.81

[1] Includes 11.63 pounds not specified by grade.

TABLE 6.—Yield of full-trimmed muscovite ruby and nonruby mica and by-products from domestic purchases by GSA, 1952–55, by depots, in pounds

Category and depot	1952 [1]	1953	1954	1955	Total
Full-trimmed:					
Spruce Pine, N. C	36,831	113,270	139,872	188,915	478,888
Franklin, N. H	4,289	25,303	35,046	29,257	93,895
Custer, S. Dak	14,395	26,125	23,894	18,433	82,847
Total	55,515	164,698	198,812	236,605	655,630
Other:					
Spruce Pine, N. C	196			16,069	16,265
Franklin, N. H	1,765	1,821	12,566	19,785	35,937
Custer, S. Dak		7,995	1,623	27,081	36,699
Total	1,961	9,816	14,189	62,935	88,901
Punch:					
Spruce Pine, N. C	296	16	8,940	119,333	128,585
Franklin, N. H	933	23,052	93,229	69,786	187,000
Custer, S. Dak	30,354	193,505	44,388	8,149	276,396
Total	31,583	216,573	146,557	197,268	591,981
Scrap:					
Spruce Pine, N. C	43	47	15,255	1,607,165	1,622,510
Franklin, N. H	1,581	21,708	193,363	367,208	583,860
Custer, S. Dak	50,906	157,505	363,174	270,622	842,207
Total	52,530	179,260	571,792	2,244,995	3,048,577

[1] Figures for July–December.

A revision of the domestic mica-purchase regulation in February 1955 made payments for hand-cobbed mica proportional to the actual yields of Good Stained or better and Stained qualities of full-trimmed block or film mica. Thus producers could receive more than the former maximum prices of $600 and $540, respectively, per short ton of ruby and nonruby hand-cobbed mica and found the sale of hand-cobbed, rather than full-trimmed, mica more attractive. As a result of the increased cost of the program, GSA modified the regulation in August so that producers paid part of the processing costs.

In June 1955 the period for notifying the Government of intention to participate in the domestic mica purchase program was extended 1 year to June 30, 1956.

DOMESTIC PRODUCTION

Sheet Mica.—Although the quantity of sheet mica sold or used by producers in 1955 was 4 percent less than in 1954, its value was 41 percent greater because of increased sales of sheet mica to the Government. North Carolina, with 86 percent of the total domestic output of sheet mica, continued to produce the most and was followed in order by New Hampshire, Maine, Georgia, New Mexico, South Dakota, Idaho, Connecticut, South Carolina, Virginia, and Alabama.

Scrap and Flake Mica.—The tonnage and value of scrap and flake mica sold or used by grinders were the highest on record. Increases over the quantity and value reported in 1954 were 18 and 19 percent, respectively.

Ground Mica.—Increases of 33 percent in tonnage and 34 percent in value, compared with 1954, advanced the total sales of ground mica in 1955 to a record. Dry grinding produced 86 percent of the total quantity. Slightly less than half the total quantity of wet-ground mica sold went to paint manufacturers and about 31 percent to rubber companies. In 1955, 21 dry-grinding and 7 wet-grinding plants produced ground mica.

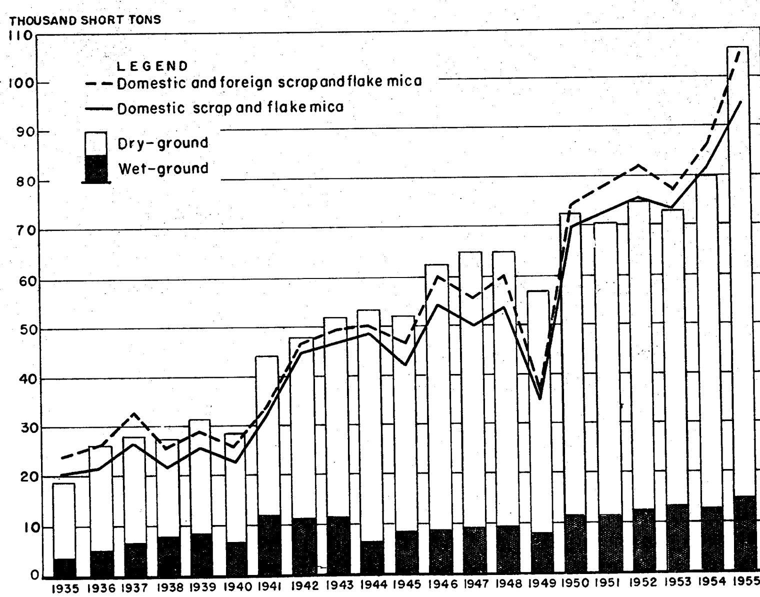

FIGURE 1.—Scrap, flake, and ground mica sold in the United States, 1935–55

TABLE 7.—Mica sold or used by producers in the United States, 1946–50 (average) and 1951–55

Year	Sheet mica						Scrap and flake mica [2]		Total	
	Uncut punch and circle mica		Uncut mica larger than punch and circle		Total sheet mica [1]					
	Pounds	Value	Pounds	Value	Pounds	Value	Short tons	Value	Short tons	Value
1946–50 (average)	508,957	$71,263	62,505	$56,343	571,462	$127,606	51,554	$1,153,419	51,840	$1,281,025
1951	544,046	108,429	50,838	51,893	594,884	160,322	71,871	1,884,087	72,168	2,044,409
1952	625,300	117,868	[3] 72,689	[3] 790,267	697,989	908,135	75,236	1,954,286	75,585	2,862,421
1953	667,241	98,010	[3] 182,153	[3] 2,055,574	849,394	2,153,584	73,259	1,823,840	73,684	3,977,424
1954:										
Arizona							1,682	17,773	1,682	17,773
Connecticut	(4)	(4)	(4)	(4)	81,951	56,097	(4)	(4)	(4)	(4)
Maine	(4)	(4)	(4)	(4)	10,320	36,894	(4)	(4)	(4)	(4)
New Hampshire	(4)	(4)	(4)	(4)	42,466	234,450	325	11,583	346	246,033
North Carolina	339,980	39,070	139,241	1,748,127	479,221	1,787,197	61,049	1,457,122	61,289	3,244,319
South Dakota			[5] 16,299	65,222	[5] 16,299	65,222	1,510	26,943	[5] 1,518	92,165
Undistributed [6]	110,125	12,877	63,143	527,745	38,531	213,181	16,507	220,351	16,572	526,523
Total	450,105	51,947	[3] [5] 218,683	[3] 2,341,094	[5] 668,788	2,393,041	81,073	1,733,772	[5] 81,407	4,126,813
1955:										
Arizona							1,353	8,742	1,353	8,742
Colorado							699	12,596	699	12,596
Connecticut			2,083	12,904	2,083	12,904	2	84	3	12,988
Maine	(4)	(4)	(4)	(4)	21,121	128,721	71	1,922	82	130,643
New Hampshire	(4)	(4)	25,773	202,567	(4)	(4)	(4)	(4)	33	203,693
New Mexico			9,431	64,930	9,431	64,930	84	2,475	89	67,405
North Carolina	366,505	39,365	186,939	2,705,869	553,444	2,745,234	60,887	1,377,035	61,164	4,122,269
South Dakota			4,854	21,383	4,854	21,383	1,322	26,853	1,324	48,236
Undistributed [6]	16,896	1,925	29,632	321,454	51,180	397,225	31,014	628,328	31,007	821,860
Total	383,401	41,290	[3] 258,712	[3] 3,329,107	642,113	3,370,397	95,432	2,058,035	95,754	5,428,432

[1] Includes small quantities of splittings in certain years.
[2] Includes finely divided mica recovered from mica and sericite schist and as a by-product of feldspar and kaolin beneficiation.
[3] Includes the full-trimmed mica equivalent of hand-cobbed mica.
[4] Included under "Undistributed" to avoid disclosure of individual company operations.
[5] Revised figure.
[6] Figures include Alabama, California, Colorado (1954), Georgia, Idaho, Maryland (1954), Montana (1954), New Mexico (1954), Pennsylvania, South Carolina, Virginia, and States indicated by footnote 4.

TABLE 8.—Ground mica sold by producers in the United States, 1946–50 (average) and 1951–55, by methods of grinding

Year	Dry-ground		Wet-ground		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	55,081	$1,939,170	8,907	$1,163,433	63,988	$3,102,603
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
1953	60,127	2,438,628	12,945	1,753,792	73,072	4,192,420
1954	67,618	3,134,277	12,454	1,754,845	80,072	4,889,122
1955	91,695	4,541,482	14,490	2,016,157	106,185	6,557,639

TABLE 9.—Mica grinders in 1955, by States, counties, and methods of grinding

State	County	Nearest town	Company	Method o grinding	
				Wet	Dry
Alabama	Chilton	Clanton	Ellis Inlow		X
Arizona	Maricopa	Buckeye	Buckeye Mica Co		X
California	Los Angeles	Los Nietos	Sunshine Mica Co		X
Colorado	Jefferson	Arvada	Beryl Ores Co		X
Do	Pueblo	Pueblo	International Minerals & Chemical Corp.		X
Georgia	Bartow	Cartersville	Thompson, Weinman & Co		X
Do	Hart	Hartwell	The Funkhouser Co		X
Illinois	Cook	Forest Park	U. S. Mica Co., Inc		X
Massachusetts	Middlesex	Wilmington	Hayden Mica Co	X	
New Hampshire	Merrimack	Penacook	Concord Mica Corp	X	
New Jersey	Bergen	Wallington	U. S. Mica Co., Inc		X
New Mexico	Santa Fe	Santa Fe	Robert E. Osthoff		X
North Carolina	Avery	Spruce Pine	Harris Clay Co		X
Do	do	Plumtree	David T. Vance	X	
Do	Buncombe	Biltmore	Asheville Mica Co		X
Do	Cleveland	Kings Mountain	Kings Mountain Mica Co		X
Do	Macon	Franklin	Franklin Mineral Products Co	X	
Do	Mitchell	Spruce Pine	De-Weld Mica Corp		X
Do	do	do	Diamond Mica Co	X	
Do	do	do	English Mica Co	X	
Do	do	Kona	International Minerals & Chemical Corp.		X
Do	Yancey	Newdale	Deneen Mica Co		X
Pennsylvania	York	Glenville	General Mining Associates		X
South Carolina	Lancaster	Kershaw	Mineral Mining Corp		X
Tennessee	Unicoi	Erwin	International Minerals & Chemical Corp.		X
Do	Washington	Johnson City	Southern Mica Co		X
Texas	Tarrant	Fort Worth	Western Mica Corp		X
Virginia		Newport News	Richmond Mica Corp	X	

CONSUMPTION

Sheet Mica.—Consumption of sheet mica (block, film, and splittings) in 1955 was 31 percent greater that in 1954.

Domestic fabricators consumed almost 4.1 million pounds of muscovite block and film mica—27 percent more than in 1954. Fabrication of lower than Stained qualities accounted for 47 percent of the total; Stained quality, 48 percent; and Good Stained or better, 5 percent. Of the total muscovite block and film mica fabricated, electronic applications consumed 61 percent, distributed by qualities as follows: 6 percent Good Stained or better, 75 percent Stained, and 19 percent lower than Stained. Grade 6 block mica constituted about 48 percent of the consumption of muscovite block and film.

Fabrication of muscovite block and film mica in 1955 was reported by 25 companies in 9 States; 14 of these companies in 3 States—New York (5), New Jersey (5), and North Carolina (4)—accounted for 54 percent of the total. Geographical distribution of the fabricators, the form of mica fabricated, and the end-product use of the fabricated mica are shown in table 12.

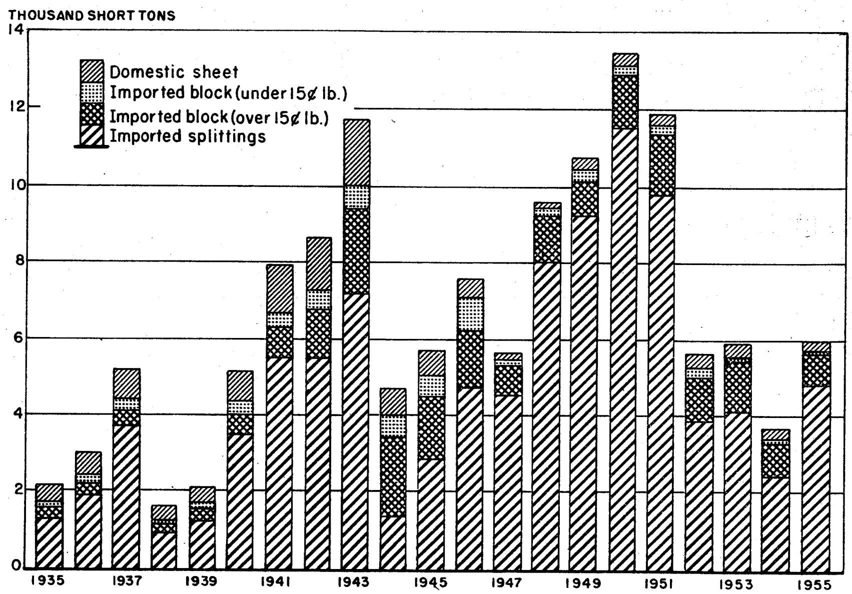

FIGURE 2.—Block mica and splittings imported for consumption in United States and sales of domestic sheet mica, 1935–55.

TABLE 10.—Fabrication of muscovite ruby and nonruby block and film mica and phlogopite block mica, by qualities and end-product uses in the United States, 1955, in pounds

Variety, form, and quality	Electronic uses				Nonelectronic uses			Grand total
	Capacitors	Tubes	Other	Total	Gage glass and diaphragms	Other	Total	
Muscovite:								
Block:								
Good Stained or better	187	21,875	939	23,001	11,428	9,856	21,284	44,285
Stained	2,233	1,839,265	22,367	1,863,865	5,687	85,217	90,904	1,954,769
Lower than Stained [1]	4,604	400,540	64,086	469,230	38	1,465,962	1,466,000	1,935,230
Total	7,024	2,261,680	87,392	2,356,096	17,153	1,561,035	1,578,188	3,934,284
Film:								
First quality	26,031			26,031		166	166	26,197
Second quality	116,392			116,392		295	295	116,687
Other quality	5,243			5,243				5,243
Total	147,666			147,666		461	461	148,127
Block and film:								
Good Stained or better [2]	142,610	21,875	939	165,424	11,428	10,317	21,745	187,169
Stained [3]	7,476	1,839,265	22,367	1,869,108	5,687	85,217	90,904	1,960,012
Lower than Stained	4,604	400,540	64,086	469,230	38	1,465,962	1,466,000	1,935,230
Total	154,690	2,261,680	87,392	2,503,762	17,153	1,561,496	1,578,649	4,082,411
Phlogopite: Block (all qualities)			220	220		10,568	10,568	10,788

[1] Includes punch mica.
[2] Includes first-and second-quality film.
[3] Includes other-quality film.

TABLE 11.—Fabrication of muscovite ruby and nonruby block and film mica in the United States, 1955, by qualities and grades, in pounds

Form, variety, and quality	Grade					
	No. 4 and larger	No. 5	No. 5½	No. 6	Other [1]	Total
Block:						
Ruby:						
Good Stained or better	17,381	2,195	6,268	15,922	94	41,860
Stained	59,027	185,348	131,588	1,456,074	29,248	1,861,285
Lower than Stained	202,603	210,966	62,607	389,049	581,799	1,447,024
Total	279,011	398,509	200,463	1,861,045	611,141	3,350,169
Nonruby:						
Good Stained or better	1,576	152	1	690	6	2,425
Stained	1,697	1,094	215	90,478		93,484
Lower than Stained	33,570	79,569	1,711	10,187	363,169	488,206
Total	36,843	80,815	1,927	101,355	363,175	584,115
Film:						
Ruby:						
First quality	2,669	9,767	3,729	8,724		24,889
Second quality	36,222	31,411	13,856	31,904		113,393
Other quality					5,238	5,238
Total	38,891	41,178	17,585	40,628	5,238	143,520
Nonruby:						
First quality	205	158	465	480		1,308
Second quality	929	1,040	540	785		3,294
Other quality					5	5
Total	1,134	1,198	1,005	1,265	5	4,607

[1] Figures for block mica include "all smaller than No. 6" grade and "punch" mica.

TABLE 12.—Mica fabricators by States, counties, and products for which muscovite and phlogopite mica were fabricated in 1955

State	County	Nearest town	Company	Products for which mica was fabricated: Muscovite, Block, Electronic uses	Muscovite, Block, Nonelectronic uses	Muscovite, Film, Electronic and nonelectronic uses	Phlogopite, Electronic and nonelectronic uses
Illinois	Cook	Chicago	Perfection Mica Co.	X	X	X	X
Do.	do.	do.	Western Electric Co., Inc.	X			
Do.	Williamson	Marion	Sangamo Electric Co.			X	
Massachusetts	Berkshire	North Adams	Sprague Electric Co.			X	
Do.	Bristol	New Bedford	Aerovox Corp., New Bedford Division			X	
Do.	Essex	Danvers	Vulcan Electric Co.				X
Do.	Suffolk	Boston	The Huse-Liberty Mica Co.	X	X		X
New Jersey	Bergen	Ridgefield	The B G Corp.		X	X	X
Do.	do.	Englewood	Industrial Mica Corp.	X	X	X	X
Do.	do.	Rochelle Park	Mica Fabricating Co.	X	X	X	
Do.	Essex	Newark	Micacraft Products, Inc.	X	X	X	
Do.	Monmouth	Manasquan	American Mica Insulation Co.	X	X	X	
New York	Kings	Brooklyn	Ford Radio & Mica Corp.	X			
Do.	do.	do.	Reliance Mica Co., Inc.	X	X	X	X
Do.	do.	do.	Victory Mica Mfg. Co., Inc.	X			
Do.	Schenectady	Schenectady	General Electric Co.		X	X	X
Do.	do.	do.	Mica Insulator Co.	X	X	X	X
North Carolina	Avery	Plumtree	The Tar Heel Mica Co., Inc.		X		
Do.	Buncombe	Asheville	Farnam Mfg. Co., Inc.	X	X	X	X
Do.	Mitchell	Spruce Pine	Carpenter & Phillips		X		
Do.	do.	do.	Spruce Pine Mica Co.	X	X		X
Ohio	Fairfield	Lancaster	Diamond Power Specialty Corp.		X		
Pennsylvania	Lancaster	do.	Radio Corp. of America	X			
Do.	McKean	Smethport	Sylvania Electric Products, Inc.	X			
Rhode Island	Washington	Hope Valley	Cornell-Dubilier Electric Corp.	X		X	
Virginia		Newport News	Asheville Mica Co.	X	X	X	X

Consumption of mica splittings in 1955 was 34 percent greater than in 1954. Most of the splittings used were from India (91 percent by weight), the remainder being principally phlogopite splittings from Madagascar. In all 14 operations in 10 States consumed mica splittings for producing built-up mica.

Built-up Mica.—Domestically produced, built-up mica consumed in 1955 was 17 percent greater in quantity and 19 percent greater in value than in 1954. Various forms of built-up mica were produced for use principally as electrical insulation. Built-up mica was produced domestically in 1955 by 12 companies operating 14 plants.

Reconstituted Mica.—This material, which is produced by papermaking procedures from specially delaminated natural mica scrap, is a substitute for built-up mica in many applications. General Electric Co. in its Laminated and Insulating Products Dept., Coshocton,

TABLE 13.—Consumption and stocks of mica splittings in the United States 1946–50 (average) and 1951–55, by sources

	1946–50 (average)		1951		1952	
	Pounds	Value	Pounds	Value	Pounds	Value
Consumption:						
Domestic	[1 2] 32,883	[1 2] $20,155	} [3] 164,213	[3] $104,868	{ ------	------
Canadian	[2 4 5] 213,085	[2 4 5] 118,889			184,541	$74,197
Indian	8,041,362	6,107,573	12,306,853	10,995,620	9,356,561	9,091,784
Madagascan	489,854	340,058	908,229	660,129	679,569	563,118
Mexican	[1 4 5] 11,083	[1 4 5] 7,045	(3)	(3)	------	------
Total	8,788,267	6,593,720	13,379,295	11,760,617	10,220,671	9,729,099
Stocks (Dec. 31):						
Domestic	[6] 11,048	[6] 5,042	------	------	------	------
Canadian	[5 6 7] 170,923	[5 6 7] 105,496	50,784	24,486	63,588	23,352
Indian	4,813,194	3,957,778	9,756,536	9,379,176	8,218,683	8,356,888
Madagascan	428,127	336,786	522,110	497,658	512,158	460,015
Mexican	[5 7] 9,181	[5 7] 5,990	------	------	------	------
Total	5,432,473	4,411,092	10,329,430	9,901,320	8,794,429	8,840,255

	1953		1954		1955	
	Pounds	Value	Pounds	Value	Pounds	Value
Consumption:						
Domestic	------	------	------	------	------	------
Canadian	158,343	$98,738	67,311	$37,505	(8)	(8)
Indian	9,443,645	7,225,899	6,158,769	3,727,441	8,204,210	$3,844,745
Madagascan	744,171	577,595	506,639	367,472	[8] 793,464	[8] 543,671
Mexican	------	------	------	------	------	------
Total	10,346,159	7,902,232	6,732,719	4,132,418	8,997,674	4,388,416
Stocks (Dec. 31):						
Domestic	------	------	------	------	------	------
Canadian	39,354	20,423	(8)	(8)	(8)	(8)
Indian	6,688,997	6,110,975	5,206,178	3,901,194	6,191,472	3,622,764
Madagascan	387,905	316,610	[8] 330,900	[8] 256,767	[8] 400,710	[8] 302,405
Mexican	------	------	------	------	------	------
Total	7,116,256	6,448,008	5,537,078	4,157,961	6,592,182	3,925,169

1 Mexican included with domestic in 1948.
2 Domestic included with Canadian in 1949–50.
3 Mexican included with domestic and Canadian.
4 Mexican included with domestic and Canadian in 1950.
5 Mexican included with Canadian in 1947.
6 Domestic included with Canadian in 1948–50.
7 Mexican included with domestic and Canadian in 1949–50.
8 Canadian included with Madagascan.

TABLE 14.—Consumption of mica splittings in the United States, 1955, by States

State	Number of consumers	Quantity (pounds)
Indiana, Michigan, Ohio, and Wisconsin	5	2,145,376
Massachusetts and New Hampshire	3	2,835,873
New York	2	2,315,439
North Carolina, Pennsylvania, and Virginia	4	1,700,986
Total	14	8,997,674

Ohio, and Minnesota Mining & Manufacturing Co. in its subsidiaries Samica Corp., Rutland, Vt., and Mica Insulator Co., Schenectady N. Y., produced reconstituted mica commercially in 1955. The total production was 53 percent greater than in 1954.

TABLE 15.—Built-up mica [1] sold or used in the United States, 1953–55, by kinds of product

Product	1953		1954		1955	
	Pounds	Value	Pounds	Value	Pounds	Value
Molding plate	1,704,644	$3,323,141	1,184,965	$2,213,392	1,664,239	$3,337,871
Segment plate	2,106,226	4,054,997	1,504,028	2,778,582	2,151,471	4,278,900
Heater plate	822,207	2,221,995	580,846	1,681,071	639,127	1,730,629
Flexible (cold)	559,671	1,713,996	355,608	946,862	564,007	1,689,908
Tape [2]	2,254,587	8,704,367	2,130,759	7,672,310	1,595,129	6,759,207
Other	201,174	705,837	149,582	537,433	310,433	1,088,274
Total	7,648,509	20,724,333	5,905,788	15,829,650	6,924,406	18,884,789

[1] Consists of a composite of alternate layers of a binder and irregularly arranged and partly overlapped splittings.
[2] Includes a small quantity of built-up mica for "Other combination materials."

Ground Mica.—Sales of ground mica in 1955 were greater than in 1954 by 33 percent in quantity and 34 percent in value. Paint (using 65 percent more tonnage of ground mica than in 1954), consumed almost as large a proportion (29 percent) of the total as the previously predominant user—roofing material (30 percent). Other uses included well-drilling compounds, rubber, and plastics.

TABLE 16.—Ground mica sold by producers in the United States, 1954–55, by uses

Use	1954			1955		
	Short tons	Percent of total	Value	Short tons	Percent of total	Value
Roofing	32,663	41	$1,024,572	31,518	30	$1,051,874
Wallpaper	772	1	105,040	866	1	87,532
Rubber	5,021	6	484,063	7,339	7	687,216
Paint	18,696	23	1,764,717	30,922	29	2,491,228
Plastics	1,352	2	111,048	2,232	2	179,165
Welding rods	695	1	46,404	1,970	2	150,003
Well drilling	6,157	8	285,138	(1)	(1)	(1)
Miscellaneous [2]	14,716	18	1,068,140	31,338	29	1,910,621
Total	80,072	100	4,889,122	106,185	100	6,557,639

[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 (1955), and other purposes.

PRICES

Mica fabricators offered to purchase domestic sheet mica at prices that were unchanged from 1954.

Prices offered by the Government for domestically produced full-trimmed and half-trimmed mica meeting specifications also were the same as in 1954. From February 10 to August 5 the Government purchased domestically produced, hand-cobbed mica at prices proportional to the actual yields of Good Stained or better and Stained qualities of full-trimmed block or film mica. After August 5 hand-cobbed mica could be sold to the Government by either of two procedures. One of these was the former "B" program, which offered a maximum of $600 per short ton of ruby mica and $540 for nonruby. Under the alternate procedure the Government processed the hand-cobbed mica. Payment was for the yield of full-trimmed mica of Heavy Stained or better qualities at prices shown in table 18, minus a processing charge of $1.45 per pound.

North Carolina scrap mica continued to be quoted at $25 to $30 per short ton, depending on quality.

Dry- and wet-ground mica prices were steady throughout the year at the level prevailing in 1954.

TABLE 17.—Prices for various grades of clear sheet mica in North Carolina district, Dec. 31, 1955 [1]

[E&MJ Metal and Mineral Markets]

Grade (size)	Price per pound
Punch	$0.10 to $0.16
1½ x 2 inch	$0.70 to $1.60
2 x 2 inch	$1.10 to $1.60
2 x 3 inch	$1.60 to $2.00
3 x 3 inch	$1.80 to $2.30
3 x 4 inch	$2.00 to $2.60
3 x 5 inch	$2.60 to $3.00
4 x 6 inch	$2.75 to $4.00
6 x 8 inch	$4.00 to $8.00

[1] Stained or electric—sold at approximately 10 to 15 percent lower than clear sheet.

TABLE 18.—Prices for domestically produced muscovite mica purchased by the Goverment, 1955

	Price per pound				
	Full-trimmed			Half-trimmed	
	Good Stained or better	Stained	Heavy Stained	Stained	Heavy Stained
Block and film mica:					
Ruby:					
No. 3 and larger	$70.00	$18.00	$13.00	$12.00	$8.00
No. 4 and No. 5	40.00	8.00	6.00	5.00	4.00
No. 5½ and No. 6	15.00	5.00	3.00	3.00	2.00
Nonruby:					
No. 3 and larger	70.00	14.40	10.40	9.60	6.40
No. 4 and No. 5	40.00	6.40	4.80	4.00	3.20
No. 5½ and No. 6	15.00	4.00	2.40	2.40	1.60

Hand-cobbed mica:	*Per short ton*
Ruby	$600
Nonruby	$540

TABLE 19.—Prices of dry- and wet-ground mica in the United States, December 1955 [1]

[Oil, Paint and Drug Reporter]

	Cents per pound		Cents per pound
Dry-ground:		Wet-ground [2]—Continued.	
Paint, 100-mesh	4¼	Paint or lacquer, less than carlots [3]	8½
Plastic, 100-mesh	4¼	Rubber	7½
Roofing, 20- to 80-mesh	3–4	Rubber, less than carlots [3]	8½
Wet-ground: [2]		Wallpaper	7¾
Biotite	6¼	Wallpaper, less than carlots [3]	8¼
Biotite, less than carlots [3]	7	White, extra fine	7¾
Paint or lacquer	7¾	White, extra fine, less than carlots [3]	8½

[1] In bags at works, carlots, unless otherwise noted.
[2] Freight allowed east of the Mississippi River, ½ cent higher west of the Mississippi River, 1 cent higher west of the Rockies.
[3] Exwarehouse or freight allowed east of the Mississippi River.

FOREIGN TRADE[3]

Imports.—In 1955 imports of mica of all varieties increased 85 percent in quantity over those in 1954. Most categories contributed to the gain, but the largest increases were for uncut films and splittings (90 percent) and muscovite scrap (more than 100 percent).

Imports of muscovite block and film in 1955 were 57 percent greater than in 1954. India furnished 52 percent of the total block and film imports and Brazil, 45 percent. Of the Stained and better qualities of these imports, India furnished 63 and Brazil 34 percent.

Tariff Commission compilations of general imports of muscovite block and film mica, by varieties and principal sources, are compared in table 23 with United States Department of Commerce data on imports for consumption of unmanufactured and manufactured muscovite mica.

Exports.—Total exports of mica and mica products in 1955 compared with 1954 were virtually unchanged in quantity. The tonnage of ground mica exported decreased 4 percent but again constituted the bulk of the mica exports and so counterbalanced the 33-percent increase in exports of other manufactured mica and the 40-percent increase in exports of unmanufactured mica.

TABLE 20.—Mica imported into and exported from the United States, 1946–50 (average) and 1951–55

[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
1946–50 (average)	2, 977, 925	$2, 225, 066	4, 920	$66, 110	8, 553	$12, 340, 057	14, 961	$14, 631, 233	1, 419	$787, 268
1951	3, 563, 242	3, 855, 063	5, 885	93, 357	11, 250	18, 568, 148	18, 917	22, 516, 568	1, 894	1, 101, 917
1952	2, 481, 669	3, 520, 922	6, 531	106, 475	5, 276	11, 053, 579	13, 048	14, 680, 976	2, 472	911, 076
1953	2, 599, 007	4, 279, 273	3, 927	72, 100	5, 763	10, 910, 292	10, 990	15, 261, 665	2, 402	1, 109, 865
1954	1, 829, 457	[1] 3, 197, 918	4, 647	[1] 63, 341	3, 363	[1] 5, 448, 706	8, 924	[1] 8, 709, 965	3, 328	1, 514, 738
1955	1, 747, 106	3, 333, 721	9, 461	121, 343	6, 156	[1] 7, 814, 400	16, 490	[1] 11, 269, 464	3, 314	1, 707, 629

[1] Owing to changes in tabulating procedures by U. S. Department of Commerce, data known not to be comparable with earlier years.

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

TABLE 21.—Mica imported for consumption in the United States, 1946–50 (average), 1951–54 [1] (totals), and 1955, 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
1946-50 (average)	2,804,554	$21,195	7,035,925	$44,915	247,937	$43,435	617,309	$75,197	2,112,679	$2,106,434
1951	494,740	4,284	11,275,723	89,073	169,586	28,827	364,494	33,371	3,029,162	3,792,865
1952	579,008	3,831	12,482,160	102,644	116,142	20,187	355,803	28,025	2,009,724	3,472,710
1953	1,205,633	13,793	6,647,233	58,307	251,811	46,727	128,401	11,404	2,218,795	4,221,142
1954	549,476	7,521	8,744,446	[1] 55,820	40,050	9,448	132,530	11,194	1,656,877	[1] 3,177,276
1955:										
North America:										
Canada	270,200	2,822	2,000	61			150	18	3,303	10,982
Mexico			165,345	1,560						
Total	270,200	2,822	167,345	1,621			150	18	3,303	10,982
South America:										
Argentina							77,161	5,591	74,701	63,285
Brazil							62,532	5,425	927,720	1,658,176
Total							139,693	11,016	1,002,421	1,721,461
Europe:										
Germany, West									2,000	560
Italy									1,200	3,348
United Kingdom									300	2,159
Total									3,500	6,067
Asia: India			16,190,688	97,116					547,987	1,404,460
Africa:										
Angola									20,476	87,281
British East Africa			224,000	1,899					18,529	71,511
Federation of Rhodesia and Nyasaland									1,957	2,396
Madagascar									4,963	16,524
Mozambique									4,127	2,005
Union of South Africa			2,069,457	17,885						
Total			2,293,457	19,784					50,052	179,717
Total unmanufactured	270,200	2,822	18,651,490	118,521			139,843	11,034	1,607,263	3,322,687

TABLE 21.—Mica imported for consumption in the United States, 1946–50 (average), 1951–54 [1] (totals), and 1955, by kinds and by countries of origin—Continued

	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 thick		Over 12/10,000 inch thick					
	Pounds	Value	Pounds	Value	Pounds	Value	Pounds	Value
1946–50 (average)	15,229,288	$11,241,447	555,327	$760,734	19,503	$135,013	15,804,118	$12,137,194
1951	19,665,057	13,533,318	1,823,938	3,848,677	43,405	729,059	21,532,400	18,111,054
1952	7,986,592	6,426,616	1,908,735	3,220,505	59,560	971,756	9,954,887	10,618,877
1953	8,377,873	4,041,972	2,645,230	5,069,044	69,349	1,218,721	11,092,452	10,329,737
1954	4,807,338	[1] 1,657,784	1,592,224	[1] 2,743,725	30,277	[1] 660,035	6,429,839	[1] 5,061,544
1955:								
North America: Mexico	121	3,348	18,743	8,557	8,118	186,159	26,982	198,064
South America:								
Argentina			1,313	1,070			1,313	1,070
Brazil	310	258	937,172	936,955			937,482	937,213
Total	310	258	938,485	938,025			938,795	938,283
Europe:								
France	25,912	11,362					25,912	11,362
Germany, West					4,368	126,673	4,368	126,673
Italy					454	6,035	454	6,035
Netherlands					42	252	42	252
Spain					589	4,094	589	4,094
Sweden	6,905	5,504					6,905	5,504
United Kingdom	22,584	9,129	900	7,890	11,384	250,157	34,868	267,176
Total	55,401	25,995	900	7,890	16,837	387,211	73,138	421,096
Asia:								
India	8,771,294	2,245,384	1,551,637	2,846,614	16,127	138,337	10,339,058	5,230,335
Japan			2,793	10,128	10,476	252,836	13,269	262,964
Total	8,771,294	2,245,384	1,554,430	2,856,742	26,603	391,173	10,352,327	5,493,299
Africa:								
Angola			1,620	3,862			1,620	3,862
British East Africa			6,212	6,085			6,212	6,085
Madagascar	795,338	346,004					795,338	346,004
Total	795,338	346,004	7,832	9,947			803,170	355,951
Total films and splittings	9,622,464	[1] 2,620,989	2,520,390	3,821,161	51,558	[1] 964,543	12,194,412	[1] 7,406,693

	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
1946-50 (average)	166,054	$136,549	3,567	$8,035	11,868	$28,174	1,117,935	$30,104
1951	106,176	119,008	25,840	79,568	55,566	217,281	779,910	41,237
1952	53,612	87,935	28,174	141,344	36,886	177,768	479,498	27,655
1953	45,186	82,679	42,635	374,112	26,542	104,608	320,000	19,156
1954	27,776	51,920	23,593	[1] 141,523	43,401	[1] 181,719	200,000	12,000
1955:								
North America: Mexico	4,066	4,751	17,100	33,168	4,103	14,097		
South America: Brazil	110	138			40,534	131,325		
Europe:								
France			26	920				
Germany, West	1,316	1,316	1,317	7,442	595	1,953		
Italy			1,233	44,086	14	517		
Spain			71	270				
United Kingdom			6,752	97,417	1,724	19,299		
Total	1,316	1,316	9,399	150,135	2,333	21,769		
Asia: India	32,000	40,691	5,506	9,146	1,050	1,171		
Total manufactured: Other	37,492	[1] 46,896	32,005	[1] 192,449	48,020	[1] 168,362		

[1] Owing to changes in tabulating procedures by U. S. Department of Commerce, data known to be not comparable to other years.

TABLE 22.—Muscovite block and film mica, United States general imports, 1954–55, by qualities and principal sources,[1] [2] in pounds

Quality	Countries						Total	
	India		Brazil		Other			
	1954	1955	1954	1955	1954	1955	1954	1955
Block:								
Good Stained and better	72, 479	141, 685	121, 349	133, 661	19, 378	15, 595	213, 206	290, 941
Stained	515, 904	1, 322, 261	639, 009	753, 721	38, 497	74, 287	1, 193, 410	2, 150, 269
Heavy Stained	110, 488	205, 898	426, 582	545, 145	33, 964	9, 933	571, 034	760, 976
Lower	84, 504	145, 050	225, 097	341, 714		6, 776	309, 601	493, 540
Total	783, 375	1, 814, 894	1, 412, 037	1, 774, 241	91, 839	106, 591	2, 287, 251	3, 695, 726
Film:								
First quality	54, 771	63, 926			60		54, 831	63, 926
Second quality	135, 904	140, 395			510	130	136, 414	140, 525
Other quality	2, 900	4, 053					2, 900	4, 053
Total	193, 575	208, 374			570	130	194, 145	208, 504
Block and film:								
Good Stained and better [3]	263, 154	346, 006	121, 349	133, 661	19, 948	15, 725	404, 451	495, 392
Stained [4]	518, 804	1, 326, 314	639, 009	753, 721	38, 497	74, 287	1, 196, 310	2, 154, 322
Heavy Stained	110, 488	205, 898	426, 582	545, 145	33, 964	9, 933	571, 034	760, 976
Lower	84, 504	145, 050	225, 097	341, 714		6, 776	309, 601	493, 540
Total	976, 950	2, 023, 268	1, 412, 037	1, 774, 241	92, 409	106, 721	2, 481, 396	3, 904, 230

[1] Compiled by U. S. Tariff Commission from official documents of U. S. Bureau of Customs.

[2] Does not include imports of mixed grades and qualities: In 1954, from Angola, Brazil, Canada, Mexico, Portuguese East Africa, and Union of South Africa—total 79,130 pounds; in 1955, from Angola, Argentina, Brazil, Eritrea, and India—total 15,151 pounds.

[3] Includes first- and second-quality film.

[4] Includes other-quality film.

TABLE 23.—Mica block and film imported into the United States, 1954-55, by variety and principal sources, in pounds

	U. S. Tariff Commission data		U. S. Department of Commerce data	
	1954	1955	1954	1955
Muscovite block:				
India	783,375	1,814,894	570,325	547,987
Brazil	1,412,037	1,774,241	1,599,946	1,864,892
Other	91,839	106,591	105,171	124,642
Total	2,287,251	3,695,726	[1] 2,275,442	[1] 2,537,521
Muscovite film:				
India	193,575	208,374	[2] 721,122	[2] 1,551,637
Brazil				
Other	570	130		
Total	194,145	208,504	721,122	1,551,637

[1] 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 thick.

[2] Manufactured films and splittings, not cut or stamped to dimensions, over 12/10,000-inch thick, from India.

TABLE 24.—Mica and manufactures of mica exported from the United States, 1946–50 (average), 1951–54 (totals), and 1955, by countries of destination

[U. S. Department of Commerce]

Country	Unmanufactured		Manufactured			
			Ground or pulverized		Other	
	Pounds	Value	Pounds	Value	Pounds	Value
1946–50 (average)	282,893	$60,775	2,281,086	$123,386	273,071	$603,107
1951	398,662	93,572	3,136,548	189,836	254,179	818,509
1952	592,901	40,700	4,172,951	234,082	180,482	636,294
1953	45,046	27,978	4,560,883	240,356	197,370	841,531
1954	318,518	79,310	6,058,118	342,860	280,415	1,092,568
1955:						
North America:						
Canada	31,122	9,312	2,286,700	96,550	215,602	814,369
Canal Zone					2,490	4,446
Cuba			146,563	7,839	3,290	7,150
Dominican Republic			10,000	900		
Jamaica					2,500	2,250
Mexcio	17,504	7,076	316,675	16,431	8,045	21,803
Total	48,626	16,388	2,759,938	121,720	231,927	850,018
South America:						
Argentina			56,200	3,512		
Bolivia					1,740	1,890
Brazil					3,479	11,282
Chile					6,127	21,703
Colombia					197	2,733
Peru	50,000	3,560			3,674	4,004
Venezuela			757,499	43,776	859	1,247
Total	50,000	3,560	813,699	47,288	16,076	42,859
Europe:						
Belgium-Luxembourg	8,880	4,460	612,100	44,908	29,095	99,334
Denmark			2,000	180		
France			403,930	31,908	62,463	209,097
Germany, West	3,400	4,489	535,000	45,636	920	3,763
Iceland	20,000	1,350				
Italy			381,100	20,804	14,468	46,934
Netherlands			49,000	4,154	7,256	26,452
Spain			11,000	770		
Sweden			22,000	1,894	6,555	42,293
Switzerland			9,200	644		
United Kingdom			68,180	4,052	624	1,559
Total	32,280	10,299	2,093,510	154,950	121,381	429,432
Asia:						
India			8,000	560		
Indonesia					150	1,340
Israel			38,000	3,163		
Japan	303,385	3,747			860	2,276
Kuwait			10,200	620		
Philippines	13,200	1,247			185	1,160
Total	316,585	4,994	56,200	4,343	1,195	4,776
Africa:						
Belgian Congo					680	1,020
Ethiopia			15,000	937		
Mozambique			10,000	620		
Union of South Africa			60,000	2,435	169	600
Total			85,000	3,992	849	1,620
Oceania: Australia					1,120	11,390
Grand total	447,491	35,241	5,808,347	332,293	372,548	1,340,095

TECHNOLOGY

Natural Mica.—Preparation, grading, qualifying, uses, consumption, and other pertinent information for marketing natural sheet mica were detailed in a publication of the Bureau of Mines.[4]

The National Academy of Sciences reported on its survey to ascertain the degree to which lower qualities of natural mica can be used in strategic electronic applications.[5]

The Federal Geological Survey reported on deposits of mica in Alaska,[6] Colorado,[7] and South Dakota,[8] and the Maine Geological Survey described occurrences of mica schist.[9]

Results of studies of the structure of natural mica with various substitutions in the lattice were published.[10]

The American Society for Testing Materials adopted tentative methods of testing electrical insulation for its dielectric properties [11] and pasted mica used for electrical insulation.[12]

Wet-ground mica as an extender in vinyltoluene oil-copolymer flat wall paints improved the suspension characteristics, washability, and storage properties of the paint.[13] The ability of wet-ground mica to give good transmission and at the same time extensive scattering of light makes it valuable in compounding opaque window paints.[14] Primers for steel acquire improved aging characteristics when wet-ground mica is part of the formulation.[15] Of particular interest to the production of wet-ground mica was a patent issued for a wet-screening apparatus.[16]

The Central Glass and Ceramic Research Institute of Calcutta developed a process for manufacturing insulating brick from waste mica to give a product that compared favorably with brick made from vermiculite.[17]

Synthetic Mica.—Major emphasis of work on synthetic mica by the Bureau of Mines at its Electrotechnical Laboratory, Norris, Tenn., was the search for a means of growing large single crystals of synthetic mica. In attempts to grow single sheets of mica by the Kyropoulos technique of gradually withdrawing a seed crystal from a melt, temperature control was inadequate for evaluation of possible

---

[4] Thomson, R. D., Marketing Sheet Mica: Bureau of Mines Inf. Circ. 7729, 1955, 20 pp.
[5] Materials Advisory Board, Panel on Mica, Natural Muscovite Block and Film Mica: Nat. Acad. Sciences Rept. MAB 99-C, Aug. 19, 1955, 35 pp.
[6] Sainsbury, C. L., Geology of Two Areas of Pegmatite Deposits in Southeastern Alaska: Ms. on open file at Geol. Survey offices.
[7] Thurston, W. R., Pegmatites of the Crystal Mountain District, Larimer County, Colo.: Geol. Survey Bull. 1011, 1955, 185 pp.
[8] Sheridan, D. M., Geology of High Climb Pegmatite, Custer County, S. Dak.: Geol. Survey Bull. 1015-C, 1955, pp. 59-98.
[9] Shainin, V. E., and Dellwig, L. F., Pegmatites and Associated Rocks in the Newry Hill Area, Oxford County, Maine: Maine Geol. Survey Bull. 6, 1955, pp. 1-58.
[10] Heinrich, E. W., and Levinson, A. A., Studies in the Mica Group; X-Ray Data on Roscoelite and Barium-Muscovite: Am. Jour. Sci., vol. 253, No. 1, January 1955, pp. 39-43.
Brown, G., The Effect of Isomorphous Substitutions on the Intensities of (001) Reflections of Mica- and Chlorite-Type Structures: Mineralogical Mag. (London), vol. 30, 1955, pp. 657-665.
[11] American Society for Testing Materials, Tentative Methods of Test for Dielectric Breakdown Voltage and Dielectric Strength of Electrical Insulating Materials at Commercial Power Factor: D 149-55T, 1955, pp. 493-499.
[12] American Society for Testing Materials, Tentative Methods of Testing Pasted Mica Used in Electrical Insulation: D 352-55T, 1955, pp. 935-941.
[13] Wet Ground Mica Assoc., Inc., The Modification of Vinyltoluene Oil-Copolymer Flat Wall Paints by Wet-Ground Mica: Bull. 20, July 1955, 4 pp.
[14] Wet Ground Mica Assoc., Inc., An Opaque Window Paint Based on the Light-Scattering Effect of Wet-Ground Mica: Bull. 21, September 1955, 2 pp.
[15] Chatfield, H. W., The Effect of Mica on the Embrittlement of Anti-Corrosive Primers for Steel: Product Finishing, vol. 8, October 1955, pp. 50-56.
[16] Rolston, J. A. (assigned to English Mica Co.), Apparatus for Classifying Flaky Materials: U. S. Patent 2,704,604, Mar. 22, 1955.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 45.

feasibility of the method. Synthetic mica melts were crystallized in crucibles being withdrawn from the furnace at a controlled slow rate to study the effects of thermal gradient and batch composition on the size and quality of crystals. Graphite crucibles in a helium atmosphere were not suitable for this work, but silicon nitride crucibles proved very satisfactory for containing the fluorphlogopite melt at 1,400° C. in an oxidizing atmosphere. Variations in the composition of the fluorphlogopite batch indicated that a small excess of potassium, aluminum, and silicon favored production of large, single crystals but that an excess of magnesium favored small crystals. X-ray and optical data were published for selected crystals of synthetic fluorphlogopite.[18]

A 5-ton batch containing excess magnesium and fluoride (a composition reported in German work during World War II as the most suitable for growing large, single crystals by a crucible method) was melted by the internal-electric-resistance technique. The flake size of the mica produced was remarkably uniform but was smaller than that obtained from batches with compositions nearer to theoretical fluorphlogopite.

Research on the reconstitution of synthetic flake mica resulted in the discovery of laboratory methods to produce a thermally bonded sheet, which, though promising, was not yet adequate in mechanical strength and flexibility for use in electronic tube spacers. Its electrical properties, particularly those required in capacitor applications, also required improvement.

A systematic study of the numerous isomorphs of synthetic fluorphlogopite mica was begun. Various compositions were reacted either in the solid state or in melts, and the products were evaluated for identity of phases, crystallization behavior, hot-pressing characteristics, and, on promising materials, various physical constants.

Ceramic materials continued to be important coincident developments of the research on synthetic mica. A method was invented for phosphate bonding of synthetic mica to produce a machinable ceramic material with good electrical properties.[19] Hot pressing of combinations of synthetic mica with other synthetic minerals gave ceramic materials that resisted abrasion and impact but still retained the machinability of mica ceramics.

The first commercial production of synthetic mica flake was begun in September at the new plant of Synthetic Mica Corp. at Caldwell, N. J.[20] The internal-electric-resistance melting process [21] developed at the Bureau of Mines Electrotechnical Laboratory was used to produce melts of approximately 10 tons. The product was not a substitute for strategic block and film mica but was used principally in glass-bonded mica ceramics. These glass-bonded materials when

---

[18] Kohn, J. A., and Hatch, R. A., Synthetic Mica Investigations: VI, X-ray and Optical Data on Synthetic Fluorphlogopite: Am. Mineral., vol. 40, 1955, pp. 10–21.

[19] Comeforo, J. E. (assigned to United States of America as represented by the Secretary of the Interior), Machinable Ceramic Dielectric Material: U. S. Patent 2,704,261, Mar. 15, 1955.

[20] Chemical and Engineering News, Synthetic Mica Plant: Vol. 33, No. 41, Oct. 10, 1955, p. 4278.
Chemical Engineering, First Commercial Mica Plant—3-way success: Vol. 62, No. 12, December 1955, pp. 124–126.
Materials and Methods, More Synthetic Mica From New Plant: Vol. 42, No. 5, November 1955, pp. 13, 239.
Steel, Substitute: Vol. 137, No. 16, Oct. 17, 1955, p. 113.

[21] Humphrey, R. A. (assigned to United States of America, as represented by the Secretary of the Interior) Electric Furnace and Electric Melting and Crystallizing Method for Minerals: U. S. Patent 2,711,435, June 21, 1955.

formulated with pulverized synthetic mica will withstand temperatures up to 1,000° F., compared with 700° F. for similar products using natural mica.[22]

In August the Office of Defense Mobilization certified an intensified program of research and development on synthetic mica as a substitute for strategic natural mica and designated General Services Administration to negotiate contracts with Government and industry for basic research, applied research, and evaluation of substitute materials.

A summary of Japanese research on synthetic mica was published,[23] and some Russian experiments on hydrothermal synthesis of mica were described.[24]

Results of tests of polycrystalline synthetic mica, first published in 1954 by the Office of Naval Research, appeared under a new title.[25]

Built-up and Reconstituted Products From Synthetic or Natural Mica.—Built-up mica bonded with polyester resin was an improved insulation for high voltages in generators.[26] Reconstituted mica sheet, impregnated with various binders, was found to have definite advantages over built-up mica in many applications.[27] A variation of the Samica process of preparing pulp suitable for reconstituted mica was described,[28] as was a method for bonding reconstituted mica.[29]

Additional patents were issued relating to the process for producing a continuous sheet of integrated mica, as originally disclosed in United States Patents 2,405,576, 2,490,129, and 2,659,412.[30]

Limited production of an electrical insulating material in sheet form from dry-ground mica by phosphate bonding and hot pressing was begun by the Farnam Mfg. Co. in cooperation with the Spruce Pine Mica Co. This material was the result of research sponsored by the two companies at the North Carolina State College Minerals Research Laboratory, Asheville, N. C. A flexible dielectric material formed from ground mica and a plastic binder was patented.[31]

WORLD REVIEW

The estimated world production of mica in 1955 was 16 percent greater than in 1954. Increased output of scrap mica in the United States and of total sheet and scrap in India and Africa accounted for the gain.

---

[22] Chemical Engineering, Synthetic Mica: Key to Usefulness at 1,000° F.: Vol. 62, No. 10, October 1955, p. 148.

[23] Noda, T., Synthetic Mica Research in Japan: Jour. Am. Ceram. Soc., vol. 38, No. 4, April 1955, pp. 147–152.

[24] Veres, G. I., Merenkova, T. B., and Ostrovskii, I. A., [Synthetic Pure Iron Mica]: Doklady Akad. Nauk S. S. S. R., vol. 101, 1955, pp. 147–150; Chem. Abs., vol. 49, No. 17, Sept. 10, 1955, p. 11513a.

[25] Hanley, T. E., Vacuum Properties of New Synthetic Mica: Ceram. Age, vol. 66, No. 4, October 1955, pp. 40–41.

[26] Canadian Chemical Processing, Improved Synthetic Resin Insulation; Thermalastic: Vol. 39, May 1955, pp. 58–62.

[27] Materials and Methods, New Epoxy-Bonded Mica Insulation: Vol. 46, No. 6, June 1955, pp. 112–113. Finholt, R. W., A New Insulateng Material for Traction Motors: Elec. Eng., vol. 74, No. 9, September 1955, p. 797.

Kreitler, F. C., New Silicone-Mica Insulation for Heavy-Duty Mine Motors: Eng. Min. Jour., vol. 156, No. 12, December 1955, pp. 94-95.

[28] Bouchet, A. J. G. (assigned to Samica Corp.), Mica Pulp: U. S. Patent 2,709,158, May 24, 1955.

[29] Richardson, C. D., and Zavist, A. F. (assigned to General Electric Co.), Treated Mica Paper Insulation: U. S. Patent 2,707,204, Apr. 26, 1955.

[30] Heyman, M. D. (assigned to Integrated Mica Corp.), Mica Sheeting Apparatus: U. S. Patent 2,703,598, Mar. 8, 1955. Apparatus for Intermittently Delivering Liquid in Uniform Amounts, at a Uniform Rate, and Under Constant Pressure: U. S. Patent 2,705,456, Apr. 5, 1955. Mica Flake Classifying Device and Method: U. S. Patent 2,708,032, May 10, 1955.

[31] Robinson, P., and Peck, D. B. (assigned to Sprague Electric Co.), Dielectric Materials: U. S. Patent 2,704,105, Mar. 15, 1955.

TABLE 25.—World production of mica, by countries,[1] 1946–50 (average) and 1951–55, in thousand pounds [2]

[Compiled by Helen L. Hunt]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada (sales):						
Block		614	182	283	70	
Splittings	6,462	6	7	8	2	1,186
Ground		2,063	988	665	937	
Scrap		2,278	838	1,310	697	
United States (sold or used by producers):						
Sheet	571	595	698	849	669	642
Scrap	103,109	143,742	150,472	146,518	162,146	190,864
Total	110,142	149,298	153,185	149,633	164,521	192,692
South America:						
Argentina:						
Sheet	780	397	485	540	529	99
Scrap						139
Brazil	3,609	3,655	4,676	4,347	3,962	[3] 3,300
Peru	93	---	---	---	---	---
Uruguay	11	2	2	2	---	---
Total	4,493	4,054	5,163	4,889	4,491	[3] 3,540
Europe:						
Austria	366	677	---	---	---	---
Italy	40	---	---	---	---	---
Norway, including scrap	569	2,172	1,171	2,185	3,968	3,307
Spain	11	24	18	29	18	20
Sweden:						
Block	227	93	18	7	4	---
Ground		381	346	377	331	368
Total [1 3]	34,000	59,000	57,000	59,000	60,000	60,000
Asia:						
Ceylon	---	(4)	20	13	---	(4)
India (exports):						
Block		3,609	3,261	3,840	3,609	4,744
Splittings	30,498	30,730	12,650	12,211	10,855	42,483
Scrap		20,615	18,516	11,444	23,031	
Taiwan (Formosa):						
Sheet	---	33	2	51	44	---
Scrap		1,036	29			
Total [1 3]	30,700	57,100	36,700	32,000	48,600	62,700
Africa:						
Angola:						
Sheet	201	33	64	42	24	33
Scrap and splittings		267	441	22	362	518
Eritrea	2	---	---	---	---	---
French Morocco:						
Sheet	185	26	---	(4)	11	---
Scrap		55	13	29	18	
Kenya	4	2	4	---	---	---
Madagascar (phlogopite):						
Block	1,413	2,112	90	115	101	62
Splittings		---	2,266	1,684	1,056	534
Mozambique, including scrap	66	24	4	7	2	29
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia, sheet	2	13	35	18	7	4
Southern Rhodesia:						
Block	721	207	209	148	183	141
Scrap		560	1,464	201	---	---
South-West Africa, scrap	26	251	---	---	---	---
Tanganyika (exports):						
Block		154	238	165	174	146
Ground	315	---	33	---	---	---
Scrap		---	2	115	62	613

See footnotes at end of table.

TABLE 25.—World production of mica, by countries,[1] 1946–50 (average) and 1951–55, in thousand pounds—Continued

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
Africa—Continued						
Uganda	2	(4)	(4)		(4)	
Union of South Africa:						
Sheet	3,347	11	11	11	4	11
Scrap		3,911	5,871	4,281	4,107	7,818
Total	6,284	7,626	10,745	6,838	6,111	9,909
Oceania: Australia [5]	1,102	1,182	1,105	1,069	1,316	1,054
World total (estimate) [1]	185,000	280,000	265,000	255,000	285,000	330,000

[1] In addition to countries listed, mica is also produced in China, Korea, Rumania, and U. S. S. R., but data on production 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 Mica chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Less than 0.5 ton.
[5] These figures include the following tonnages of damourite produced in South Australia, in thousand pounds: 1946–50 (average): 1,016; 1951: 1,131; 1952: 1,032; 1953; 996; 1954: 1,151; 1955: 977.

Angola.—Production of both block and scrap mica in 1955 increased sharply over corresponding figures for 1954, according to preliminary data from the Angolan Department of Geology and Mines, as follows:

		1954	*1955 (preliminary)*
Mica block	thousand pounds	23,975	32,690
Mica scrap	do	361,464	515,876

Exports of mica in 1955, all to the United States, totaled 19 short tons of block mica and 23 short tons of scrap mica.[32]

Argentina.—Production of sheet mica declined further during the first half of 1955 because increased production costs were not accompanied by a price increase from Institute Argentino de Promocion del Intercambio, the organization obligated to purchase any mica offered by producers.[33]

Australia.—The Hart's Range-Plenty River mica field, Australia's only significant source of muscovite mica, with an average annual production of about 60,000 pounds of block mica per year, was described in detail.[34]

Mine production of block mica declined from 84,619 pounds in 1954 to 56,649 pounds in 1955, while scrap-mica production dropped from 80,864 pounds to 20,160. Exports of mica of all types totaled 7,784 pounds in 1955, compared with 18,808 pounds in 1954.[35]

Brazil.—The Government established a new schedule of declared values for exports of mica and began inspecting shipments to compare actual with invoiced quality.[36]

Total mica exports in 1955 were 988 short tons, an increase of 36 percent over the 1954 tonnage.[37]

[32] U. S. Consulate, Luanda, Angola, State Department Dispatch 185; Apr. 24, 1956, p. 12.
[33] U. S. Embassy, Buenos Aires, Argentina, State Department Dispatch 95; Aug. 5, 1955, pp. 2–3.
[34] Joklik, G. F., The Mica-Bearing Pegmatites of the Hart's Range, Central Australia: Econ. Geol., vol. 50, No. 6, September–October 1955, pp. 625–649.
[35] U. S. Embassy, Melbourne, Australia, State Department Dispatch 29: Aug. 31, 1956, pp. 10, 14.
[36] U. S. Embassy, Rio de Janeiro, Brazil, State Department Dispatch 299: Sept. 2, 1955, p. 1. State Department Dispatch 811: Dec. 23, 1955, p. 2.
[37] U. S. Embassy, Rio de Janeiro, Brazil, State Department Dispatch 389: Oct. 2, 1956.

TABLE 26.—Salient statistics of the Canadian mica industry, 1954–55 [1]

	1954		1955	
	Pounds	Value	Pounds	Value
Production (primary sales):				
Trimmed	18,939	$17,811	24,317	$26,019
Splittings	1,901	3,551		
Sold for mechanical splitting	40,150	8,841	8,000	2,080
Rough, mine-run, or rifted	11,416	1,495	25,275	2,272
Ground or powdered	937,076	44,057	943,158	42,837
Scrap	687,205	8,571	639,958	4,313
Unclassified	10,083	813		
Total	1,706,770	85,139	1,640,708	77,521
Imports:				
Unmanufactured	232,700	87,215	198,900	105,810
Manufactured		365,990		482,853
Total	232,700	453,205	198,900	588,663
Exports:				
Unmanufactured:				
Rough, untrimmed	60,200	12,647	2,000	195
Trimmed	17,400	21,583	46,900	41,318
Scrap	453,600	6,241	313,000	4,060
Total unmanufactured	531,200	40,471	361,900	45,573
Manufactured:				
Manufactures		2,847		42
Ground	240,000	13,319	900	45
Total manufactured		16,166		87
Total exports		56,637		45,660

[1] Compiled from data from the following source: Dominion Bureau of Statistics, Industry and Merchandising Division, The Miscellaneous Non-Metal Mining Industry, 1955: Pp. 0–25 to 0–26.

Canada.—Production of mica decreased 4 percent in quantity and 9 percent in value below 1954. Quebec was the principal supplier of phlogopite—the predominant variety produced—and Ontario furnished the remainder. Production of mica schist in British Columbia continued.[38] Salient statistics of the Canadian mica industry in 1954 and 1955 are shown in table 26.

The Spar-Mica Corp. Ltd., formed by Electro Refractories & Abrasives Corp., and Strategic Materials Corp., will mine and process mica and feldspar in Bergeronnes township on the north shore of the Gulf of St. Lawrence.[39]

Finland.—Mica has been produced only as a byproduct of feldspar refining, and the small quantity of flake recovered (20 to 30 tons annually) is used in plastering compounds.[40]

India.—The decline in export markets resulted in a serious recession in the mica industry. One-third of the 600 mines in Bihar were closed forcing nearly 50,000 persons out of work. To stabilize the entire industry the Government encouraged organization of cooperatives among smaller producers, the use of modern machinery, intensive research to develop new uses for mica, and establishment of Indian mica-consuming industries. The Government of Bihar provided

[38] Dominion Bureau of Statistics, Industry and Merchandising Division, The Miscellaneous Non-Metal Mining Industry, 1955: Pp. 0–25—0–26.
[39] Engineering and Mining Journal, vol. 156, No. 7, July 1955, p. 168.
[40] U. S. Embassy, Helsinki, Finland, State Department Dispatch 7: July 5, 1955, p. 4.

electric power to one important mining area, and a private company planned a micanite factory.[41]

Indian mica production for 1955, as measured by exports, totaled 2,401 short tons of block, 8,240 short tons of splittings, and 12,850 short tons of other mica. Approximate values, in dollars and (rupees), were, respectively, 9,279,000 (44,185,680) 7,130,000 (33,950,716) and 243,000 (1,157,656).[42]

Norway.—Mica production was largely in connection with feldspar mining and declined to 1,653 short tons in 1955 from 1,967 short tons in 1954.[43]

Renndalsvik Minerals Products A/S planned to recover mica from large mica-slate deposits on the island of Meloy in Nordland County. Production of 4,400 short tons per year was anticipated, mostly for export.[44]

Pakistan.—Systematic prospecting of the Clifton Beach black sands was planned to evaluate the possibility of recovering mica.[45]

Rhodesia and Nyasaland, Federation of.—A total of 141,616 pounds of block mica valued at $102,247 (£36,387) was produced in 1955 compared with 1954 production of 184,897 pounds valued at $153,921 (£54,776).[46] A detailed description of the commercial mica deposits was published.[47]

Tanganyika.—In 1955 production of block mica was 73 short tons and of scrap mica 307 short tons. Provisional values were set at $191,313 (£68,083) and $7,697 (£2,739) respectively.[48]

[41] Birmingham, W. P., Marketing India's Mica: Canada Foreign Trade, vol. 103, No. 10, May 14, 1955 pp. 24–25.
Canadian Mining Journal, India's Mica Industry: Vol. 76, No. 6, June 1955, p. 89.
[42] U. S. Embassy, New Delhi, India, State Department Dispatch 636: Nov. 23, 1956.
[43] U. S. Embassy, Oslo, Norway, State Department Dispatch 248: Oct. 10, 1956, p. 17.
[44] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 2, February 1956, p. 32.
[45] Mining Journal (London), Mica and Ilmenite: Vol. 245, No. 6258, July 29, 1955, p. 124.
[46] U. S. Consulate, Salisbury, Southern Rhodesia, State Department Dispatch 219: Nov. 28, 1956, p. 2.
[47] Rhodesian Mining Review (Rhodesia), Mica Deposits in Southern Rhodesia: Vol. 20, No. 9, September 1955, pp. 37–41.
[48] U. S. Consulate, Dar es Salaam, Tanganyika, State Department Dispatch 133: May 2, 1956, encl. 1, p. 2.

Molybdenum

By Wilmer McInnis[1] and Mary J. Burke[2]

UNITED STATES mine production of molybdenum in 1955 (92 percent of estimated world output), was the highest in history. Most of the increase was from byproduct sources. Owing to the high level of industrial activity, consumption of concentrate was higher than in any year since 1943. Industry stocks of concentrate declined to the lowest level since they were first recorded by the Bureau of Mines in 1941. Stocks of primary product[3] at producers' plants also declined during 1955.

Exports of molybdenum concentrate (including molybdic oxide) in 1955 increased about 8 percent over 1954.

Quoted prices for molybdenite concentrate and most primary products were increased by about 5 percent on December 15, 1955.

TABLE 1.—Salient statistics of molybdenum in the United States, 1946–50 (average) and 1951–55, thousand pounds of contained molybdenum

	1946–50 (average)	1951	1952	1953	1954	1955
Concentrate:						
Production of concentrate	24,596	38,855	43,259	57,243	58,668	61,781
Shipments of concentrate [1]	27,294	37,955	42,717	53,823	[2] 64,021	64,467
Value of shipments, thousand dollars [3]	20,837	36,177	40,845	52,362	[2] 64,070	66,692
Shipments for export	[4] 3,472	3,270	5,290	5,893	12,974	11,805
Consumption of concentrate	21,272	33,691	32,715	31,193	24,710	38,799
Imports for consumption	10	4	50	--------	154	134
Stocks of concentrate end of year [5]	17,525	5,058	6,856	11,326	5,317	2,730
Primary products: [6]						
Production of products	21,023	32,775	32,383	30,283	24,328	37,774
Shipments to domestic destinations	21,589	29,845	30,211	29,595	23,717	35,935
Shipments for export [7]	1,159	1,388	1,844	1,107	1,640	2,671
Total shipments of primary products	22,748	31,233	32,055	30,702	25,357	38,606
Stocks of primary products [8]	7,243	3,037	3,373	3,894	3,430	3,156

[1] Including exports.
[2] Revised figure.
[3] Largely estimated by Bureau of Mines.
[4] Actual exports; includes roasted concentrate, except for 1949 and 1950.
[5] At mines and at plants making molybdenum products.
[6] Comprises ferromolybdenum, molybdic oxide, and molybdenum salts and metal.
[7] Reported by producers to the Bureau of Mines.
[8] Producers' stocks, end of year.

[1] Commodity specialist.
[2] Statistical clerk.
[3] Includes ferromolybdenum, molybdic oxide, and molybdenum salts and metal.

DOMESTIC PRODUCTION OF ORE AND CONCENTRATE

Molybdenum production in 1955 exceeded the previous record established in 1943 by over 100,000 pounds. Although monthly production was at a high rate throughout the year (except for July and August, when strikes at several byproduct plants drastically curtailed output from these sources), supply during the latter part of the year was tight, and some concentrate scheduled for delivery to the National Stockpile was diverted to industry.

Nearly all of the molybdenum produced in 1955 was derived from the mineral molybdenite (MoS_2). A small quantity was derived from the mineral powellite [$Ca(Mo,W)O_4$], which was recovered as a byproduct from the Pine Creek mine near Bishop, Calif. The molybdenite content of ores mined chiefly for molybdenum ranged from about 0.4 to 3.3 percent and copper and tungsten ores in which molybdenum was recovered as a byproduct, ranged from about 0.01 to 0.08 percent molybdenite. Molybdenum contained in tungsten concentrate and recovered in steel plants is not included in the statistical tables.

Molybdenum was produced in six States in 1955; Colorado led, followed by Utah, Arizona, New Mexico, California, and Nevada. The concentrate produced ranged from 39 to 91 percent molybdenite (MoS_2). The output of mines operated chiefly for molybdenum increased about 1 percent, and byproduct production was 17 percent higher than in 1954. Shipments of concentrate (metal content) comprised 52,662,000 pounds to domestic destinations and 11,805,000 pounds for export. Concentrate was converted to molybdenum trioxide (MoO_3) at plants in Langeloth and Washington, Pa.; Canton, Ohio; Miami, Ariz.; and Denver, Colo.

Molybdenum Mines.—The Climax mine, Lake County, Colo., and the Questa mine, Taos County, N. Mex., were the only domestic mines operated chiefly for molybdenum in 1955.

Molybdenum output from these mines was about 70 percent of the total produced in 1955. A modernization and expansion program at the Climax mine, which was begun about 1951, was described by management and engineering personnel of the Climax Molybdenum Co.[4]

A new unit costing about $1 million was being added to the 29,000-ton-a-day mill; this unit can be used either to increase milling capacity by about 3,500 tons of ore a day or to increase present recovery by grinding the ore finer with no increase in tonnage milled. According to the annual report[5] of the Climax Molybdenum Co.: the mine produced and the mill treated 9,227,700 tons of ore during 1955, an average of about 30,000 tons per operating day. This was a record output and continued to constitute the largest production from a single undergound mine of any kind in North America. About 60 percent of the ore was drawn from the Phillipson level and the balance from the Storke level.

Byproduct Sources.—Molybdenum produced as a byproduct of copper and tungsten mining, represented 30 percent of total output in 1955. Bagdad Copper Corp. (Bagdad, Ariz.), Kennecott Copper

---

[4] Mining Engineering, vol. 7, No. 8, August 1955, pp. 726–780.
[5] Climax Molybdenum Co, Annual Report to Stockholders, 1955, p. 3.

Corp. (Chino Mines Div., Hurley, N. Mex., Nevada Mines Div., McGill, Nev., and Utah Copper Division, Arthur and Magna Mills—near Salt Lake City, Utah), Miami Copper Co. (Miami, Ariz.), and Phelps Dodge Corp. (Morenci, Ariz.) recovered molybdenite concentrate from copper ores. The San Manuel Copper Corp. nearly completed construction of a unit to recover molybdenite concentrate from its copper operations at San Manuel, Ariz. and production was expected to begin early in 1956.

Compared with 1954 Bagdad Copper Corp. increased molybdenum production in 1955 by 34 percent; Kennecott Copper Corp., Chino Mines Division, increased output by 20 percent, and the Utah Copper Division by 14 percent. Miami Copper Co. and Phelps Dodge Corp. increased production by about 1 and 5 percent, respectively. Union Carbide Nuclear Co. (formerly U. S. Vanadium Co.) recovered molybdenite concentrate by flotation and molybdic oxide by chemical process as byproducts of tungsten ore and concentrate at its Pine Creek operations near Bishop, Calif.

CONSUMPTION AND USES

Following the high level of industrial activity, domestic consumption of molybdenum in 1955, exceeded only by the war years 1942 and 1943, totaled 38.8 million pounds, 57 percent over 1954. Consumption of molybdenum products, as measured by shipments to consumers, was 52 percent higher than in 1954.

About 85 to 90 percent of all molybdenum consumed in 1955 was used in ferrous alloys, to which it was added mostly in the form of molybdic oxide, ferromolybdenum, or calcium molybdate. Some producers added a relatively small quantity of molybdenite to steel when the addition of both molybdenum and sulfur was desired.

Molybdenum was also used as metal, in nonferrous alloys, and in nonmetallics.

Most noteworthy was increased use (as measured by shipments) of molybdenum-type (Class A), high-speed steel, which was 69 percent higher than in 1954. This class of high-speed steel comprised almost 87 percent of all high-speed steel shipped during the year. Molybdenum is added to Class A high-speed steel in quantities ranging from 5 to 9 percent, principally for its red-hardness effect. Although molybdenum is added to alloy engineering and structural steels in quantities ranging from only about 0.05 to 0.5 percent, these steels form the largest use of the metal. Probably 10 to 15 percent of all molybdenum consumed in 1955 went into cast iron, where it contributed to hardness, strength, or other desired properties.

The use of metallic molybdenum was believed to have increased significantly during the year. Some major uses of the metal were in electronic tubes, glass melting electrodes, heating elements in electric furnaces, and vacuum melting of high-temperature alloys. Scrap was the principal source of molybdenum for use in high-temperature alloys in past years, but newly produced molybdenum made significant gains in these alloys toward the end of the year.

Molybdenum disulfide lubricants, catalysts, pigments, chemical reagents, and fertilizer were among the many nonmetallic uses of

457676—58——53

molybdenum. Molybdenum was reported[6] to have been used commercially to catalyze oxidation, hydrogenation, dehydrogenation, isomerization, cyclization, chlorination, and condensation chemical reactions. Phosphomolybdic and phosphotungstomolybdic acids were reported to be the most important forms of molybdenum used in organic pigments.[7] It was reported that molybdenum was used both as a major constituent and as an accelerator or promoter in the formation of protective or decorative coatings on metal.[8]

A relatively small quantity of molybdenum was used in treating certain acid soils. It was reported that in many acid soils it is more efficient to apply molybdenum direct than to release it through liming.[9]

TABLE 2.—Production, shipments, and stocks of molybdenum products in the United States, 1955

(Thousand pounds of contained molybdenum)

Product	Production[1]	Shipments			Stocks, end of year
		Domestic	Export	Total	
Molybdic oxide[2]	27,700	26,009	2,401	28,410	1,963
Molybdenum metal powder	331	345	3	348	68
Ammonium molybdate	215	165		165	109
Sodium molybdate	213	219		219	34
Other[3]	9,315	9,197	267	9,464	982
Total	37,774	35,935	2,671	38,606	3,156

[1] Comprises total production of all products less quantities of oxide and ammonium molybdate used to produce other products.
[2] Includes molybdic oxide briquets, molybdic acid, and molybdenum trioxide.
[3] Includes ferromolybdenum, calcium molybdate, cobalt molybdenum, nickel molybdenum, acid phosphomolybdic, etc.

STOCKS

Stocks of molybdenum concentrate decreased 49 percent during 1955 and at the year end were the lowest since they have been recorded by the Bureau of Mines. Stocks of primary products at producers' plants decreased 8 percent during the year. Details of stocks are given in table 1.

[6] Danziger, Benjamin H., Catalysts: Ind. Eng. Chem., vol. 47, No. 8, August 1955, pp. 1495–1500.
[7] Williams, W. W., and Conley, J. W., Organic Pigments: Ind. Eng. Chem., vol. 47, No. 8, August 1955, pp. 1507–1510.
[8] Price, Donald, Metal Coatings: Ind. Eng. Chem., vol. 47, No. 8, August 1955, pp. 1511–1513.
[9] Kline, Charles H., Molybdenum and Lime in the Treatment of Acid Soils: Jour. Soil and Water Conservation, vol. 10, No. 2, March 1955, pp. 63–69, 75.

PRICES

Prices quoted for molybdenite concentrate and most primary products were increased about 5 percent on December 15. The beginning and year-end prices are given in table 3.

TABLE 3.—Prices of molybdenum in the United States in 1955

	Price per pound of contained molybdenum, f. o. b. shipping point	
	Jan. 1	Dec. 31
Molybdenite concentrate (MoS_2)	[1] $1.05	[1] $1.10
Ferromolybdenum 58-64 percent Mo:		
Powdered	1.57	1.66
All other sizes	1.46	1.54
Calcium molybdate ($CaOMoO_3$)	1.28	1.34
Technical molybdic oxide (MoO_3):		
Bagged	1.24	1.30
Canned	1.25	1.31
Metallic powder, 99 percent	3.00	3.00

[1] Plus cost of containers.

FOREIGN TRADE [10]

Exports of molybdenum concentrate (including molybdic oxide) recorded in pounds of contained molybdenum, reached a new high in 1955—about 8 percent over 1954. Increased steel production in Europe and the greater use of molybdenum in alloy steels by some producers are believed to be the reasons for the substantial increase in exports. Shipments to Austria, Canada, France, Italy, Sweden, and the United Kingdom increased, but shipments to Belgium-Luxembourg, West Germany, Japan, and the Netherlands decreased compared with 1954. Exports are given by countries in table 4. Details regarding raw-concentrate shipments and other molybdenum products, as reported to the Bureau of Mines, are given in table 5. Because of time lag between shipment from mine or plant and actual export, this information is not directly comparable to the data in table 4. Exports of specified molybdenum products are given in table 6.

Imports believed to have been wholly molybdenum concentrate were 134,395 pounds (contained molybdenum), exclusively from Canada.

Tariff.—The tariffs on molybdenum and its products were unchanged in 1955. The duty on ore and concentrate remained at 35 cents a pound of contained molybdenum. The duty on ferromolybdenum, molybdenum metal and powder, calcium molybdate, and other compounds and alloys of molybdenum was 25 cents a pound of contained molybdenum plus 7.5 percent ad valorem.

[10] Figures on United States imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 4.—Molybdenum ore [1] and concentrate (including roasted concentrate) exported from the United States, 1946–50 (average) and 1951–55, by countries of destination

[U. S. Department of Commerce]

Country	1946–50 (average)		1951		1952		1953		1954		1955	
	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value	Molybdenum content (pounds)	Value
North America:												
Canada	115,893	$90,835	294,687	$313,957	535,800	$609,414	404,626	$454,294	232,287	$248,305	529,359	$599,082
Canal Zone	93	92	700	712	450	352	590	881				
Cuba	388	163										
Mexico	1,143	699			12,622	13,082	3,119	3,050	2,716	3,096	1,000	1,250
Total	117,517	91,789	295,387	314,669	548,872	622,848	408,335	458,225	235,003	251,401	530,359	600,332
South America:												
Argentina	410	362										
Venezuela	160	147										
Total	570	509										
Europe:												
Austria	8,568	7,587	9,996	11,397	34,965	39,859	80,020	91,823	305,588	351,833	585,405	724,297
Belgium-Luxembourg					23,154	27,971	13,400	15,745	15,480	18,392	1,998	2,650
Czechoslovakia	4,364	3,084										
Denmark					3,000	3,900						
Finland			2,957	7,841	4,400	5,720						
France	869,382	690,921	420,161	397,125	1,735,176	1,958,951	1,368,112	1,386,909	2,306,383	2,321,539	2,368,726	2,470,469
Germany	300,784	255,601	761,731	786,750	[2] 1,986,670	[2] 2,121,494	[2] 1,028,275	[2] 1,087,912	[2,3] 3,725,351	[2,3] 3,872,874	[2,3] 3,621,486	[2,3] 3,953,999
Italy	112,781	88,656	135,712	147,408	192,994	225,967	7,056	8,700	145,860	164,835	157,324	174,445
Netherlands	17,857	17,849	41,524	50,000			4,410	5,027	710,945	774,619	217,900	327,442
Norway	12,000	11,284										
Spain					9,990	13,447						
Sweden	297,937	224,640	241,349	257,051	479,680	546,475	339,208	379,062	806,247	847,576	1,465,222	1,647,137
Switzerland					2,476	3,120	595	1,050				
Trieste									33,919	38,390		
United Kingdom	2,098,268	1,737,184	1,758,108	1,711,739	882,355	892,693	3,420,028	3,465,136	4,717,073	4,770,026	5,354,342	5,542,038
Total	3,721,941	3,036,806	3,371,538	3,369,311	5,354,860	5,839,597	6,261,104	6,441,364	12,766,846	13,160,084	13,772,403	14,842,477

Asia:												
Japan	8,135	6,839	62,340	51,476	199,035	250,192	366,547	406,368	540,661	572,701	277,196	339,171
Philippines											400	1,220
Taiwan							350	578				
Total	8,135	6,839	62,340	51,476	199,035	250,192	366,897	406,946	540,661	572,701	277,596	340,391
Africa: Federation of Rhodesia and Nyasaland									4,000	4,700		
Oceania:												
Australia					59,085	67,567	1,100	1,254				
New Zealand					10,080	11,491						
Total					69,165	79,058	1,100	1,254				
Grand total	3,848,163	3,135,943	3,729,265	3,735,456	6,171,932	6,791,695	7,037,436	7,307,789	13,546,510	13,988,886	14,580,358	15,783,200

[1] No molybdenum ore was believed exported.
[2] West Germany.

TABLE 5.—Molybdenum reported by producers as shipments for export from the United States, 1953–55, in thousand pounds of contained molybdenum

	1953	1954	1955
Concentrate (not roasted)	5,893	12,974	11,805
Roasted concentrate (oxide)	796	1,427	2,401
All other primary products	311	213	270
Total	7,000	14,614	14,476

TABLE 6.—Exports of specified molybdenum products, 1952–55, gross weight in pounds

[U. S. Department of Commerce]

	1952	1953	1954	1955
Ferromolybdenum [1]	1,090,104	646,411	247,763	349,193
Metal and alloys	172,285	21,826	34,358	22,564
Wire	14,605	15,980	10,563	11,482
Powder	4,096	17,290	15,423	21,173
Primary forms, mainly rods, sheets, and tubes	8,040	13,078	26,001	3,952

[1] Ferromolybdenum contains about 60–65 percent molybdenum.

TECHNOLOGY

Mining.—Molybdenum ores were mined in massive silicified replacement deposits and in relatively small vein-type deposits. In addition, a large part of the molybdenum produced was recovered as a byproduct from molybdenum-bearing copper and tungsten deposits. Mining methods included large-scale caving and cut-and-fill stoping. The zones of hydrothermal alteration in the Climax molybdenite deposit were described.[11] The deposit, roughly shaped like a horseshoe, is mined by large-scale caving. Problems in caving the ore were discussed:[12] Incomplete removal of pillars hindered caving of the ore; transfer of weight over large areas caused loss of production and high repair cost.

Milling and Production of Primary Products.—Flotation was universally employed in concentrating molybdenite. At plants where molybdenite was recovered as a byproduct from copper ores, differential flotation was used. Flotation of molybdenite at the Morenci concentrator by the use of ferrocyanide to maintain maximum depressing effects on copper and iron sulfide was described.[13]

Molybdenite concentrate is converted to molybdic oxide (MoO_3) by roasting in a gas-fired furnace. The oxide is the material for virtually all other molybdenum products. Ferromolybdenum was produced by electric furnace and exothermic processes.

Metal and Alloys.—Metallic molybdenum, produced by hydrogen reduction of purified molybdic oxide, was converted to ingot by sintering in a hydrogen atmosphere and by consumable-electrode arc melting in

[11] Vanderwilt, John W., and King, Robert U., Hydrothermal Alteration at the Climax Molybdenite Deposit: Min. Eng., vol. 7, No. 1, January 1955, pp. 41–53.
[12] Henderson, Robert, Comments on Caving at Climax: Min. Cong. Jour., vol. 41, No. 7, July 1955, pp. 45–48.
[13] Papin, J. E., Flotation of Molybdenite at the Morenci Concentrator: Min. Eng., vol. 7, No. 2, February 1955, pp. 145–147.

vacuum. Production, fabrication, properties, and applications were the subjects of several articles on arc-cast molybdenum.[14] Research by the Bureau of Mines on bomb reduction of molybdenum trioxide to massive metal by the use of calcium metal as a reductant was described.[15] A patent was issued for electrolytic production of molybdenum [16] and a survey of the literature on the electrodeposition of molybdenum published [17] concluded that with the exception of this process, no satisfactory deposit of molybdenum metal has been obtained. Investigation of initiation of discontinuous yielding in ductile molybdenum indicated that nitrogen may be more effective than carbon in strengthening grain boundaries.[18]

Research at Battelle Institute determined that stable oxides of certain metals dispersed in molybdenum produce compositions with greater creep strength than those of conventional molybdenum alloys.[19] In an investigation of the oxidation of molybdenum it was reported that the rates of formation of the different oxides on molybdenum in pure oxygen at 1 atm. were determined in the temperature range of 500° to 770° C.[20]

WORLD REVIEW

Canada.—The Molybdenite Corp. of Canada, Ltd., was the only producer of molybdenum in Canada in 1955. All production (the highest since 1944) was from the La Corne mine about 25 miles north of Val d'Or in western Quebec. The company increased mill capacity from 400 to 540 tons of ore a day. A plant for the conversion of molybdenite concentrate to molybdic oxide was being constructed and expected to be in operation by mid-1956.

Chile.—The recovery of molybdenite as a byproduct from copper ores at the Braden Copper Co. El Teniente mine near Sewell continued to make Chile the world's second largest producer of molybdenum. Production in 1955 was slightly higher than in the previous year. Exports of molybdenite concentrate from Chile are given by country of destination in table 8.

Japan.—Molybdenum was produced from several small mines in Japan in 1955. Production in 1955 was slightly lower than in 1954.

Mexico.—Cia Minera Bemnewilco, in the municipality of Nacozari Garcia, Sonora, was Mexico's only producer of molybdenum in 1955. Production during the year was about a third that of 1954.

---

[14] Deuble, Norman L., Large Molybdenum Ingots by Arc-Casting: Metal Progress, vol. 67, No. 4, April 1955, pp. 87–90. Arc-Cast Molybdenum Ingot to Bar, Sheet, or Wire: Metal Progress, vol. 67, No. 5, May 1955, pp. 89–92. Arc-Cast Molybdenum-Fabrication of Parts: Metal Progress, vol. 67, No. 6, June 1955, pp. 101–105. Properties of Arc-Cast Molybdenum: Metal Progress, vol. 68, No. 1, July 1955, pp. 105–110. Applications of Arc-Cast Molybdenum: Metal Progress, vol. 68, No. 2, August 1955, pp. 77–79.
Iron Age, Arc-Cast Molybdenum; Better High-Temperature Properties: Vol. 176, No. 5, pp. 79–81. How to Work Arc-Cast Molybdenum, vol. 176, No. 6, pp. 95–97.
Bruckart, W. L., and Hyler, W. S., A Study of the Room Temperature Fatigue Properties of Molybdenum: Jour. Metals, vol. 7, No. 2, February 1955, pp. 287–290.

[15] Gilbert, H. L. and Block, F. E., Bomb Reduction of Molybdenum Trioxide by Calcium Metal: Jour. Electrochem. Soc., vol. 102, No. 7, July 1955, pp. 394–398.

[16] Senderoff, Seymour, and Brenner, Abner (assigned to United States of America), Electrolytic Production of Molybdenum Powder and Coherent Deposits: U. S. Patent, 2,715,093, Aug. 9, 1955.

[17] Campbell, T. T., and Jones, A., A Survey on the Literature of the Electrodeposition of Molybdenum Bureau of Mines Inf. Circ. 7723, July 1955, p. 6.

[18] Steel, Molybdenum: Vol. 137, No. 15, October 1955, p. 231.

[19] Metal Industry, Increasing Creep Strength of Molybdenum: Vol. 87, No. 25, December 1955, p. 509.

[20] Simnad, M., and Spilners, Aija, Kinetics and Mechanism of the Oxidation of Molybdenum: Jour. Metals, vol. 7, No. 9, September 1955, pp. 1011–1016.

TABLE 7.—World production of molybdenum in ores and concentrates by countries,[1] 1946–50 (average) and 1951–55, in thousand pounds [2]

(Compiled by Pearl J. Thompson)

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
Australia	7	2	(3)	2	2	2
Austria	22	42	40	----	----	(4)
Canada	220	229	304	194	452	774
Chile	1,343	3,803	3,624	3,031	2,663	2,817
Finland	75	----	----	----	----	----
French Morocco	31	----	----	----	----	----
Hong Kong	----	(3)	(3)	2	(3)	(3)
Japan	37	119	196	397	450	439
Korea, Republic of	9	11	15	20	22	24
Mexico	421	----	----	(3)	159	55
Norway	143	276	282	317	335	379
Peru	4	7	7	11	2	2
Sweden	4	----	----	----	----	----
United States	24,596	38,855	43,259	57,243	58,668	61,781
Yugoslavia	216	679	1,453	1,920	441	(4)
World total (estimate) [1]	28,300	44,700	49,800	63,800	63,900	67,200

[1] Molybdenum also has been produced in China, North Korea, Rumania, Spain, 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 molybdenum chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[3] Less than 500 pounds.
[4] Data not yet available; estimate by author of chapter included in total.

TABLE 8.—Exports of molybdenite concentrate [1] from Chile, 1951–55, by countries of destination, in thousand pounds [2]

(Compiled by Corra A. Barry)

Country	1951	1952	1953	1954	1955
France	1,598	1,339	462	368	458
Germany	790	----	771	392	400
Italy	----	66	----	----	----
Netherlands	----	----	676	438	516
Sweden	310	295	147	156	330
United Kingdom	4,851	5,800	3,581	3,192	3,964
United States	1,543	----	----	----	----
Total	9,092	7,500	5,637	4,546	5,668

[1] Dry concentrate containing approximately 96 percent MoS_2 with 58 percent contained molybdenum.
[2] Compiled from Customs Returns of Chile.

Norway.—Virtually all molybdenum in Norway in 1955 was derived from the Knaben mine near Egersund on the southwestern coast. The small Kvina mine, which resumed production in 1952 after having been closed for a number of years, stopped production in the summer of 1955.

Natural and Manufactured Iron Oxide Pigments

By Milford L. Skow[1] and Eleanor V. Blankenbaker[2]

DEMAND for finished pigments of natural and manufactured (synthetic) iron oxides was the highest since mineral blacks were excluded from the classification in 1951. The high level of activity in the construction industry, increased the need for pigments in paint and cement, and operation of the automobile industry at peak capacity, was an important factor in the demand. The development of latex paints to their present position in the industry is an important factor in the demand for iron oxide pigments, with their alkali-resistant characteristics.

DOMESTIC PRODUCTION

Crude Materials.—The quantity of crude iron oxide pigment materials sold in 1955 was 29 percent higher than in 1954, whereas the value was only 11 percent higher. A total of 11 producers in 8 States mined 56,000 short tons of the crude material and sold 52,700 short tons with a value of $413,400. These materials were mined by crude-pigment producers (23,400 short tons) and also by iron-ore producers as a byproduct (32,600 short tons).

Finished Pigments.—Total sales of finished pigments were 18 percent greater in quantity and 25 percent greater in value than in 1954.

Natural pigments, with the same share of the market as in 1954, constituted 36 percent of the quantity and 19 percent of the value of total finished iron oxide pigments sold in 1955. Natural red pigments composed 44 percent of the natural iron oxide pigments; natural browns, 29 percent; and natural yellows, 17 percent.

The tonnage of manufactured iron oxide pigments sold in 1955 increased 17 percent and the value 25 percent over comparable figures for 1954. Of the manufactured pigments, reds and yellows predominated, with 76 and 19 percent, respectively.

A total of 17 companies reported sales of finished natural and manufactured iron oxide pigments in 1955. Production was reported from nine States, with Pennsylvania supplying a larger proportion of the tonnage than any other State.

[1] Commodity specialist.
[2] Literature research clerk.

TABLE 1.—Crude iron oxide pigment materials produced and sold or used by processors in the United States, 1954–55, by kinds

Pigment	1954			1955		
	Quantity mined (short tons)	Quantity sold (short tons)	Value	Quantity mined (short tons)	Quantity sold (short tons)	Value
Black iron oxide:						
Magnetite						
Brown iron oxide:						
Metallic brown	956	956	$4,720	30	30	$240
Sienna				6,015	5,331	67,478
Umber	508	458	9,773	501	471	9,145
Vandyke brown				119	119	714
Red iron oxide	[1] 27,366	[1] 23,225	[1] 230,036	36,129	33,363	267,988
Yellow iron oxide:						
Natural yellow iron oxide	2,378	1,958	17,276	2,425	2,631	13,155
Ocher	[1] 8,601	[1] 8,601	[1] 32,949	9,522	9,516	42,476
Sienna	891	723	35,412			
Sulfur mud	694	694	6,492	400	400	6,000
Other	4,303	4,303	34,891	877	877	6,224
Total	[1] 45,697	[1] 40,918	[1] 371,549	56,018	52,738	413,420

[1] Revised figure.

TABLE 2.—Crude iron oxide pigment materials mined and sold or used in the United States, 1955, by sources

Source	Quantity mined (short tons)	Quantity sold or used (short tons)	Value
Iron oxide pigment mines	23,376	20,096	$169,857
Iron ore mines	32,642	32,642	243,563
Total	56,018	52,738	413,420

TABLE 3.—Crude iron oxide pigment materials mined and sold or used in the United States, 1955, by States

State	Number of producers	Quantity mined (short tons)	Quantity sold or used (short tons)	Value
Georgia	1	6,139	6,139	$35,607
Missouri	1	275	275	9,000
Pennsylvania	2	519	519	6,714
New York, Michigan	4	36,732	33,966	265,099
Colorado, Minnesota, Virginia	3	12,353	11,839	97,000
Total	11	56,018	52,738	413,420

TABLE 4.—Finished iron oxide pigments sold by processors in the United States, 1946–50 (average) and 1951–55 [1]

Year	Short tons	Value	Year	Short tons	Value
1946–50 (average)	115,072	$11,492,971	1953	108,350	$14,246,726
1951	126,432	14,987,075	1954	97,951	13,977,538
1952	105,242	13,267,766	1955	115,302	17,471,681

[1] For 1946–51, includes mineral blacks.

TABLE 5.—Finished iron oxide pigments sold by processors in the United States, 1954–55, by kinds

Pigment	1954		1955	
	Short tons	Value	Short tons	Value
Blacks:				
Magnetite	16	$954	596	$19,009
Manufactured magnetic black (pure)	2,198	533,979	2,149	567,869
Browns:				
Natural brown iron oxide (metallic)	6,234	494,743	8,365	739,891
Manufactured brown iron oxide (pure)	1,204	340,549	1,487	435,451
Sap brown	39	6,570	38	6,073
Umbers:				
Burnt	2,721	366,623	2,819	400,139
Raw	587	72,030	622	80,706
Vandyke brown	122	24,772	145	35,015
Reds:				
Natural red iron oxide	13,230	645,832	16,693	915,087
Sienna, burnt	818	173,339	1,120	228,500
Manufactured red iron oxide:				
Pure red iron oxides:				
Calcined copperas	15,720	3,979,417	19,839	5,088,295
Other chemical processes	5,445	1,396,977	5,849	1,512,579
Mixtures of natural and pure red iron oxides	6,699	828,963	6,143	832,739
Other manufactured red iron oxides	16,498	1,468,786	20,659	2,179,013
Venetian red	4,094	449,955	3,701	417,306
Pyrite cinder	299	26,001	357	32,825
Yellows:				
Natural yellow iron oxide	84	11,592	119	16,007
Ocher	5,909	210,404	6,034	199,234
Manufactured yellow iron oxide (pure)	11,175	2,380,785	13,917	3,142,460
Sienna, raw	873	156,895	976	174,824
Other	3,986	408,372	3,674	448,659
Total	97,951	13,977,538	115,302	17,471,681

TABLE 6.—Sales of finished iron oxide pigments in the United States, 1955, by States

State	Number of producers	Quantity sold (short tons)	Value
Georgia	1	1,994	$61,006
Illinois, Ohio, Pennsylvania	6	72,364	10,548,444
Maryland, Virginia	3	17,157	1,648,131
New Jersey, New York	4	4,414	340,293
Other [1]	3	19,373	4,873,807
Total	17	115,302	17,471,681

[1] Includes California and a quantity unspecified by State.

PRICES

Prices for most of the iron oxide pigments were higher than in 1954, principally because of increased costs of production and transportation. Market quotations for most of these pigments were about one-half cent per pound higher, but the increase for umbers was 1 cent per pound and for metallic brown was 1½ cents.

TABLE 7.—Prices of finished iron oxide pigments in 1955 [1]

Blacks:	
Mineral blacks.........short ton..	$31.00
Black oxide of iron.........pound..	.13½
Browns:	
Brown, metallic.........short ton..	90.00
Precipitated brown oxide.........pound..	.14¼
Spanish browns:	
High grade.........short ton..	(2)
Low grade.........do....	(2)
Umber, Turkey, burnt, powdered.........do....	140.00
Umber, American.........pound..	.06½
Vandyke brown.........do....	.09¾
Reds:	
Indian red, American common.........do....	.09
Indian red, American pure.........do....	.12¾
Indian red, English.........do....	(2)
Iron oxide, casks:	
Domestic, natural.........do....	.04
Persian Gulf.........do....	.06¾
Spanish.........do....	.05¾
Sienna, American, burnt and powdered, in bags.........short ton..	115.00
Sienna, Italian, burnt and powdered, in barrels.........do....	240.00
Venetian red.........pound..	.03½
Yellows:	
Hydrate iron oxide.........do....	(2)
Iron oxide, yellow.........do....	.11
Ocher, domestic.........do....	.01¾
Ocher, French.........do....	.05½
Sienna, American, raw, powdered, in barrels.........short ton..	115.00
Sienna, Italian, raw, powdered, in barrels.........do....	255.00

[1] Quotations from Paint, Oil and Chem. Rev., vol. 118, No. 25, Dec. 15, 1955, p. 48.
[2] Not quoted.

FOREIGN TRADE [3]

Total imports of iron oxide pigments into the United States increased 30 percent in quantity and 41 percent in value compared with 1954 as gains were registered for every category. Imports were 28 percent greater in quantity and 41 percent in value for manufactured pigments and 32 percent in quantity and 42 percent in value for nat-

TABLE 8.—Selected iron oxide pigments imported for consumption in the United States, 1952–55

[U. S. Department of Commerce]

Pigments	1952		1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Natural:								
Ocher, crude and refined	798	$46,777	177	$9,122	154	$8,666	218	$15,362
Siennas, crude and refined	566	49,702	700	59,747	338	34,848	840	[1] 80,041
Umber, crude and refined	1,603	44,435	2,725	78,310	2,598	74,276	2,654	79,446
Vandyke brown	119	6,685	164	8,958	89	5,194	151	9,206
Other [2]	2,388	118,914	2,716	123,432	2,546	120,600	3,702	161,488
Total	5,474	266,513	6,482	279,569	5,725	243,584	7,565	345,543
Manufactured (synthetic)	3,317	432,451	4,531	522,618	4,997	602,847	6,394	[1] 850,095
Grand total	8,791	698,964	11,013	802,187	10,722	846,431	13,959	[1] 1,195,638

[1] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to prior years.
[2] Classified by the U. S. Department of Commerce as: "Natural iron-oxide and iron-hydroxide pigments, n. s. p. f."

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

ural pigments. Natural varieties accounted for 54 percent of the total quantity and 29 percent of the total value of iron oxide pigments imported.

TABLE 9.—Iron oxide pigments exported from the United States, 1952–55, by countries of destination

[U. S. Department of Commerce]

Country	1952		1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:								
Canada	2,545	$288,382	2,886	$351,393	2,208	$265,266	3,149	$404,717
Cuba	297	59,502	293	69,652	197	48,578	205	53,252
Dominican Republic	33	9,693	35	11,529	22	5,122	35	9,480
Guatemala	23	5,877	42	13,515	33	8,162	20	6,931
Haiti	45	5,049	23	4,615	9	3,260	38	4,930
Honduras	20	4,559	2	527			4	1,400
Mexico	90	31,787	181	47,474	128	61,525	64	27,300
Netherlands Antilles	10	3,657	3	990	10	2,720	14	5,195
Panama	11	2,900	7	1,686	37	5,193	1	390
Other North America	32	10,825	38	12,350	22	8,320	35	11,675
Total	3,106	422,231	3,510	513,731	2,666	408,146	3,565	525,270
South America:								
Argentina	46	20,250					20	7,682
Bolivia	1	187	2	526	4	1,060	36	16,763
Brazil	41	11,786	3	912	78	21,116	30	8,045
Chile	18	4,950	45	8,750	8	3,290	22	12,764
Colombia	93	31,728	94	31,450	176	76,478	198	62,120
Peru	10	2,954	32	9,507	15	5,196	95	21,470
Uruguay	6	1,602			1	528	4	9,365
Venezuela	133	33,842	137	35,489	210	38,943	105	38,044
Other South America	3	1,167	27	5,328	5	1,717	3	795
Total	351	108,466	340	91,962	497	148,328	513	177,048
Europe:								
Belgium-Luxembourg	8	2,912	15	4,504	40	11,824	22	18,300
France	9	12,179	47	13,864	5	9,212	61	12,974
Greece	2	652			3	695		
Iceland					7	7,347		
Italy	6	14,942	13	6,520	14	11,007	7	9,785
Netherlands	135	5,292	75	3,006	104	5,918	175	18,675
Norway	1	141					30	1,932
Portugal	5	1,356	7	1,740	11	3,068	11	3,075
Sweden	6	1,578	10	2,230	7	1,902	3	796
Switzerland	14	3,934	4	3,746	45	9,948	12	5,636
Turkey							33	8,041
United Kingdom	3	720	1	252			2	1,130
Other Europe	1	302	(1)	112	1	564	8	5,058
Total	190	44,008	172	35,974	237	61,485	364	85,402
Asia:								
Hong Kong	(1)	136	3	720			5	1,000
Indonesia	31	9,284					10	3,061
Israel and Palestine	4	895	(1)	106	[2] 2	[2] 1,400		
Japan	24	8,108	14	4,327	13	7,074	25	7,408
Philippines	47	10,321	27	8,219	69	33,656	119	34,955
Other Asia	18	4,878	6	4,762	16	5,022	26	5,330
Total	124	33,622	50	18,134	100	47,152	185	51,754
Africa:								
Belgian Congo	2	460	6	2,569			1	1,200
Union of South Africa	87	23,690	94	25,726	51	16,100	101	36,472
Other Africa	8	950			1	576	7	2,925
Total	97	25,100	100	28,295	52	16,676	109	40,597
Oceania	2	340	1	235	2	542	8	13,785
Grand total	3,870	633,767	4,173	688,331	3,554	682,329	4,744	893,856

[1] Less than 1 ton.
[2] Israel.

That portion of the iron oxide pigments designated "natural iron-oxide and iron-hydroxide pigments" by the United States Department of Commerce constituted 49 percent of the imports of all natural varieties and came from Spain (88 percent), United Kingdom (7 percent), France (3 percent), Canada, French Morocco, Union of South Africa, and West Germany. Italy furnished all the crude ocher and 11 percent of the refined ocher, the remaining 89 percent of which came from the Union of South Africa. Crude siennas were imported from Italy (60 percent) and Malta, Gozo, Cyprus (40 percent), and refined siennas came from Italy (74 percent), Malta, Gozo, and Cyprus (21 percent), and West Germany (5 percent). Of the imports of umber, Malta, Gozo, and Cyprus furnished all the crude and 92 percent of the refined with the United Kingdom furnishing the remainder of the refined (8 percent). Vandyke brown was imported from West Germany exclusively.

Imports of manufactured (synthetic) iron oxide pigments came from West Germany (65 percent), Canada (25 percent), United Kingdom (8 percent), and the Netherlands (2 percent).

The tonnage of iron oxide pigments exported—the highest since 1950—was 33 percent greater, with a value 31 percent higher than in 1954. The largest quantity went to Canada, which received 66 percent of the total.

TECHNOLOGY

A patent was granted for a process to form yellow and red iron oxide pigments selectively by oxidizing an aqueous solution of ferrous carbonate under closely controlled conditions. Both pigments are thermally stable and are used to tint transparent lacquers.[4] Also patented were processes for making a red iron oxide suitable for pigments by sulfatizing and calcining black iron oxide made from waste pickle liquor [5] and for precipitating an improved pigment of soft texture from aqueous ferrous sulfate or chloride.[6]

The effect of process variables on the properties of a red pigment prepared from copperas was discussed in an article.[7]

In June the American Society for Testing Materials accepted for use, pending adoption, a tentative practice for reporting particle size of pigments.[8]

WORLD REVIEW

Argentina.—The total production of red and yellow iron oxides in 1954 was reported to be 4,400 short tons.[9] Data for 1955 were not available.

Cyprus.—In 1954 exports of umber, mostly to the United States and the United Kingdom, totaled 5,598 short tons valued at $92,683 (£36,452), compared with 5,487 short tons valued at $88,037

[4] Marcot, G. C. (assigned to American Cyanamid Co.), Iron Oxide Pigments: U. S. Patent 2,696,426, Dec. 7, 1954.

[5] Swaney, W. A. (assigned to United States Steel Corp.), Converting Black Iron Oxide to Red Iron Oxide: U. S. Patent 2,705,188, Mar. 29, 1955.

[6] Marsh, B. J. (assigned to C. K. Williams & Co.), Red Hydrous Ferric Oxide: U. S. Patent 2,716,595, Aug. 30, 1955.

[7] Uspenskaya, I. L. N., Bergman, A. G., and Rudin, V. Y., [The Effect of Thermal Conditions on the Shade and Color of Red Iron Oxide Obtained From Copperas]: Jour. Appl. Chem. (USSR), vol. 28, 1955, pp. 1006–1009; Chem. Abs., vol. 50, No. 8, Apr. 25, 1956, p. 6067c.

[8] American Society for Testing Materials, Tentative Recommended Practice for Reporting Particle-Size Characteristics of Pigments: D 1366–55T, June 1955, 5 pp.

[9] State Department Dispatch 1103, Buenos Aires, Argentina, May 31, 1955, p. 15.

(£31,330) in 1953. In 1954 Umber Corp. of Larnaca mined 4,377 short tons of umber and exported 5,366 short tons, 489 short tons of red and yellow ochers, and 3.4 short tons of terre verte. Limassol Chemical Products Co., Ltd., produced no umber during 1954 but exported 232 short tons (207 long tons).[10] Figures were not available for 1955.

Egypt.—According to latest available information, 132 short tons of ocher was produced in 1954. Production of other iron oxide pigments was 125 short tons in 1954 and 3,109 short tons in 1955.[11]

France.—Production of ocher in 1955 was 14,850 short tons with a value at the mine of $462,857 (162 million francs).[12]

French Morocco.—Ocher concentrate is a byproduct of the hematite mine of Compagnie Minière et Métallurgique, at Kettara. Production declined slightly during the last three years but probably will remain above 2,200 short tons annually.[13]

Germany, West.—A total of 67,079 short tons valued at $10,118,000 (36,134,000 Deutschemark) was produced in 1955.[14]

India.—Ocher production in 1954, the latest year for which figures were available, totaled 84,567 short tons valued at $114,899 (547,139 rupees), according to the Geological Survey of India.[15]

In 1955 the Geological Survey of India reported the discovery of red oxide iron deposits about 1 mile south of Haragonadona in Bellary Taluk and 2 miles northwest of Malapannanagudi in Hospet Taluk. Reserves were estimated at over 224,000 short tons, and the Survey recommended establishing a paint-manufacturing plant in the Bellary district.[16]

Italy.—Output of umber and sienna totaled 6,350 short tons in 1954.[17]

Pakistan.—Ocher production in 1955 was 292 short tons valued at $1,096 (5,220 rupees).[18] Late in 1955, the Government imposed a 1-year ban on the granting of new mining concessions for ochers. The ban was imposed to enable the Pakistan Industrial Development Corp., Karachi, which has been entrusted with the task of setting up an iron and steel industry in Pakistan, to prospect the iron-ore-bearing areas.[19]

Union of South Africa.—Production of iron oxide pigments for 1953 and 1954, the most recent years reported, follows: [20]

Pigment	Production, short tons	
	1953	1954
Ochers	5,365	6,898
Umbers	820	1,103
Other iron oxides	1,506	1,325
Total	7,691	9,326

[10] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, pp. 40–41.
[11] State Department Dispatch 956, Cairo, Egypt, Mar. 13, 1956.
[12] State Department Dispatch 2478, Paris, France, June 22, 1956, enclosure 1, p. 2.
[13] State Department Dispatch 21, Casablanca, French Morocco, Aug. 1, 1955, p. 19.
[14] State Department Dispatch 2489, Bonn, Germany, June 11, 1956.
[15] State Department Dispatch 403, New Delhi, India, Nov. 25, 1955.
[16] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 1, January 1956, p. 27.
[17] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 4, October 1955, p. 40.
[18] State Department Dispatch 203, Karachi, Pakistan, Sept. 25, 1956, p. 2.
[19] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 1, January 1956, p. 27.
[20] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, pp. 38–39.

Nickel

By Hubert W. Davis [1]

THE SUPPLY of nickel was again insufficient to satisfy both civilian and stockpile needs in 1955, despite a 13-percent increase in world production. Diversion to industry was made of 24 million pounds from scheduled shipments to the National Stockpile.

World production (exclusive of U. S. S. R.) of nickel advanced for the fifth consecutive year to establish a new high of 216,000 short tons in 1955, a 13-percent gain over 1954. Of this output, Canada furnished 81 percent, producing at a rate 8 percent greater than in 1954. Outputs in New Caledonia and Cuba were greater by 50 and 4 percent, respectively. Although domestic production of recoverable nickel increased from 831 tons in 1954 to 3,800 tons in 1955, it was equivalent to only 3.5 percent of consumption. World production of nickel was expected to continue its uptrend in 1956.

Consumption of nickel in the United States in 1955 rose to 109,300 short tons, a 15-percent increase over 1954 and the largest since 1944. The steel industry continued to be the chief consumer; 41 percent of all nickel used in 1955 was in stainless and engineering alloy steels.

Imports of nickel into the United States increased for the sixth consecutive year to establish a new record of 142,600 short tons in 1955, an 8-percent increase over 1954. Canada and Norway supplied 89 percent of the 1955 total; the nickel imported from Norway was produced from Canadian ore.

Prices of electrolytic nickel, nickel oxide powder, and nickel oxide sinter remained unchanged throughout 1955.

TABLE 1.—Salient statistics for nickel, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
United States:						
Production:						
Primary:						
Byproduct of copper refining short tons	717	756	633	591	639	451
Metal from domestic ore refined short tons				11	192	3,356
Secondary do	8,223	8,602	7,479	8,352	8,605	11,540
Imports (gross weight)[1] do	[2] 98,225	101,620	118,372	131,169	143,662	151,388
Exports (gross weight)[3] do	7,263	4,622	6,941	15,168	14,245	20,601
Consumption do	84,809	86,683	101,397	105,681	94,733	109,304
Price per pound [4] cents	31½–50½	50½–56½	56½	56½–60	60–64½	64½
Canada:						
Production short tons	119,756	137,903	140,559	143,693	[5] 161,279	174,581
Exports do	121,489	130,239	142,022	143,818	[5] 158,719	173,880
World production (excludes U. S. S. R.) short tons	128,000	145,000	162,000	174,000	192,000	216,000

[1] Comprises refined metal, matte, oxide powder, and oxide sinter.
[2] Figures for 1946–47 include scrap.
[3] Excludes "Manufactures" for 1946–52, weight not recorded.
[4] 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 1945–47, and 1¼ cents, 1948–55.
[5] Revised figure.

[1] Commodity specialist.

457676—58——54

PRODUCTION

Domestic production of nickel (other than from imported matte and oxide) continued to be small; it comprised chiefly metal recovered from scrap (nickel anodes and nickel-silver and copper-nickel alloys, including Monel metal), primary nickel recovered from copper refining, and nickel contained in ore produced at Riddle, Oreg., Fredericktown, Mo., and Cobalt, Idaho.

In 1955 the Hanna Nickel Smelting Co. placed two furnaces in commercial operation to smelt ore from the deposit near Riddle, Oreg. During 1955, 284,415 dry short tons of ore averaging 1.47 percent nickel was moved over the 1½-mile tramway from the top of the mountain to the storage yard at the plant, and 7,609 tons of ferronickel averaging 42.5 percent nickel was produced. Two additional furnaces and related equipment will be completed in March 1956. Ultimate annual capacity of the plant will be about 8,000 short tons of nickel contained in ferronickel. The new refinery of National Lead Co. at Fredericktown, Mo., treated a pyrite concentrate containing 5.4 percent nickel, and some nickel metal was produced. In Idaho nickel was recovered as a byproduct of the cobalt ore at the Blackbird mine in Lemhi County. More detailed information on domestic production is contained in Minerals Yearbook, volume III.

Substantial quantities of nickel-bearing ferrous scrap are recovered and used chiefly in the production of engineering alloy steels and stainless steels, but no figures on the quantity are available.

A total of 902,000 pounds of nickel, in the form of both crude (434,000 pounds) and refined (468,000 pounds) nickel sulfate, was recovered in 1955 as a byproduct of copper refining at Baltimore, Md.; Carteret and Perth Amboy, N. J.; Laurel Hill, N. Y.; and Tacoma, Wash. Shipments were 881,000 pounds (nickel content), of which 452,000 pounds was crude nickel sulfate sold to refiners for use as an intermediate in the manufacture of refined nickel sulfate and other nickel salts. Although all of the nickel recovered as a byproduct of copper refining is credited to domestic production, some is actually recovered from imported raw materials, largely blister copper.

TABLE 2.—Nickel produced in the United States, 1946–50 (average) and 1951–55

	Primary (nickel content, in short tons)[1]		Secondary	
	Byproduct of copper refining	Ore	Nickel content, in short tons	Value
1946–50 (average)	717		8, 223	$6, 648, 503
1951	756		8, 602	9, 759, 829
1952	633		7, 479	8, 799, 791
1953	591	11	8, 352	10, 399, 910
1954	639	2, 006	8, 605	10, 821. 648
1955	451	4, 411	11, 540	15, 445, 000

[1] Value withheld to avoid disclosing individual company operations.

In addition to the refined nickel sulfate (468,000 pounds) recovered as a byproduct of copper refining in 1955, 4,125,000 pounds (nickel content) of refined nickel salts (chiefly sulfate) was produced in the

United States from crude nickel sulfate and from refined nickel, nickel oxide, and nickel scrap. Thus, total production of refined nickel salts in the United States was 4,593,000 pounds (nickel content) in 1955; shipments to consumers for electroplating, catalysts, and ceramics were 4,575,000 pounds.

A preliminary report on the copper-nickel mineralization in the gabbro-granite contact zone in the Superior National Forest, Lake County, Minn., was published.[2] The work by the Bureau of Mines substantiated the presence of copper-nickel sulfides over a considerable area and indicated that they extend at least 500 feet down dip from the gabbro-granite contact outcrop. Mineral-dressing studies indicated that the sulfides are amenable to concentration and satisfactory recoveries can be expected by standard milling methods. Nickel recoveries would be lower than copper, owing to the presence of nickel in the lattice of olivine gangue molecule.

CONSUMPTION AND CONSUMERS' STOCKS

The total consumption of nickel in 1955 was 15 percent more than in 1954. Of the 1955 total consumption, 41 percent was utilized in stainless and engineering alloy steels. The usage of nickel in stainless and engineering alloy steels was 30 and 33 percent, respectively, greater than in 1954.

Consumption of nickel in cast irons, high-temperature and electrical-resistance alloys, catalysts, electroplating, ceramics, and magnets was larger by 32, 31, 13, 8, 37, and 30 percent, respectively; but usage for nonferrous alloys was 6 percent smaller.

As heretofore, most nickel consumed in 1955 was in the form of metal, but the proportion of oxide powder and oxide sinter used was slightly larger than in 1954.

TABLE 3.—Nickel (exclusive of scrap) consumed and in stock in the United States, 1954–55, by forms, in short tons of nickel

Form	1954			1955		
	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]	67,241	8,477	151	82,561	6,801	113
Oxide powder and oxide sinter	16,191	1,372	25	18,785	1,447	165
Matte	9,710	255		6,219	181	
Salts [2]	1,591	490	4	1,739	469	
Total	94,733	10,594	180	109,304	8,898	278

[1] Includes a relatively small but undetermined quantity of secondary nickel (ingot or shot remelted from scrap nickel and scrap-nickel alloys).
[2] Figures for consumption estimated to represent about 80 percent of total.

[2] Grosh, W. A., Pennington, J. W., Wasson, P. A., and Cooke, S. R. B., Investigation of Copper-Nickel Mineralization in Kawishiwi River Area, Lake County Minn.: Bureau of Mines Rept. of Investigations 5177, 1955, 18 pp.

TABLE 4.—Nickel (exclusive of scrap) consumed in the United States, 1951–55, by forms, in short tons of nickel

Form	1951	1952	1953	1954	1955
Metal	68,001	75,007	73,773	67,241	82,561
Oxide powder and oxide sinter	8,798	15,472	19,997	16,191	18,785
Matte	8,741	9,766	10,470	9,710	6,219
Salts [1]	1,143	1,152	1,441	1,591	1,739
Total	86,683	101,397	105,681	94,733	109,304

[1] Figures estimated to represent about 80 percent of total.

TABLE 5.—Nickel (exclusive of scrap) consumed in the United States, 1951–55, by uses, in short tons of nickel

Use	1951	1952	1953	1954	1955
Ferrous:					
Stainless	21,792	27,343	22,274	20,399	26,520
Other steels	16,425	17,978	18,959	13,637	18,181
Cast iron	3,716	3,639	4,214	4,115	5,431
Nonferrous [1]	26,952	[2] 33,736	[2] 33,657	[2] 31,197	29,361
High-temperature and electrical resistance alloys	7,408	8,020	8,221	6,597	8,669
Electroplating:					
Anodes [3]	5,410	6,139	13,274	13,460	14,627
Solutions [4]	455	484	972	1,323	1,357
Catalysts	1,384	1,460	1,435	1,344	1,525
Ceramics	249	199	251	304	417
Magnets	646	595	798	681	882
Other	2,246	[2] 1,804	[2] 1,626	[2] 1,676	2,334
Total	86,683	101,397	105,681	94,733	109,304

[1] Comprises copper-nickel alloys, nickel-silver, brass, bronze, beryllium alloys, magnesium and aluminum alloys, Monel, Inconel, and malleable nickel.
[2] Revised figure.
[3] Figures represent quantity of nickel put into process for producing rolled anode bars, plus nickel used in casting anodes and nickel cathodes used as anodes in plating operations. Therefore, figures do not represent quantity of nickel anodes consumed by platers.
[4] Figures estimated to represent about 70 percent of total.

SUBSTITUTES

The continuing shortage of nickel led to further efforts to develop stainless steels containing less nickel and to search for substitute materials. In this connection, the increasing use of chromium-manganese-nickel (1 to 5 percent nickel) stainless steels as substitutes for versatile 18–8 (18 percent chromium—8 percent nickel) stainless steels resulted in a substantial saving in nickel.

To compensate for the shortage of nickel, platers continued to test various materials, such as bright copper plate as a major part of the total thickness followed by a thin nickel coating, chrome-plated copper, and bright white brass. Thus far, however, no satisfactory alternate coating in commercial use has been found as satisfactory as a heavy deposit of nickel.[3]

PRICES

Throughout 1955 the contract price to United States buyers for electrolytic nickel in carlots f. o. b. Port Colborne, Ont., was 64½ cents a pound, including duty of 1¼ cents. For nickel oxide sinter (no duty) the price remained at 60¾ cents a pound (nickel content)

[3] Iron Age, vol. 175, No .1, Jan .6, 1955, p. 196

f. o. b. Copper Cliff, Ont. These prices have been in effect since November 24, 1954. Cuban nickel oxide powder and nickel oxide sinter were priced at 59½ and 60¾ cents a pound (nickel content) in bags f. o. b. Philadelphia, Pa., in 1955.

FOREIGN TRADE [4]

The quantity of new nickel imported into the United States advanced for the sixth consecutive year, was 8 percent more than in 1954, and was the largest of record. Imports were comprised chiefly of metal, oxide powder, oxide sinter, and roasted and sintered matte. As heretofore, Canada was the chief source of imports. The roasted and sintered matte was refined to Monel metal and other products at the plant of International Nickel Co., Inc., Huntington, W. Va. Some Cuban nickel oxide sinter was converted to metal at Huntington.

TABLE 6.—New nickel products imported for consumption in the United States, 1954–55, by countries, gross weight in short tons

[U. S. Department of Commerce]

Country	Metal		Ore and matte		Oxide powder and oxide sinter		Nickel residues [1]	
	1954	1955	1954	1955	1954	1955	1954	1955
North America:								
Canada	85,478	96,733	14,135	9,088	14,255	16,213	211	89
Cuba					18,009	16,683		
Total	85,478	96,733	14,135	9,088	32,264	32,896	211	89
Europe:								
France	674	948						
Germany, West	94	180			(2)			
Netherlands		44						
Norway	10,914	11,311						
United Kingdom	42	128						
Total	11,724	12,611						
Asia: Japan [3]	61	60						
Grand total	97,263	109,404	14,135	9,088	32,264	32,896	211	89

[1] Reported to Bureau of Mines by importers.
[2] 30 pounds.
[3] Excludes Nansei and Nanpo Islands, n. e. c.

The nickel content of refined nickel, oxide powder, oxide sinter, matte, and residues imported into the United States was estimated at 142,600 short tons in 1955 compared with 131,800 tons in 1954.

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 powder, oxide sinter, and matte entered the United States duty free.

Exports of nickel were principally products manufactured from imported raw materials. Nickel and nickel-alloy metals in ingots, bars, rods, and other crude forms and scrap and nickel and nickel-alloy metal sheets, plates, and strips comprised the bulk of the foreign shipments. Canada (4,093 short tons), United Kingdom (2,931 tons),

[4] Figures on U. S. imports and exports (unless otherwise indicated) compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

Netherlands (1,542 tons), and West Germany (10,277 tons) were the chief foreign markets in 1955.

TABLE 7.—Nickel products (excluding residues) imported for consumption in the United States, 1953–55, by classes

[U. S. Department of Commerce]

Class	1953		1954		1955	
	Short tons (gross weight)	Value	Short tons (gross weight)	Value	Short tons (gross weight)	Value
Nickel ore and matte	14,605	$5,794,264	14,135	$5,357,824	9,088	$3,264,015
Nickel pigs, ingots, shot, cathodes, etc.[1]	84,714	102,461,751	97,263	124,178,843	109,404	148,925,269
Nickel scrap [1]	865	288,518	444	275,587	435	596,913
Nickel oxide powder and oxide sinter	31,850	26,286,337	32,264	25,234,419	32,896	30,124,298
Total	--------	134,830,870	--------	155,046,673	--------	182,910,495

[1] Separation of metal from scrap is on basis of unpublished tabulations.

TABLE 8.—New nickel products imported for consumption in the United States, 1946–50 (average) and 1951–55, in short tons [1]

[U. S. Department of Commerce]

Year	Gross weight				Total	
	Metal	Ore and matte	Oxide powder and oxide sinter	Residues [2]	Gross weight	Nickel content (estimated)
1946–50 (average)	[3] 68,334	13,960	15,931	(4)	[5] 98,225	[6] 90,336
1951	76,805	12,829	11,986	282	101,902	93,190
1952	79,538	14,430	24,404	674	119,046	108,850
1953	84,714	14,605	31,850	516	131,685	118,737
1954	97,263	14,135	32,264	211	143,873	131,784
1955	109,404	9,088	32,896	89	151,477	142,631

[1] Figures, by years, for 1926–48 in Minerals Yearbook 1948, p. 885.
[2] Reported to Bureau of Mines by importers.
[3] Figures for 1946–47 include nickel scrap.
[4] Not available.
[5] Excludes "Residues."
[6] Figures for 1946–47 include nickel content of nickel scrap and those for 1947–50 include nickel content of "Residues."

TABLE 9.—Nickel products exported from the United States, 1953–55, by classes

[U. S. Department of Commerce]

Class	1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
Nickel and nickel-alloy metals in ingots, bars, rods, and other crude forms, and scrap	14,712 (with next line)	$9,673,576 (with next line)	12,818	$8,939,332	19,317	$14,098,863
Nickel and nickel-alloy metal sheets, plates, and strips			941	1,925,327	647	1,511,441
Nickel and nickel-alloy semifabricated forms, not elsewhere classified	278	935,722	336	1,068,818	429	1,480,935
Nickel-chrome electric resistance wire, except insulated	178	609,110	150	522,457	208	773,180
Total	--------	11,218,408	--------	12,455,934	--------	17,864,419

TECHNOLOGY

Bureau of Mines.—The Bureau of Mines continued research on nickel ores from several localities. The results of smelting tests at its Northwest Electrodevelopment Laboratory (Albany, Oreg.), on two 5-ton samples of nickeliferous serpentine and laterite from the Surigao area, Philippines, were published.[5] The average nickel content (dried) of the serpentine and laterite was 1.89 and 1.84 percent, respectively. When enough reductant was used in the furnace charge, about 93 percent of the nickel was recovered from these ores as a high-grade, low-carbon ferronickel; about 35 pounds of nickel was recovered from each ton of dry ore smelted.

The Albany Station also made 1 continuous smelting test on a 15-ton shipment of ore analyzing 0.84 percent Ni and 44.9 percent Fe from the Cle Elum, Wash., deposit, with the object of utilizing the nickel and iron in producing a low-carbon nickel-iron alloy. The most satisfactory results were obtained when no flux was used in the charge. Over 98 percent of the nickel and 77 percent of the iron were recovered in the alloy, which contained 2.11 percent Ni, 0.62 percent Cr, 0.10 percent Co, 0.01 percent Si, 0.21 percent C, 0.27 percent P, and remainder essentially Fe. The test indicated that a low-carbon nickel-iron alloy, suitable for many types of structural steels, can be produced from this material.

The Albany Station also investigated the recovery of nickel and cobalt by carbothermic reduction of weathered serpentine averaging (dried) 1.60 and 0.068 percent, respectively, of nickel and cobalt from the Ocujal-San Juan deposits in Oriente Province, Cuba. Test results demonstrated that up to 93 percent of the nickel and 86 percent of the cobalt were recovered in a low-carbon ferronickel. The alloy produced during the first period contained 26.9 percent nickel and 0.80 percent cobalt. Use of the alloy, however, would be limited because of its relatively high cobalt content. Consumption of power and electrode compared favorably with the results obtained from smelting nickeliferous ores from other well-known deposits.

At the Bureau of Mines Mississippi Valley Experiment Station (Rolla, Mo.), mineralogical examinations, X-ray studies, and differential thermal analyses on Cuban laterite, serpentine, and special samples were underway. Results had not indicated the presence of a specific nickel mineral. However, information obtained will be of value in understanding the composition of the ores and reactions that take place under various roasting conditions which might lead to more efficient methods of recovering nickel from laterite and altered serpentine in Cuba.

At the Bureau of Mines Salt Lake City (Utah) Experiment Station, roasting and leaching studies continued on Cuban nickeliferous laterite and serpentine. Continuous reductive roasting tests were made on mine-run ore averaging 1.40 and 0.07 percent, respectively, of nickel and cobalt from the Ocujal-San Juan deposit, under the optimum temperature and fluidizing conditions determined from batch tests. Minus-20-mesh ore was roasted at 750° C. using different feed rates. Samples of the calcine were rod-milled in a 7-percent ammonia solution

[5] Banning, L. H., and Anable, W. E., Preliminary Electric Smelting Research on Philippine Nickeliferous Ores; Bureau of Mines Rept. of Investigations 5129, 1955, 13 pp.

to pass 200-mesh, then mechanically agitated with aeration. In two tests, leaching of calcines gave extractions of 80.3 percent nickel in each and 58 and 66 percent cobalt. In one test, the flue dust was leached without being ground. The nickel extraction was virtually the same as for the calcine; cobalt extractions were about 10 percent lower.

Laboratory batch and column tests were made on pregnant solutions using cation exchange resins Amberlite IRC–50 and Dowex 50–X2, X4, and X8 to separate nickel from cobalt. No simple process for producing pure nickel and cobalt products has yet been achieved by ion-exchange methods. Production of a nickel product with a reduced cobalt content, plus a small amount of nickel-free cobalt, has been demonstrated on a laboratory scale, but the process would be complicated and costly.

Preliminary tests using alkyl phosphoric acids in liquid-liquid extraction technique in an ammoniacal system have shown considerable promise for separating and recovering nickel and cobalt. Indications were that nickel and cobalt can be stripped from the organic phase with either acid or ammonium carbonate. Loss of extractant, owing to hydrolysis and solubility in ammoniacal solution, was a problem. Exploratory tests showed that the loss can be reduced by the addition of tributylphosphate or by using a higher molecular weight extractant. The liquid-liquid extraction technique appeared to offer greater hope than ion exchange for separating and recovering nickel and cobalt. Consequently, in 1956 this phase of the research will be emphasized to develop a feasible method for the Nicaro (Cuba) plant.

Industry.—International Nickel Co. of Canada, Ltd., conducted research to improve its existing production methods and to develop new and better processes for producing nickel. Trial operation at the first unit of its iron-ore recovery plant near Copper Cliff, Ontario, was begun in November. The plant employs an Inco-developed process for recovering nickel and iron ore from nickeliferous pyrrhotite. The direct rolling of powdered nickel into strip was advanced from the laboratory to plant-scale production. Research was also devoted to development of new nickel-cobalt alloys having special magnetostrictive characteristics. Several new products developed in the company laboratories were introduced in 1955, including a new high nickel-iron-chromium alloy capable of resisting attack under many especially corrosive conditions; a new multipurpose welding rod capable of making strong, ductile joints between dissimilar metals in a wide range of compositions and in varied combinations; and a ductile corrosion-resistant cupola iron, which has the ductility and strength of ductile iron.

The pyrrhotite plant of Falconbridge Nickel Mines, Ltd., at Falconbridge, Ontario, was operated on a pilot basis on concentrate from the Falconbridge mill for the latter 9 months of 1955. Although it experienced a number of mechanical difficulties not unusual in a new plant of radical design, metallurgical results were encouraging, and the company believed that the process promised real improvements to its treatment circuit, as well as providing a high-grade iron byproduct. A Cottrell dust collector was completed at Falconbridge.

The metal-refining process at the refinery of Sherritt Gordon Mines, Ltd., at Fort Saskatchewan, Alberta, was described.[6] The process comprises leaching, copper separation, unsaturated sulfur oxidation, and sulfamate hydrolysis, nickel-metal reduction, cobalt recovery, and ammonium sulfate recovery.

Patents were issued for processes for separating nickel and cobalt,[7] and for nickel-chromium alloys.[8]

A new nickel-chromium-cobalt-type alloy—Jetalloy 1570—which contains no strategic columbium was developed.[9] It is capable of retaining its high strength at temperatures above 1,500° F. for extended periods.

A patent was issued for a process for producing bright nickel deposits,[10] and two continuous flow methods of plating were described.[11]

WORLD REVIEW

The world output of nickel continued its uptrend for the fifth consecutive year to establish a new high of 216,000 short tons in 1955, a 13-percent increase over 1954. Record outputs were made in Canada, Cuba, New Caledonia, United States, and Union of South Africa. Canada has supplied 85 percent of the world output of nickel since 1951.

NORTH AMERICA

Canada.—Virtually all of the Canadian output was derived from copper-nickel ores of the Sudbury district, Ontario, and Lynn Lake area, Manitoba. Some nickel was also recovered as a byproduct from silver-cobalt ores of Cobalt, Ontario. Five companies—International Nickel Co. of Canada, Ltd., Falconbridge Nickel Mines, Ltd., Nickel Rim Mines, Ltd., and Nickel Offsets, Ltd., all in the Sudbury district, and Sherritt Gordon Mines, Ltd., in the Lynn Lake area—supplied virtually all production in 1955. Nickel production in Canada was 174,600 short tons in 1955, an 8-percent gain over 1954 and the highest of record. Exports of nickel from Canada also established a new high of 173,900 short tons in 1955, a 10-percent gain over 1954.

Sales of nickel in all forms by the International Nickel Co. of Canada, Ltd., were 145,232 short tons in 1955 compared with 141,000 tons in 1954.[12]

---

[6] Nashner, Sidney, Nickel Refining—Process for Nickel Powder Production at Fort Saskatchewan: Metal Ind., vol. 87, No. 26, Dec. 23, 1955, pp. 527–528.

[7] Schaufelberger, F. A., (assigned to Chemical Construction Corp.) Method of Precipitating Cobalt Carbonate From Cobalt-Nickel Salt Solutions: U. S. Patent 2,711,956, June 28, 1955. Method of Separating Cobalt as Carbonates From Nickel-Cobalt Mixtures: U. S. Patent 2,711,957, June 28, 1955. The Separation of Nickel From a Mixture Containing Soluble Compounds of Nickel and Cobalt: U. S. Patent 2,711,958, June 28, 1955.

[8] Spendelow, H. R., Jr., and Crafts, Walter (assigned to Union Carbide & Carbon Corp.), Nickel-Base Alloy for High-Temperature Service: U. S. Patent 2,703,277, Mar. 1, 1955.

Gresham, H. A., Dunlop, Adam, and Wheeler, M. A. (assigned to Rolls-Royce, Ltd.), Nickel-Chromium Alloys Having High Creep Strength at High Temperatures: U. S. Patent 2,712,498, July 5, 1955.

Harris, G. T., and Child, H. C. (assigned to William Jessop & Sons), Nickel-Cobalt-Chromium Alloy: U. S. Patent 2,713,538, July 19, 1955.

[9] Guard, R. W., and Prater, T. A., New Super Alloy Speeds Jet Progress: Iron Age, vol. 176, No. 16, Oct. 20, 1955, pp. 116–118.

[10] Kardos, Otto, Menzel, T. J., and Sweet, J. L. (assigned to Hanson-Van Winkle-Munning Co.), Bright Nickel Plating: U. S. Patent 2,712,522, July 5, 1955.

[11] Baker, S. W., Nickel Plating Without Current: Steel, vol. 136, No. 2, Jan. 10, 1955, pp. 66–67.

[12] International Nickel Co. of Canada, Ltd., Annual Report: 1955, p. 5.

TABLE 10.—World mine production (exclusive of U. S. S. R.) of nickel, by countries, 1946–50 (average) and 1951–55, in short tons of contained nickel

[Compiled by Berenice B. Mitchell]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada [1]	119,756	137,903	140,559	143,693	[2] 161,279	174,581
Cuba (content of oxide)	2,922		8,924	13,844	14,545	15,138
United States:						
Byproduct of copper refining	717	756	633	591	639	451
Recovered nickel in domestic ore refined				11	192	3,356
Total	123,395	138,659	150,116	158,139	176,655	193,526
South America: Brazil (content of ferronickel)		(3)	29	55	(3)	57
Europe:						
Finland (content of nickel sulfate)	(3)	(3)	65	[4] 309	89	134
Norway (content of ore)	12					
Total	(3)	(3)	65	309	89	134
Asia:						
Burma (content of speiss)		700	70	16	116	72
Iran (content of speiss)						1
New Caledonia [5]	3,568	4,600	9,900	13,100	13,000	19,500
Total	3,568	5,300	9,970	13,116	13,116	19,573
Africa:						
French Morocco (content of cobalt ore)			201	132	162	167
Rhodesia and Nyasaland, Federation of: Southern Rhodesia (content of ore)				(6)	(6)	(6)
Union of South Africa (content of matte and refined nickel)	638	1,254	1,444	1,891	2,112	2,598
Total	638	1,254	1,645	2,023	2,274	2,765
World total (estimate)	128,000	145,000	162,000	174,000	192,000	216,000

[1] Comprises refined nickel and nickel in oxide produced and recoverable nickel in matte, exported.
[2] Revised figure.
[3] Data not available; estimate by author of the chapter included in the total.
[4] Includes 233 tons in matte.
[5] Comprises nickel content of matte and ferronickel produced and estimate (by author) of recoverable nickel in ore exported. Mine production (nickel content) was as follows: 1946–50 (average), 3,260 tons; 1951, 7,400 tons; 1952, 11,750 tons; 1953, 18,800 tons; 1954, 15,100 tons; 1955, 28,000 tons.
[6] Data not available. Production of ore was in 1953, 63 tons; 1954, 62 tons and 1955, 18 tons.

Whereas total ore mined by Inco in 1955 was slightly below the record established in 1954, the total nickel-copper in the ore mined was higher. Ore mined from underground—12,759,482 tons—was the largest in company history, compared with 11,988,208 tons in 1954. Some 70 percent of the underground ore mined was again obtained by caving and blasthole mining methods.[13] Open-pit ore mined was 1,488,109 tons compared with 2,468,046 tons in 1954. A total of 14,247,591 tons was mined in 1955 compared with 14,456,254 tons in 1954. According to the company, proved ore reserves at the end of 1955 were 262,369,000 tons containing 7,897,800 tons of nickel-copper—the highest on record—compared with 261,619,000 tons containing 7,875,000 tons of nickel-copper at the end of 1954. Underground development in the producing mines advanced 110,090 feet (21 miles) in 1955, bringing the total footage to 2,091,963 or 396 miles. Con-

[13] The caving method is an adaptation of a mining technique by which great masses of ore are induced to cave and disintegrate by their own weight. The blasthole mining method differs from the caving method only insofar as explosives are used to break the ore.

cerning developments at certain mines, the company reported as follows:[14]

In the Frood-Stobie mine the ventilation system for areas of the Stobie section above the 1,000-foot level approached completion, and the air intake system for the Frood section was extended to permit stoping operations at the 3,600-foot level. At the Creighton mine, development was started for mining below the 68 level, which is 5,425 feet below surface. When completed, this new development will constitute the world's deepest nickel mining operation.

Installation of a large semi-automatic ore hoist on surface and a pumping station at the 3,200-foot level was completed and put into operation at the Murray mine. At the Garson mine, the ore loading pocket below the 4,000-foot level was completed and excavation started for the crusher station and ore storage bin for this area.

The deepening program at No. 2 and No. 3 shafts at the Levack mine was continued, depth of the No. 2 shaft reaching 3,640 feet. In addition, shaft stations at the No. 3 shaft were completely excavated at the 3,200, 3,400 and 3,600-foot levels.

During the year, special steps were taken which make available an additional 3,500,000 tons of ore for mining by low-cost open-pit methods. This involved driving two ore haulage tunnels with an aggregate length of 2,200 feet in the rock walls at the Frood-Stobie open pit, thus bypassing a portion of the main ramp road around the sides of the pit. As a result, the ore in the ramp is now being recovered from the surface rather than by underground mining.

Inco continued intensive exploration for new sources of nickel, with some shift in emphasis based on new areas of interest and completion of planned programs. During 1955, $5,182,000 was spent in this search for new sources of nickel. Exploration in the Sudbury district included 522,836 feet of drilling in its operating mines and drilling from the surface at a number of its other properties, some of which showed encouraging indications of mineralization. Exploratory work, which has been underway for a number of years at Crean Hill in the Sudbury district, will result in the opening of a new mine. By year end a shaft had been sunk to a depth of 1,242 feet below the collar, and the shaft station at the 750-foot level was completed. It is expected that this new mine will be ready in 3 years. The exploration shaft at Moak Lake, in the Mystery Lake area of Manitoba, was completed to a depth of 1,325 feet in 1955. Driving of lateral exploration drifts was begun and will be followed by underground diamond drilling. Exploration activities also included major programs in the Northwest Territories, Saskatchewan, and Quebec, geological and airborne geophysical surveys and property examinations in Ontario, and studies in countries other than Canada.

Falconbridge Nickel Mines, Ltd., again established new records in production of ore and matte in 1955. Ore delivered for treatment from the Falconbridge, McKim, Mount Nickel, Hardy, and East mines in the Sudbury district was 1,678,545 short tons (1,407,909 tons in 1954). In addition to company ore, 65,567 tons of ore and concentrate was received for treatment from independent mines in the district in 1955 (113,530 tons in 1954). Seven percent more nickel matte was produced than in 1954.

The following information concerning developments, exploration, expansions, and reserves was abstracted from the 27th Annual Report of Falconbridge Nickel Mines, Ltd., for 1955.

No new mines joined the production ranks in 1955, but Mount Nickel, Hardy, and East mines completed their first full year of

[14] Work cited in footnote 12, p. 9.

production. Good progress was made on the Longvack, Boundary, Fecunis Lake, and Onaping mines, which are under development. At the Longvack mine the inclined shaft was completed early in 1955 and underground development was carried out during the balance of the year; surface stripping preparations for glory-hole mining were nearly completed by the year end. At the Boundary mine the winze was completed, stations for 6 levels between the 1,375 and 1,900 foot horizons were cut, and lateral developments and delineation of the ore body were getting underway at the year end. At Fecunis Lake mine shaft sinking and underground development continued to advance slightly ahead of schedule. During 1955 the main shaft was deepened 1,310 feet to 3,418 feet and the service shaft advanced 1,589 feet to 3,154 feet; the depth objectives for these shafts are approximately 3,985 and 3,325 feet, respectively. Sinking at the service shaft was expected to be completed in February 1956 and the main shaft by mid-1956. Lateral development to explore the ore on the 2,550-foot level, station cutting to provide room for underground installations, and underground diamond drilling to delineate the ore body were begun during 1955. By the year end the shaft at the Onaping mine had been sunk 245 feet below the collar.

At Populus Lake, Kenora district, an exploratory shaft was sunk to 540 feet. Shaft sinking was suspended until exploratory lateral development and drilling can be concluded on two levels to determine the characteristics and grade of the mineralized area more fully. Deeper drilling from the surface has suggested the desirability of later exploration at greater depths. Geological examinations, mapping, geophysical surveys, and surface drilling were also carried on in several areas, of which two at least were believed to merit further exploration.

Ore reserves totaled 39,848,000 short tons on December 31, 1955, and comprised 17,425,000 tons of developed ore averaging 1.50 percent nickel and 0.83 percent copper in the Falconbridge, East, McKim, Mount Nickel, Hardy, and Longvack mines and 22,423,000 tons of indicated ore averaging 1.37 percent nickel and 0.65 percent copper in Sudbury district holdings.

During the first full year of operation, Sherritt Gordon Mines, Ltd., produced 16,666,600 pounds of nickel metal at its refinery at Fort Saskatchewan, Alberta, compared with a designed capacity of 16,-800,000 pounds. According to the company,[15] "the year's operation of the plant has confirmed our high opinion of the technical merits of the process and also our expectation that the cost of producing high quality refined nickel from Lynn Lake concentrate would be lower than by any other known process."

At its "A" and "EL" mines at Lynn Lake, Manitoba, 761,257 short tons of ore was hoisted in 1955 compared with 560,460 tons in 1954. Ore milled in 1955 totaled 761,584 tons, from which 89,681 tons of concentrate was produced. Concentrate containing 6,124 tons of nickel was shipped to International Nickel Co. for refining. At the "A" mine routine development continued through 1955 for the purpose of mining the lower "A" ore body. A start was made on development work for opening up the "C" and "E" ore bodies for mining. At the "EL" mine all development was directly connected with min-

[15] Sherritt Gordon Mines, Ltd., Annual Report: 1955, p. 3.

ing of the ore body. During 1955 an exploration program was initiated which resulted in finding two more ore bodies. More detailed work on the previously known ore bodies also resulted in a net addition to the tonnage. As a result, the ore reserve, as of December 31, 1955, totaled 13,820,000 tons averaging 1.146 percent nickel and 0.587 percent copper, an increase of 338,000 tons over the tonnage reported as of December 31, 1954.

Among the smaller companies, Nickel Rim Mines, Ltd., (formerly East Rim Nickel Mines, Ltd.), and Nickel Offsets, Ltd., both in the Sudbury district, continued to make shipments to Falconbridge Nickel Mines, Ltd. Elsewhere in Canada, Hudson-Yukon Mining Co., a subsidiary of Hudson Bay Mining & Smelting Co., Ltd., at its Wellgreen property in the Kluane Lake district, Yukon Territory, drove 6,300 feet of lateral development headings and started a winze to permit development at greater depth.[16] Ore reserves were reported at 728,000 tons averaging 2.05 percent nickel and 1.42 percent copper, with small amounts of cobalt, gold, platinum, and palladium. Development was also carried out by Eastern Metals Corp., Ltd., at its property in Montmagny County, Quebec, and by Quebec Nickel Corp., Ltd., at its Gordon Lake-Werner Lake property in the Kenora district, Ontario. North Rankin Nickel Mines, Ltd., planned to construct a 250-ton mill at its property on the west coast of Hudson Bay, Northwest Territories, and Eastern Mining & Smelting Corp., Ltd., (a merger of Quebec Nickel Corp. and Eastern Smelting & Refining Co.), proposed to erect smelting and refining facilities to treat nickel and copper concentrate at Chicoutimi, Quebec.

Cuba.—Production of nickel in Cuba established a new high in 1955 and was 4 percent greater than in 1954—itself a record year. The output of oxide powder and oxide sinter was 17,486 short tons (15,138 tons of nickel plus cobalt content) in 1955 compared with 18,187 tons (14,545 tons of nickel plus cobalt content) in 1954. The 1955 output consisted of 2,335 tons of oxide powder averaging 77.12 percent of nickel plus cobalt and 15,151 tons of sinter averaging 88.03 percent of nickel plus cobalt.

Exports of nickel oxide from Cuba in 1955 were 17,202 short tons (14,801 tons of nickel plus cobalt content) and consisted of 2,683 tons of oxide powder averaging 77.05 percent of nickel plus cobalt and 14,519 tons of sinter averaging 87.70 percent of nickel plus cobalt.

Production of ore was 1,428,727 dry short tons in 1955 compared with 1,337,562 tons in 1954. Ore fed to the driers was 1,426,531 dry short tons averaging 1.39 percent of nickel in 1955 compared with 1,368,569 tons averaging 1.42 percent of nickel in 1954.

Good progress was made in expanding by 75 percent the nickel-producing facilities at the United States Government-owned plant at Nicaro, Cuba. Completion was expected in December 1956.

Freeport Sulphur Co. completed its 50-ton-per-day pilot plant near New Orleans, La., in December 1955 and began test work on a 10,000-ton shipment of laterite from its deposits in the Moa Bay area of Cuba. Upon successful completion of the pilot-plant program, the company plans to build a commercial plant to produce 30 million pounds of nickel and 3 million pounds of cobalt annually. The commercial plant will have facilities in Cuba and the United States.

[16] Department of Mines and Technical Surveys, Nickel in Canada, 1955 (Prelim.): Ottawa, 1956, p. 4.

In Cuba the ore, which averages about 1.35 and 0.14 percent, respectively, of nickel and cobalt, will be treated by an acid-leach process to produce a high-grade bulk nickel-cobalt concentrate, which will be shipped to the United States, where it will be reduced by a hydrogen process to yield separate products of high-purity nickel and cobalt.

Table 11 gives income and costs at the United States-owned nickel plant at Nicaro, Cuba, for January 1, 1952, through December 31, 1955. During this period production of oxide was 130,222,000 pounds containing 104,902,000 pounds of nickel plus cobalt.

TABLE 11.—Income and costs at the Nicaro nickel plant, Nicaro, Cuba, January 1, 1952 through December 31, 1955

[General Services Administration]

	Costs	Income
Total income from sales		$51,742,329
Cost of commodities sold:		
Ore royalties	$7,093,648	
Direct labor	4,685,031	
Other manufacturing costs	[1] 42,051,294	
Total production costs	53,829,973	
Less: Inventory—work in process	146,161	
Cost of finished products available for sale	53,683,812	
Less: Inventory—finished products on hand	2,363,960	
Cost of commodities sold	51,319,852	
Excess of income over cost of commodities sold		[2] 422,477

[1] Includes $11,466,710 representing depreciation of the Government's capital investment in the plant.
[2] In addition, the sale of nickel to the National Stockpile at cost saved the Government $4 million.

A report on exploration and significance of the nickel-ore reserves of Cuba, and history of operations of the nickel-recovery plant at Nicaro, Cuba, was published.[17]

The origin of Cuban nickel ore has been described.[18]

EUROPE

Finland.—Small quantities of nickel occur with the ores of the Outokumpu copper mine and the Nivala nickel-copper mine. However, the quantity of nickel is too small for conversion to primary metal. Consequently, the nickel was used for producing nickel sulfate at the Pori metal works of Outokumpu Oy. Nickel sulfate production was 606 short tons containing about 134 tons of nickel in 1955, compared with 416 tons containing 89 tons in 1954.

France.—The only nickel refinery in France is that of Société le Nickel at Le Havre, which refines matte imported from New Caledonia. Production of nickel metal was 6,063 short tons in 1955 compared with 5,320 tons in 1954. In addition, 268 tons of ferronickel was produced in 1954.

[17] McMillan, W. D., and Davis, H. W., Nickel-Cobalt Resources of Cuba: Bureau of Mines Rept. of Investigations 5099, 1955, 86 pp.
[18] DeVletter, D. R., How Cuban Nickel Ore Was Formed—a Lesson in Laterite Genesis: Eng. and Min. Jour., vol. 156, No. 10, October 1955, pp. 84-87, 178.

TABLE 12.—Nickel metal production, apparent consumption, and foreign trade in France, 1947–54, in short tons

[Minerais et Metaux]

	1947	1948	1949	1950	1951	1952	1953	1954
Production	1,943	2,102	2,676	3,772	5,340	3,606	3,538	5,320
Imports	4,798	1,506	4,895	111	1,871	3,514	3,091	4,367
Exports				844	587	104	231	[1] 2,379
Apparent consumption	6,741	3,608	7,571	3,039	6,624	7,016	6,398	7,308

[1] Includes 772 tons nickel in ferronickel.

Greece.—Greek authorities approved a $2.5 million loan for the Larymna nickel project to the Greek Chemical Product & Fertilizer Co.[19] Ferronickel will be produced from ore obtained from the Karditsa mine.

Norway.—Despite a strike of stevedores at Norwegian ports in late November and early December, which resulted in the loss of about 1 million pounds of nickel, output at the refinery of Falconbridge Nickel Mines, Ltd., at Kristiansand established a new high of about 20,400 short tons, a 7-percent increase over 1954. The metal was produced from matte imported from Canada. Deliveries of nickel were 20,568 short tons in 1955 compared with 19,395 tons in 1954. By the end of 1955, output of refined nickel had reached a rate equivalent to 22,500 short tons per year. Further expansion in capacity will continue until balanced operations at a production level of 27,500 tons of nickel a year have been reached.

ASIA

Burma.—Nickel in the form of speiss was produced in Burma as a byproduct of lead-zinc mining at the Bawdwin mine of the Burma Corporation, Ltd. Output of speiss was 356 short tons containing about 72 tons of nickel in 1955, compared with 548 tons containing about 116 tons of nickel in 1954.

Indonesia.—It was reported [20] that Sumitomo Metal Mining Co., a Japanese firm, planned to resume operation of a nickel mine in Colaca, southern Celebes Island. The mine, which has been inactive since World War II, will be developed jointly by the owner, Tradja Mining Co., and the Japanese company, which will furnish the funds and technique. The ore will be exported to Japan. Estimated reserve was reported to be 3 million tons of 3-percent-nickel ore.

Japan.—Production of nickel in Japan consisted of 3,832 short tons of pure nickel and 2,881 tons (nickel content) of ferronickel in 1955 compared with 2,630 tons of pure nickel and 2,147 tons of ferronickel in 1954. New Caledonia was the main source of nickel ore.

New Caledonia.—Production of nickel ore (containing about 25 percent moisture) in New Caledonia was 1,098,000 short tons containing 28,000 tons of nickel in 1955 compared with 578,000 tons containing 15,100 tons of nickel in 1954. The Thio mine on the

[19] American Metal Market, vol. 62, No. 118, June 18, 1955, p. 3.
[20] Engineering and Mining Journal, vol. 156, No. 11, November 1955, p. 198.

southeastern coast of the island is the most completely mechanized and, consequently, the largest producer; it accounted for 46 percent of the total production of ore in 1955.

TABLE 13.—Production of nickel ore in New Caledonia in 1955, by mines, in short tons

[New Caledonia Mines Service]

Mine	Operator	Production	
		Gross weight	Nickel content
Thio	Société le Nickel	515,661	12,784
Pin Pin	do	101,931	2,998
Stamboul	Edouard Pentecost	15,580	425
Eureka	do	105,877	3,121
Alice 20 Extension	do	8,095	246
Alice 24	do	2,665	73
Alice 27	do	27,519	791
Philomene	do	35,803	948
Saint Louis	do	5,507	153
Liliane	Compagnie Génerale des Minerais Caledoniens	33,796	862
Sylvestre II	do	16,464	341
A. M. N. 3	Papon	10,458	300
Koue	Henri Lafluer	2,846	75
H. L. Ni. 1	do	95,678	2,046
H. L. Ni. 1	P. Videault	17,817	513
P. B. 2	do	2,943	87
Tunney 4 and 9	Camille Girard	6,867	154
Boualoudjelina	do	51,782	1,161
D'Artagnan	L. Montagnat	26,362	596
Bouchon	do	6,988	154
Les Carrières 3	August Fricette	4,409	140
Trou Bleu	Société Oceanienne Minière	3,371	96
Total		1,098,419	28,064

Production of nickel matte and ferronickel by Société le Nickel in 1955 was 20 percent more than in 1954. Construction of an extension to the existing dam and power plant on the Yate River and modernization of the smelter of Société le Nickel at Noumea to utilize the increased electricity to be produced began about mid-1955.[21] These projects are both aimed at lowering the costs of production of matte and ferronickel and lessening the dependence of the smelter on Australian coal. The smelter consists of 3 water-jacket furnaces, 3 Bessemer converters, and 3 electric furnaces.

TABLE 14.—Production of nickel matte and ferronickel by Société le Nickel, 1954–55, in short tons

[New Caledonia Mines Service]

Product	1954		1955	
	Gross weight	Nickel content	Gross weight	Nickel content
Matte	8,277	6,365	9,219	7,066
Ferronickel	10,800	2,915	15,151	4,032
	19,077	9,280	24,370	11,098

[21] White, L. M., American Vice Consul, Noumea, New Caledonia, Minerals Review of New Caledonia for 1955: State Department Despatch 88, Apr. 30, 1956, 17 pp.

Exports of nickel ore in 1955 (virtually all to Japan) were 2¼ times greater than in 1954; and those of matte and ferronickel (virtually all to France) were larger by 18 and 21 percent, respectively.

TABLE 15.—Nickel ore and nickel products exported from New Caledonia in 1954–55, in short tons

[New Caledonia Mines Service]

	1954		1955	
	Gross weight	Nickel content	Gross weight	Nickel content
Ore	163,719	(1)	370,762	(1)
Matte	8,317	6,397	9,838	7,533
Ferronickel	12,955	3,513	15,925	4,243

[1] Not reported.

AFRICA

Union of South Africa.—Since 1938 there has been a small annual output of nickel from the sulfide ore in the Rustenburg district by Rustenburg Platinum Mines, Ltd. Production comprised 2,223 short tons of nickel in matte and 375 tons of electrolytic nickel in 1955 compared with 2,112 tons in 1954. Electrolytic nickel was produced for the first time in 1955. In 1955, 1,817 tons of matte was exported to England for refining.

457676—58——55

Nitrogen Compounds

By E. Robert Ruhlman [1]

EXPANSION of the synthetic-nitrogen industry in the Unite States continued during the year, and by the end of 1955 the total capacity was estimated to be 3.4 million tons of nitrogen, a 15-percent increase over 1954. Consumption did not keep pace with capacity, and by December 1, 1955, industry was operating at only about 87 percent of capacity. Following the recommendations of an industry advisory committee and the Business and Defense Services Administration, United States Department of Commerce, the Office of Defense Mobilization decided against establishing an expansion goal for nitrogen-storage facilities.

DOMESTIC PRODUCTION

The production of synthetic anhydrous ammonia continued its upward trend in 1955 and was 16 percent more than in 1954, the previous record high year. Ammonium sulfate production from both synthetic and byproduct coking plants increased in 1955, and total output exceeded 1954 by 21 percent. Ammonium nitrate production was 10 percent higher than in the previous year. Synthetic sodium nitrate continued to be produced by only Allied Chemical & Dye Corp., Hopewell, Va., and Olin Mathieson Chemical Corp., Lake Charles, La.

TABLE 1.—Principal nitrogen compounds produced in the United States, 1946–50 (average) and 1951–55, in short tons

Commodity	1946–50 (average)	1951	1952	1953	1954	1955
Ammonia (NH_3):						
Synthetic plants:						
Anhydrous ammonia [1]	1,157,790	1,777,074	2,052,114	2,287,785	2,719,666	3,163,041
Byproduct coking plants (NH_3 content):						
Aqua ammonia	24,320	24,878	22,060	24,846	16,104	16,621
Ammonium sulfate	193,585	224,566	200,603	236,533	205,705	252,986
Subtotal	217,905	249,444	222,663	261,379	221,809	269,607
Grand total	1,375,695	2,026,518	2,274,777	2,549,164	2,941,475	3,432,648
Principal ammonium compounds:						
Ammonium sulfate:						
Synthetic plants [1 2]	520,178	622,084	812,795	576,232	928,447	1,131,106
Byproduct coking plants	774,340	898,263	802,412	946,133	822,818	981,326
Total	1,294,518	1,520,347	1,615,207	1,522,365	1,751,265	2,112,432
Ammonium nitrate, basis solution, 100 percent NH_4NO_3 [1]	1,006,545	1,346,443	1,467,341	1,558,457	1,857,626	2,051,089

[1] Data from Bureau of Census Facts for Industry series.
[2] Includes ammonium sulfate produced at byproduct coking plants from purchased ammonia.

[1] Commodity specialist.

The ammonium nitrate plant of Brea Chemicals, Inc., Brea, Calif., with a capacity of 50,000 tons per year of prilled ammonium nitrate, began operating in 1955.[2] Brea now produces ammonia, ammonium phosphate, nitric acid, and ammonium nitrate prills and solutions. Construction of the 300-ton-per-day ammonia plant of Calumet Nitrogen Products Co., Hammond, Ind., was begun in May. CNCP, owned by Standard Oil Co. of Indiana and Sinclair Refining Co., will obtain hydrogen from the parent companies' oil refineries.[3] Colorado Fuel & Iron Corp. announced that it will begin producing and marketing diammonium phosphate as a result of recent changes in methods and facilities of the coke operations at its steel plant near Pueblo, Colo.[4] The new anhydrous ammonia plant of Columbia-Southern Chemical Corp., Natrium, W. Va., began operation during the latter half of 1955.[5] Escambia Bay Chemical Corp., formerly Gulf Chemical Co., began constructing a plant to produce ammonia and other nitrogen compounds.[6] This company was owned by United Gas Corp., Electric Bond & Share Corp., and National Research Corp.[7] Gonzales Chemical Industries, Inc., planned to construct an ammonia and nitrogen-compounds plant at Guanica, Puerto Rico, with an annual capacity of 42,000 tons of anhydrous ammonia.[8] Ketona Chemical Corp., owned by Alabama By-Products Corp. and Hercules Powder Co., planned to expand its proposed ammonia plant at Tarrant, Ala., to include facilities for producing nitrogen solutions.[9] The raw materials for this plant will be derived entirely from coke-oven gas. Lion Oil Co., producer of ammonia at El Dorado, Ark., and Luling, La., merged with Monsanto Chemical Co.[10] The new company will offer both nitrogen and phosphorus fertilizers and chemical products. Mississippi River Chemical Co. began operating its plant at Selma, Mo., near the end of the year. Products included ammonia, nitric acid, and ammonium nitrate.[11] Northern Chemical Industries contracted for construction of a 125-ton-per-day anhydrous ammonia plant at Searsport, Maine, using fuel oil as a source of hydrogen.[12] Pennsylvania Salt Manufacturing Co. of Washington began operating its anhydrous ammonia plant at Portland, Oreg.[13] Phillips Pacific Chemical Co., formed by Phillips Petroleum Co. and Pacific Northwest Pipeline Corp., was considering plant sites in southeastern Washington for the proposed 200-ton-per-day ammonia plant.[14] St. Paul Ammonia Products, Inc., will build

[2] Oil and Gas Journal, Ammonium-Nitrate Plant Starts Up: Vol. 54, No. 23, Oct. 10, 1955, p. 129.
[3] Chemical and Engineering News, Calumet Nitrogen Building Indiana Ammonia Plant: Vol. 33, No. 21, May 23, 1955, pp. 2196, 2198.
[4] Western Industry, New Field for CF&I: Vol. 20, No. 2, February 1955, p. 96.
[5] Chemical Engineering, One Fertilizer Plant Starts Up; Four Planned: Vol. 62, No. 10, October 1955, p. 126.
[6] Chemical and Engineering News, Ammonia Firm Buys 2,000-Acre Site Near Pensacola: Vol. 33, No. 9, Feb. 28, 1955, p. 849.
[7] Chemical Engineering, vol. 62, No. 7, July 1955, p. 136.
[8] Chemical and Engineering News, Puerto Rican Ammonia: Vol. 33, No. 43, Oct. 24, 1955, p. 4566.
[9] Oil, Paint and Drug Reporter, Nitrogen Solutions Plant Contract Let by Ketona: Vol. 167, No. 19, May 9, 1955, p. 39.
[10] Chemical and Engineering News, Monsanto-Lion Oil Merger: Vol. 33, No. 37, Sept. 12, 1955, pp. 3834–3835.
[11] Chemical and Engineering News, Nitrogen—Fresh From the Farm: Vol. 33, No. 12, Sept. 12, 1955, pp. 3771–3772.
[12] Industrial and Engineering Chemistry, Ammonia Plants: Vol. 47, No. 9, part I, September 1955, p. 106 A-1.
[13] Chemical and Engineering News, Pennsalt of Washington Plans Startup of Ammonia Plant: Vol. 33, No. 11, Mar. 14, 1955, p. 1070.
[14] Oil, Paint and Drug Reporter, Ammonia Plant to be Built by Phillips Pacific Chemical: Vol. 168, No. 3, July 18, 1955, p. 5.

an ammonia plant near St. Paul, Minn., with a capacity of 200 tons per day.[15] Southern Nitrogen Co., Inc., planned to construct a 250-ton-per-day ammonia plant at Savannah, Ga.[16] This plant will include facilities for manufacturing nitric acid, prilled ammonium nitrate, nitrogen solutions, and urea. Standard Oil Co. of California planned an ammonia and nitric acid plant to utilize hydrogen-bearing off-gases from oil refineries near Richmond, Calif.[17] Construction of the ammonia plant of United States Steel Corp. near Provo, Utah, was begun near the end of 1955. Processes to be used include the Blaw-Knox–Linde separation process to recover hydrogen from coke-oven gas and nitrogen from the air and the Blaw-Knox–Montecatini process for ammonia synthesis.[18] Products will include anhydrous ammonia, nitric acid, and prilled and liquid ammonium nitrate. Proposed ammonia plants also were announced during 1955 for Southwestern Agrochemical Corp. in the Salt River Valley, Ariz.; [19] Umbaugh Chemicals, Inc., at Walsenburg, Colo.; [20] and The Texas Co. at Lockport, Ill.[21]

CONSUMPTION AND USES

Agriculture continued to be the leading consumer of nitrogen and its compounds. The chemical industry, while using a small quantity of elemental nitrogen, requires most of its nitrogen in various compounds. Over 1.9 million tons of contained nitrogen was consumed by agriculture during the year ended June 30, 1955, a 6-percent increase above the previous year. The principal chemical nitrogen materials, in order of importance as fertilizers, were: (1) Ammonium nitrate and ammonium nitrate-limestone mixtures, (2) sodium nitrate, (3) anhydrous and aqua ammonia, (4) ammonium sulfate, (5) nitrogen solutions, (6) calcium cyanamide, and (7) calcium nitrate.

According to the United States Department of Agriculture, for the year ended June 30, 1955, consumption of ammonium nitrate, calcium nitrate, anhydrous ammonia, and calcium cyanamide as fertilizers increased 21, 10, 1, and 1 percent, respectively, whereas consumption of ammonium nitrate-limestone mixtures, sodium nitrate, and ammonium sulfate was 8, 5, and 3 percent less, respectively, than in 1953–54.

PRICES

Prices of nitrogen compounds remained about the same or were slightly less during 1955. The quoted prices of various nitrogen compounds at the beginning and end of 1955 and the effective date of price changes as published in the Oil, Paint and Drug Reporter, are shown in table 2.

[15] Chemical Week, vol. 77, No. 19, Nov. 5, 1955, p. 16.
[16] Manufacturers Record, $14 Million Fertilizer Plant Planned at Savannah, Ga.: Vol. 124, No. 11, November 1955, p. 47.
[17] Chemical and Engineering News, Calspray Goes All Out in Fertilizer: Vol. 33, No. 33, Aug. 15, 1955, p. 3384.
[18] Mining Congress Journal, Build Ammonia Plant: Vol. 41, No. 9, September 1955, p. 101.
[19] Commercial Fertilizer, vol. 90, No. 6, June 1955, p. 60.
[20] Oil and Gas Journal, Ammonia Plant Announced: Vol. 54, No. 24, Oct. 17, 1955, p. 95.
[21] Oil and Gas Journal, vol. 54, No. 33, Dec. 19, 1955, p. 52.

TABLE 2.—Prices of major nitrogen compounds in 1955, per short ton [1]

Commodity	Jan. 3, 1955	Dec. 26, 1955	Effective date of change
Chilean nitrate, port, warehouse, bulk	$51.25	$51.25	
Sodium nitrate, synthetic, domestic, c. l. works, crude, bulk	43.50	43.50	
Ammonium sulfate, coke ovens, bulk	42.00–47.50	42.00–45.00	Sept. 17.
Cyanamide, fertilizer-mixing grade, 20.6 percent N, granular, Niagara Falls, Ontario, bagged.	55.00	55.00	
Ammonium nitrate, fertilizer grade:			
Canadian, eastern, 33.5 percent N, c. l., shipping point, bags	74.50	70.00	Sept. 17.
Western, domestic, works, bags	68.00–70.00	68.00	
Anhydrous ammonia, fertilizer, tanks, works	85.00–88.00	85.00	Sept. 17.
Ammonium-nitrate-dolomite compound, 20.5 percent N, Hopewell, Va., bags.	51.00	51.00	

[1] Quotations from Oil, Paint and Drug Reporter of the dates listed.

FOREIGN TRADE [22]

Total imports of nitrogen compounds again decreased in 1955 and were 17 percent less than in 1954. Chilean natural-nitrate imports were 17 percent less than in 1954. The average declared value per ton at port of shipment again decreased to $35.71. Chilean potassium-sodium nitrate imports rose 46 percent more in quantity and 32 percent more in value. The average declared value per ton at port of shipment in 1955 was $41.02, a decrease of $4.28 from 1954.

Exports of nitrogen compounds continued to increase and, as in 1954, were 2½ times those in the previous year. Ammonium sulfate supplied 74 percent of all United States exports.

TABLE 3.—Major nitrogen compounds imported into and exported from the United States, 1952–55, in short tons

[U. S. Department of Commerce]

	1952	1953	1954	1955
Imports:				
Fertilizer materials:				
Ammonium nitrate mixtures:				
Containing less than 20 percent nitrogen	624	8,294	(1)	(1)
Containing 20 percent or more nitrogen	467,166	755,087	524,938	405,246
Ammonium phosphate	133,288	166,497	164,133	234,523
Ammonium sulfate	238,063	523,858	305,012	173,118
Calcium cyanamide	96,195	82,218	84,211	81,708
Calcium nitrate	39,466	67,794	68,637	56,362
Nitrogenous materials, n. e. s.:				
Organic	22,067	17,104	[2] 17,748	[2] 11,194
Inorganic and synthetic, n. e. s	(3)	(3)	16,991	7,285
Potassium nitrate, crude	12,738	15,941	732	1,118
Potassium-sodium nitrate mixtures, crude	16,460	12,516	13,228	19,300
Sodium nitrate	675,329	568,873	731,530	607,663
Exports:				
Industrial chemicals:				
Anhydrous ammonia	15,431	15,119	39,257	44,054
Ammonium nitrate	5,709	6,013	7,560	5,996
Fertilizer materials:				
Ammonium nitrate	3,833	2,172	9,402	71,919
Ammonium sulfate	121,587	39,440	202,249	612,407
Nitrogenous chemical materials, n. e. s	48,109	46,585	48,871	82,116
Sodium nitrate	9,441	24,209	25,316	11,625

[1] Effective Jan. 1, 1954, not separately classified; included in "Inorganic and synthetic materials not elsewhere specified."
[2] Due to changes in classification, data not strictly comparable with earlier years.
[3] Not separately classified.

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

TABLE 4.—Sodium nitrate and potassium-sodium nitrate imported for consumption in the United States, 1946–50 (average) and 1951–55, by countries

[U. S. Department of Commerce]

	1946–50 (average)		1951		1952		1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Sodium nitrate:												
North America:												
Canada	52	$3,030	84	$4,622	50	$4,138	1	$45			50	$2,306
South America:												
Chile	620,052	19,651,318	737,188	27,015,854	675,279	27,626,811	568,872	23,268,068	731,530	$26,817,842	607,613	21,696,516
Europe:												
France			33	3,213								
Germany	2	266	5	576								
Poland			14	968								
Total	2	266	52	4,757								
Grand total	620,106	19,654,614	737,324	27,025,233	675,329	27,630,949	568,873	23,268,113	731,530	26,817,842	607,663	21,698,822
Potassium-sodium nitrate mixtures:												
North America:												
Canada			3	148								
South America:												
Chile	6,822	280,841	8,652	389,749	16,460	830,693	12,516	626,149	13,228	599,230	19,252	789,799
Europe:												
France											13	1,324
Germany, West											35	3,779
Total											48	5,103
Grand total	6,822	280,841	8,655	389,897	16,460	830,693	12,516	626,149	13,228	599,230	19,300	794,902

TECHNOLOGY

The Belgian "L'Azote" ammonia-making process, in use throughout Europe for several years, was made available in the United States through Koppers Co. of Pittsburgh, Pa. High efficiency and good utilization of waste heat were cited as advantages.[23]

The advantages of the Stengel process for producing ammonium nitrate were discussed.[24] Comparisons of the three methods of ammonium nitrate manufacture—Stengel, prilling and crystallization processes—described recent installations using each process.[25]

Heavy fuel oil was planned as the source of hydrogen for ammonia in place of natural gas.[26] Coke-oven gas, in addition to furnishing nitrogen for nitrogen compounds, was to be used as a source of hydrogen. Coke-oven gas contains about 50 percent H_2.[27] Catformer tail gas from a catalytic reforming process was also used as a source of hydrogen for ammonia manufacture.[28]

A new process for manufacturing nitrogen-15—the heavy-nitrogen isotope used in nuclear studies—was reported to produce a 99.5-atom-percent heavy-nitrogen product for about 1/100 the cost of present processes.[29]

A nickel catalyst was reported to improve performance in natural gas-ammonia production.[30] Other new equipment developed during 1955 included a quench-type reactor for ammonia production.[31] Utilizing the heat of reaction in ammoniation has made new economies possible in nitrogenous-fertilizer manufacturing.[32]

Research showed that anhydrous ammonia, in addition to use as a plant food, acts as a fungicide.[33] Results of experimental application indicated that anhydrous ammonia makes phosphates and potash, already in the soil in nonavailable forms, available to crops.[34]

Several articles were published in 1955 discussing the advantages and disadvantages of various forms of nitrogenous materials as a plant food.[35] Several news items were published regarding improved physi-

---

[23] Chemical Engineering, European Ammonia Process Available Here: Vol. 62, No. 9, September 1955, p. 126.

[24] Kramer, J. D., Shortcut to Nitrate: Instrumentation, Minneapolis-Honeywell Regulator Co., vol. 8, No. 3, 4th Quar. 1955, pp. 12–13.

[25] Chemical Engineering, What Demand Has Done To: Ammonium Nitrate: Vol. 62, No. 7, July 1955, pp. 320–323.

[26] Weber, G., Heavy Fuel Will Supply Hydrogen: Oil Gas Jour., vol. 54, No. 20, Sept. 19, 1955, pp. 80–83.

[27] Chemical Engineering, Ammonia Via Coke-Oven Gas Nears Reality: Vol. 62, No. 1, January 1955, pp. 99–100.

[28] Arnold, J. H., and Dixon, W. T., Ammonia From Catformer Tail Gas: Oil Gas Jour., vol. 54, No. 30, Nov. 28, 1955, pp. 90, 93–95, 97.

[29] Chemical Week, New High for Nitrogen-15: Vol. 77, No. 19, Nov. 5, 1955, pp. 40, 42.

[30] Chemical Engineering, More Ammonia: Nickel Catalyst Gives Higher Ammonia Synthesis Gas Rates: Vol. 62, No. 2, February 1955, p. 146.

[31] Chemical Engineering, Design Innovations to Raise Ammonia Yield: Vol. 62, No. 9, September 1955, p. 120.

[32] Chemical Engineering, Heat of Reaction Cuts Processing Costs: Vol. 62, No. 8, August 1955, p. 124–125.

[33] Chemical and Engineering News, Anhydrous Ammonia Reported Useful as a Fungicide: Vol. 33, No. 24, June 13, 1955, p. 2497.

[34] Chemical and Engineering News, vol. 33, No. 21, May 23, 1955, p. 2211.

[35] Clark, K. G., and Gaddy, V. L., Sewage and Industrial Sludges, 1955: Farm Chem., Vol. 118, No. 10, October 1955, pp. 41–45.

Hardesty, J. O., Fertilizer Urea and Its Properties: Agric. Chem., vol. 10, No. 8, August 1955, pp. 50–51, 91, 93, 95, 97.

Hopkins, D. P., Nitrogen: Plant Response Variability: Fertiliser Feeding Stuffs Jour. (London), vol. 43, No. 8, Oct. 12, 1955, pp. 337–338, 349.

Starostka, R. W., and Clark, K. G., Urea-Biuret Mixtures: Agric. Chem., vol. 10, No. 10, October 1955, pp. 49–50, 103, 105.

cal characteristics of fertilizers and rate of availability of plant food.[36]

The use of ammonium nitrate as an explosive in an open-pit coal mine was described, and its advantages were given.[37]

WORLD REVIEW

World production and consumption of nitrogen in 1955–56 continued their upward trend and were 10 and 6 percent higher, respectively, than in 1954–55, according to the annual report of Aikman (London), Ltd.

Australia.—Eight ammonium sulfate plants were operating at the end of 1955, four of them Government owned. The new plant of Electrolytic Zinc Co., at Risdon, Tasmania,[38] began operation about midyear, but below capacity due to lack of electric power.

Austria.—Linz Stickstoffwerk, A. G., the national fertilizer industry of Austria, exported over 400,000 tons of nitrogenous fertilizer, during

TABLE 5.—World production and consumption of fertilizer nitrogen compounds, years ended June 30, 1953–56, by principal countries, in short tons of contained nitrogen

[Converted from United Nations Food and Agriculture Organization]

Country	Production			Consumption		
	1953–54	1954–55 [1]	1955–56 [2]	1953–54	1954–55 [1]	1955–56 [2]
Australia	16,800	18,400	18,800	18,900	23,300	23,700
Austria	124,000	121,600	126,700	31,800	32,600	35,300
Belgium	231,800	270,100	302,000	106,500	103,800	108,000
Canada	198,900	220,400	220,400	50,800	50,700	50,700
Chile	278,700	283,500	283,500	18,200	19,000	19,000
Czechoslovakia	38,600	38,600	38,600	44,100	44,100	44,100
Denmark				86,500	84,900	88,200
Egypt	23,900	27,300	27,300	122,500	123,500	123,500
Finland	18,200	18,100	18,700	37,600	34,200	44,100
France	314,800	456,200	529,000	325,400	384,700	402,200
Germany: East	319,600	319,600	319,600	264,500	264,500	264,500
West	711,100	743,800	743,800	484,900	495,900	495,900
Greece				41,100	49,600	66,100
Hungary	13,200	13,200	59,500	16,500	16,500	55,100
India	73,000	91,600	97,500	93,500	129,100	152,000
Italy	289,200	334,500	358,200	230,300	261,700	286,500
Japan	652,600	676,000	717,400	535,400	557,300	555,400
Korea, South				99,900	108,800	147,000
Mexico	15,700	15,900	16,500	65,300	87,100	106,300
Netherlands	286,500	320,000	336,000	189,400	200,600	200,600
Norway	207,000	214,400	220,400	37,600	39,200	39,100
Peru (Guano)	47,100	49,100	52,300	53,400	52,300	59,000
Poland	140,000	140,000	253,500	165,300	165,300	220,400
Portugal	13,700	13,700	13,700	63,500	63,500	63,500
Spain	35,900	52,900	52,900	129,600	174,100	174,100
Sweden	30,300	32,600	38,900	86,100	92,700	97,300
Taiwan (Formosa)	16,900	15,200	19,500	82,100	89,000	95,300
United Kingdom	347,100	338,300	337,200	271,900	268,100	288,000
United States	1,660,700	1,819,400	1,928,500	2,198,700	2,218,000	2,261,700
Yugoslavia	3,200	3,200	3,200	20,400	20,400	20,400
World total [3]	6,137,600	6,686,300	7,186,000	6,080,900	6,409,400	6,742,800

[1] Preliminary figures. [2] Forecast.
[3] Exclusive of U. S. S. R.; includes quantities for minor producing and consuming countries not listed above.

[36] Canadian Mining and Metallurgical Bulletin, Non-Caking Sulphate Fertilizer: Vol. 48, No. 518, June 1955, p. 314.
Chemical and Engineering News, Fertilizer Combines High Nitrogen With Slow Release: Vol. 33, No. 24, June 13, 1955, p. 2558.
Commercial Fertilizer, vol. 90, No. 6, June 1955, p. 65.
Fertiliser and Feeding Stuffs Journal (London), New Fertiliser: Vol. 42, No. 6, Mar. 16, 1955, p. 275.
[37] Nordberg, Bror., New Method of Blasting With Ammonium Nitrate: Rock Products, vol. 58, No. 6, June 1955, pp. 96, 98.
[38] Chemical Week, vol. 76, No. 26, June 25, 1955, p. 38.

the year ending June 1, 1955, to 28 countries including Egypt, Greece, Hungary, Ireland, and Yugoslavia.[39]

TABLE 6.—Revised estimates of world production and consumption of nitrogen, in thousand short tons[1]

Year	Estimated production		Estimated consumption	
	For agriculture	For industry	In agriculture	In industry
1951-52	4,873	900	4,800	900
1952-53	5,424	1,012	5,437	1,012
1953-54	6,008	1,144	5,888	1,144
1954-55	6,906	1,271	6,635	1,271
1955-56	7,654	1,355	6,998	1,355

[1] Exclusive of U. S. S. R.

SOURCE: Aikman (London), Ltd., Annual Report on the Nitrogen Industry, Dec. 10, 1956.

Brazil.—Construction of a 350-ton-per-day nitrogenous-fertilizer plant was planned at Cubatao, São Paulo, to utilize residual gases of the Cubatao oil refinery.[40]

Canada.—Consolidated Mining & Smelting Co. of Canada, Ltd., completed expansion of its ammonia capacity at Calgary, Alberta, making it the leading producer of ammonia in Canada.[41] Canadian Industries, Ltd., announced plans to build a 200-ton-per-day ammonia plant at Millhaven, Ontario.[42] Quebec Ammonia Co., Ltd., contracted for the construction of a 125-ton-per-day anhydrous ammonia and nitrogenous solutions plant at Congrecoeur, Quebec.[43] Sherritt Gordon Mines, Ltd., now operating an ammonia plant at Fort Saskatchewan, Alberta, was considering doubling the capacity to 150 tons per day.[44] A new company, Northwest Nitro-Chemicals, Ltd., formed by Commercial Solvents Corp., New British Dominion Oil Co., Ltd., and Ford, Bacon & Davis Inc., was constructing a nitrogenous-fertilizer plant at Medicine Hat, Alberta. The plant, to cost more than $20 million, will produce ammonium nitrate, ammonium phosphate, nitric acid, and sulfuric acid.[45] The ammonia plant of Dow Chemical of Canada, Ltd., at Sarnia, Ontario, and the nitrogenous-solutions plant of North American Cyanamid at Port Robinson, Ontario, began operating during 1955.[46]

Chile.—Nitrate production in 1955 dropped 2 percent compared with 1954, to 1,701,519 short tons. Total exports were 1.5 million tons, 15 percent below the previous year.

[39] Chemical Age (London), Austrian Nitrate Fertiliser: Vol. 73, No. 1892, Oct. 15, 1955, p. 850.
Chemical Week, vol. 77, No. 19, Nov. 5, 1955, p. 34.
[40] Chemical and Engineering News, vol. 33, No. 11, Mar. 14, 1955, p. 1096.
[41] Western Miner and Oil Review, Cominco Increases Fertilizer Output: Vol. 28, No. 5, May 1955, p. 48.
[42] Chemical and Engineering News, Ammonia Plants for Canada: Vol. 33, No. 27, July 4, 1955, p. 2822.
[43] Fertiliser and Feeding Stuffs Journal (London), Canadian Developments: New Ammonia Plants: Vol. 42, No. 6, Mar. 16, 1955, p. 269.
[44] American Metal Market, Sherritt Gordon Plans to Expand Ammonia Unit: Vol. 62, No. 135, July 14, 1955, p. 5.
[45] Chemical Age (London), U. S. Capital for Canadian Plant: Vol. 73, No. 1888, Sept. 17, 1955, p. 582.
Oil, Paint and Drug Reporter, Commercial Solvents Enters Canadian Fertilizer Venture: Vol. 167, No. 10, Mar. 7, 1955, p. 5.
[46] Cited in footnote 42.

The precarious financial position of the Chilean nitrate industry was stressed.[47] Revisions of laws to encourage foreign investment were being considered but were not enacted by the end of the year. The Chilean Government removed the ban on sales of nitrate to Communist-dominated countries.[48]

TABLE 7.—Exports of nitrate from Chile, 1955, by countries of destination

Country of destination	Short tons	Country of destination	Short tons
Argentina	35,484	Netherlands	40,476
Australia and New Zealand	18,899	Peru	18,547
Belgium	13,259	Portugal	31,734
Brazil	77,161	Spain	145,901
Cuba	7,650	Sweden	37,144
Denmark	16,530	United Kingdom	45,561
Egypt	24,813	United States	646,466
France	113,396	Yugoslavia	10,623
Germany	25,479	Other countries	99,014
India	9,131		
Italy	42,693	Total	1,475,310
Japan	15,349		

SOURCE: American Embassy, Santiago, Chile, State Department Dispatch 763: Apr. 20, 1955, p. 1, encl. 2; No. 171, Aug. 31, 1955, p. 1, encl. 3; No. 386, Nov. 30, 1955, p. 1, encl. 2; No. 591, Feb. 7, 1956, p. 1, encl. 1.

Germany, East.—Plans to build a 48,000-ton-per-year nitrogen plant at Salzgitter in lower Saxony to utilize waste gases from an iron and steel plant were announced.[49]

Hungary.—A new ammonia plant was under construction at Kazincbarcika in north Hungary by the Borsod Chemical Works.[50]

India.—Production of nitrogenous fertilizers in 1955, mainly ammonium sulfate, was reported from the Government-owned Sindri Fertilisers and Chemicals, Ltd., plant at Sindri and private plants at Mysore and Travancore.[51] Expansion of the Sindri plant was announced to include facilities for manufacturing urea, ammonium sulfate-nitrate, nitric acid, and anhydrous ammonia.[52]

New nitrogenous-fertilizer plants were planned or being built at Nangal, Punjab; South Arcot, Madras; Hanumangarh, Rajasthan.[53]

Italy.—Production of nitrogen compounds and nitrogenous fertilizers again was higher in 1955. The output of ammonia (NH_3 content), nitric acid (36° B.) and nitrogenous fertilizers (N content) were 448,610; 910,792; and 350,424 short tons, respectively.[54]

ANIC, owned by a group of Italian-Government-controlled oil companies was constructing a nitrogenous fertilizer plant at Ravenna with an announced capacity of 350,000 tons per year.[55]

[47] Chemical and Engineering News, Chilean Nitrate Needs Capital: Vol. 33, No. 19, May 9, 1955, p. 1974. Fertiliser and Feeding Stuffs Journal (London), Chilean Nitrate Industry: Vol. 42, No. 12, June 8, 1955, p. 531.
[48] Chemical Age (London), Nitrate Ban Lifted: Vol. 73, No. 1888, Sept. 17, 1955, p. 584.
[49] Chemical and Engineering News, Germany Enlarges Synthetic Ammonia Capacity: Vol. 33, No. 26, June 27, 1955, pp. 2714–2715.
[50] Fertiliser and Feeding Stuffs Journal (London), Hungaria Ammonia Plant: Vol. 42, No. 6, Mar. 16, 1955, p. 269.
[51] Fertiliser and Feeding Stuffs Journal (London), Recent Developments in India's Fertiliser Industry: Vol. 43, No. 5, Aug. 31, 1955, pp. 194, 196, 201.
[52] Chemical Week, vol. 76, No. 23, June 4, 1955, p. 30; vol. 77, No. 8, Aug. 20, 1955, p. 28.
[53] Canada Foreign Trade, Fertilizer Factories: Vol. 103, No. 10, May 14, 1955, p. 27.
[54] American Consulate, Milan, Italy, State Department Dispatch 78, Enclosure 1: Dec. 27, 1956, pp. 16–17.
[55] Chemical Engineering, Italy Will Make Rubber and Fertilizers: Vol. 62, No. 3, March 1955, p. 132.

Japan.—Both production and exports of ammonium sulfate were greater in 1955 as compared with 1954. Most of the exports went to Formosa, South Korea, China, Philippines, and Thailand.[56]

Korea, North.—It was reported that production of ammonium nitrate at the Bon Gung Chemical Works was tripled in 1955 compared with 1954. The North Korean Government was assisting the fertilizer industry by subsidies.[57]

Korea, South.—A urea-fertilizer plant was being constructed at Chungju. The plant, scheduled for completion in early 1957, with an annual capacity of 85,000 tons of urea, will supply about one-third of South Korea's agricultural-nitrogen requirements.[58]

Netherlands.—The Nitrogen Fixation Works (SBB) of the Netherlands State Mines, with a rated annual capacity of 700,000 tons of nitrogenous fertilizers, supplied over 50 percent of the domestic needs and exported appreciable quantities. Products included ammonium sulfate, calcium ammonium nitrate, phosphate ammonium nitrate, calcium nitrate, and nitric acid. Urea was produced in a pilotplant.[59]

Pakistan.—The ammonium sulfate plant under construction at Daudkhel, with a capacity of 50,000 tons, was scheduled for completion in 1956. Additional ammonium sulfate plants were being considered at Sind and Baluchistan.[60]

Peru.—Fertilizantes Sinteticos S. A. reported plans to construct a petrochemical plant at a cost of $7 million. Products will include nitric acid and nitrogenous fertilizers.[61]

Portugal.—Under the national development plan, expansion of nitrogenous-fertilizer facilities included enlarging the ammonium sulfate plants of Amoniaco Portugues at Estarreja and of Cia Uniao Fabril do Azoto at Barreiro, and construction of a new ammonium nitrate plant was under consideration at an undisclosed location.[62]

Turkey.—Construction of the nitrogen plant at Kutahya was begun during 1955 and was scheduled for completion by mid-1958. This plant with a planned annual capacity of 110,000 tons will produce nitric acid, ammonium nitrate, and ammonium sulfate.[63]

United Kingdom.—Shell Chemical Co., Ltd., announced plans to build an ammonia and nitric acid plant at Shell Haven, Essex County, with a rated capacity of 75,000 tons of ammonia per year.[64]

---

[56] Fertiliser and Feeding Stuffs Journal (London), Japan's Sulphate Production: Vol. 43, No. 6, Sept. 14, 1955, p. 238.
[57] Chemical Week, vol. 77, No. 13, Sept. 24, 1955, p. 38.
[58] Chemical Week, vol. 76, No. 23, June 4, 1955, p. 30.
Foreign Commerce Weekly, New Fertilizer Plant Under Construction in Korea: Vol. 54, No. 21, Nov. 21, 1955, p. 28.
[59] Fertiliser and Feeding Stuffs Journal (London), Dutch Firm's 25th Anniversary: Vol. 43, No. 2, July 20, 1955, p. 64.
[60] Chemical Age (London), Fertiliser Projects: Vol. 73, No. 1884, Aug. 20, 1955, p. 384.
[61] Chemical Week, vol. 77, No. 13, Sept. 24, 1955, p. 14.
[62] Chemical and Engineering News, Portugal Ups Fertilizer Output: Vol. 33, No. 21, May 23, 1955, p. 2215.
[63] Oil, Paint and Drug Reporter, Nitrogen Plant Construction in Turkey Now Under Way: Vol. 168, No. 24, Dec. 12, 1955, p. 5.
[64] Chemical Week, vol. 77, No. 22, Nov. 26, 1955, pp. 58, 60.

Perlite

By L. M. Otis [1] and Annie L. Marks [2]

EVERY year since 1946, when expanded perlite first became a commercial product, the quantity produced and the value of both crude and expanded perlite have increased.

DOMESTIC PRODUCTION

Crude Perlite.—Eleven companies with 14 mines produced crude perlite in 6 States during 1955 compared with 15 firms operating 17 mines in 1954. Of the 1955 operating mines, 2 produced for their own use only, 6 only sold to others, and 6 produced for both their own expanding facilities and that of others. Both total tonnage and value for 1955 were 30 percent greater than in the previous year.

Total crude perlite mined in the United States in 1955 was 335,000 short tons; 147,800 tons (44 percent) come from New Mexico. Other producing States, in order of output, were Colorado, Nevada, California, Arizona, and Utah.

TABLE 1.—Crude and expanded perlite produced and sold or used by producers in the United States, 1951–55

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
1951	154,174	110,119	$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
1953	213,532	141,282	1,072,065	57,469	367,593	175,234	174,461	9,254,374
1954	261,024	154,531	1,375,706	65,172	386,394	196,447	195,499	10,278,745
1955	335,187	198,446	1,778,894	87,711	502,738	246,730	246,343	12,585,297

Expanded Perlite.—Eighty-one plants, operated by 64 companies, produced expanded perlite during 1955 compared with 81 plants operated by 72 companies in 1954. The quantity sold or used in 1955 increased 26 percent over 1954, while the value was 22 percent greater than in the previous year.

Mine and Plant Developments.—Great Lakes Carbon Corp. greatly increased the production rate of its mine in Custer County, Colo. The crude perlite was shipped to the company crushing, drying, and

[1] Commodity specialist.
[2] Statistical assistant.

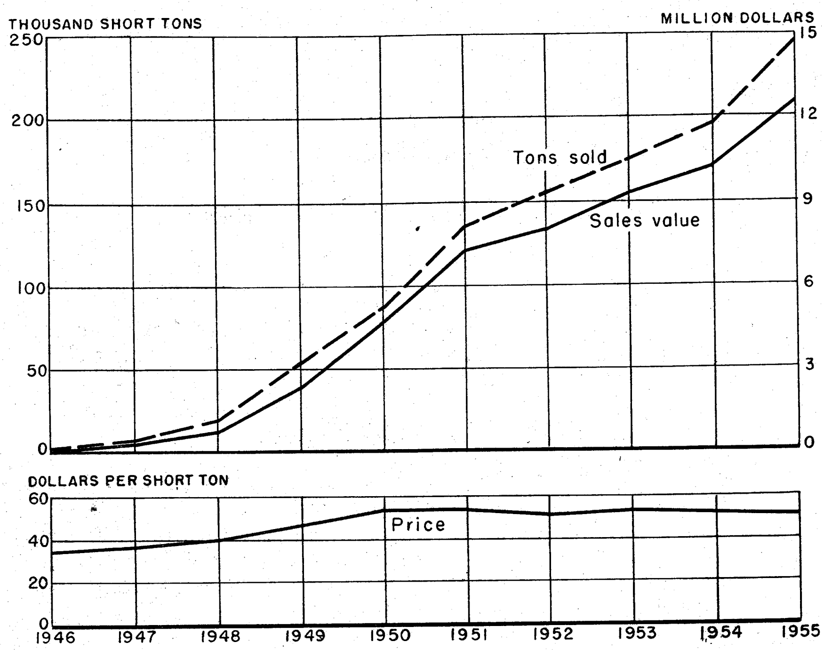

FIGURE 1.—Sales and value of expanded perlite and price per ton, 1946–55.

TABLE 2.—Expanded perlite produced and sold by producers in the United States, 1954–55, by States

State	1954				1955			
	Produced (short tons)	Sold			Produced (short tons)	Sold		
		Short tons	Value	Average value per ton		Short tons	Value	Average value per ton
California	25, 354	24, 794	$1, 079, 775	$43. 55	25, 764	25, 611	$1, 349, 947	$52. 71
Florida	5, 301	5, 109	336, 398	65. 84	5, 667	5, 617	379, 618	67. 58
Illinois	10, 877	10, 952	573, 513	52. 37	16, 662	16, 637	951, 871	57. 21
New Jersey	4, 179	4, 174	203, 830	48. 83	9, 741	9, 741	532, 726	54. 69
Ohio	10, 064	9, 868	753, 649	76. 37	10, 569	10, 606	791, 365	74. 61
Pennsylvania	15, 234	15, 289	960, 954	62. 85	16, 850	16, 921	1, 057, 077	62. 47
Other Western States [1]	62, 392	62, 296	3, 181, 755	51. 07	82, 542	82, 335	3, 666, 942	44. 54
Other Eastern States [2]	63, 046	63, 017	3, 188, 871	50. 60	78, 935	78, 875	3, 855, 751	48. 88
Total	196, 447	195, 499	10, 278, 745	52. 58	246, 730	246, 343	12, 585, 297	51. 09

[1] Includes Arizona, Arkansas, Colorado, Iowa, Kansas, Louisiana, Minnesota, Missouri, Nebraska, Nevada, New Mexico, Oklahoma (1954 only), Oregon, South Dakota (1954 only), Texas, and Utah.
[2] Includes Indiana, Maryland, Massachusetts, Michigan, New York, North Carolina, Tennessee, Virginia, and Wisconsin.

sizing plant at Florence, Colo., for reshipment to various expanding operations.[3] This company also leased with option to purchase the properties of California Perlite Corp. at Klondike, Calif., including both the perlite mine and plant.[4]

[3] The Mines Magazine, vol. 45, No. 1, January 1955, p. 33.
[4] Rock Products, Acquire Perlite Mine: Vol. 58, No. 5, May 1955, p. 41.
Mining World (News item), vol. 17, No. 6, May 1955, pp. 102–103.

Great Lakes Carbon Corp. announced franchise agreements with 4 more companies to expand perlite under the "Permalite" trade name, bringing to 23 the total number of companies in the Permalite group. New franchise recipients were: Gregg Products Co., Grand Rapids, Mich.; Buffalo Perlite Corp., Buffalo, N. Y.; Perlite Industries, Reg'd., Pierre, Quebec; and Perlite Products, Ltd., Winnipeg, Manitoba. Among those holding Permalite franchises, the following changes of names were announced: New Jersey Perlite Corp. of Hillside, N. J., changed to Certified Industrial Products, Inc.; Precast Slab & Tile Co., St. Louis, Mo., changed to Federal Cement Tile Co., St. Louis Division.[5]

International Minerals & Chemical Corp. purchased all of the assets of U. S. Mining Co. and Peerless Perlite Co. The assets include large reserves of high-quality perlite in Inyo County, a drying and grinding plant near Big Pine, and a perlite-expanding plant with headquarters in Los Angeles, Calif.[6]

U. S. Gypsum Co. started production from a new perlite plant at Grants, N. Mex. The mine is 9 miles from the mill, and haulage was done by truck.[7] The company also applied to patent 14 mining claims, presumed to have potential perlite reserves, in Pershing County, Nev.[8] This company announced plans to install perlite-expanding equipment in its Boston plant, where building plasters and gypsum-board products are now being produced.[9]

Combined Metals Reduction Co. mined, crushed, and sized perlite at Pioche, Nev. The product was shipped for expanding to the company facilities at Bauer, Utah, and to affiliate expanders in Los Angeles and Kansas City. A propane-fired, 24-inch by 24-foot-high vertical kiln was used.[10]

Western Mineral Products Co. installed a perlite-processing plant in Minneapolis, adjoining its vermiculite-exfoliating operation.[11]

CONSUMPTION AND USES

Crude Perlite.—Substantially all perlite used was in the expanded form. Consumption data for crude used by producers and sold to others for expanding are shown in table 1.

Expanded Perlite.—Plaster aggregate for both premixed and job-mixed plasters comprised 77 percent of total perlite sales in 1955 compared with 81 percent in 1954.

Following were uses in 1955: Concrete aggregate, 13 percent of the total, 2 percent more than in 1954; drilling muds and concrete used in oil wells, 5 percent, a 1½-percent increase over 1954; filter aids, 1 percent in both 1954 and 1955; and miscellaneous uses, 4 percent compared with 5 percent in 1954. The miscellaneous uses included loose-fill insulation, horticulture, paint filler, refractory brick, and absorbent for oils.

---

[5] Rock Products, Perlite Franchisees: Vol. 58, No. 1, January 1955, p. 77.
[6] Mining World, vol. 17, No. 4, April 1955, p. 85.
[7] Pit and Quarry, U. S. Gypsum Co. Perlite Mill Opened at New Mexico Site: Vol. 48, No. 4, October 1955, p. 24.
[8] California Mining Journal, U. S. Gypsum Applying for Patents: Vol. 24, No. 12, August 1955, p. 25.
[9] Plastering Industries, USG Enlarges Perlite: September 1955, p. 54.
[10] Pit and Quarry, Combined Metals Reduction Processing Perlite in Utah: Vol. 47, No. 12, June 1955, p. 141.
[11] Rock Products, Perlite-Processing Plant: Vol. 58, No. 2, February 1955, p. 60.

The Perlite Institute estimated that almost 50 percent of all base-coat plasters now contain some perlite.

PRICES

Crude perlite, in marketable form for processors, had an average mill value of $8.96 per short ton in 1955 compared with $8.90 in the previous year and $7.59 in 1953. The reported average mill value of crude processed by those companies which also mined it was $5.73 per short ton in 1955 compared with $5.93 during the previous year and $6.40 in 1953. Combining these classifications, the average for all crude perlite sold or used in 1955 was $7.97 compared with $8.02 in 1954 and $7.24 in 1953.

The 1955 average value of expanded perlite packed in bags f. o. b. plant was $51.09 per short ton, 3 percent less than the 1954 value of $52.58. The 1953 average value was $53.05.

TECHNOLOGY

Patents.—Expanded perlite was mentioned as a partial replacement material for diatomite, which, when combined with lime, can be made into molded thermal insulation of high strength and low density.[12]

Expanded perlite is included among suitable siliceous materials to be used in making a product for improving the resistance of metal surfaces to high temperatures.[13]

A patented synthetic lightweight aggregate can be made of expanded perlite and clay, formed as a slurry, extruded, pelletized, and dried.[14]

Expanded perlite was included among mineral fillers to be used in a rubber-asphalt composition for surfacing roads.[15]

New types of refractory units include expanded perlite in their composition.[16]

Expanded perlite was one of the lightweight mineral aggregates recommended for use in new types of lightweight-aggregate masses.[17]

A new type of wallboard consists of expanded perlite with a synthetic resin binder.[18] Another new type of wallboard composition employs asbestos, diatomite, and expanded perlite.[19] Another patent relates to the same type of wallboard composition but includes both expanded and unexpanded perlite.[20]

A new type of expanded perlite aggregate was patented.[21]

---

[12] Binkley, M. F. (assigned to Johns-Manville Corp., New York, N. Y.), Method of Manufacturing Heat-Insulating Shapes: U. S. Patent 2,699,097, Jan. 11, 1955.

[13] Martens, C. R., and Bellamy, J. S. (assigned to Sherwin-Williams Co., Cleveland, Ohio), Resinous Composition Method of Coating Metals Therewith to Increase High-Temperature Resistance Thereof and Article Produced Thereby: U. S. Patent 2,699,407, Jan. 11, 1955.

[14] Hashimoto, T. (assigned to The Research Counsel, Inc., Denver, Colo.), Synthetic Lightweight Aggregate: U. S. Patent 2,699,409, Jan. 11, 1955.

[15] Endres, H. A., Shaw, J. W., Jr., and Pullar, H. B. (assigned to Wingfoot Corp., Dayton, Ohio), Rubber Compositions: U. S. Patent 2,700,655, Jan. 25, 1955.

[16] Parsons, J. R. (assigned to Chicago Fire Brick Co., Chicago, Ill.), Plastic Insulating Refractory Composition: U. S. Patent 2,702,752, Feb. 22, 1955.

[17] Willson, C. D., Cement-Bound Lightweight-Aggregate Masses: U. S. Patent 2,703,289, Mar. 1, 1955.

[18] Seybold, H. S., Method of Cladding Binder-Containing Board Compositions With Sheet Material: U. S. Patent 2,704,965, Mar. 29, 1955.

[19] Seybold, H. S., Wallboard Composition and Method of Making Same: U. S. Patent 2,705,197, Mar. 29, 1955.

[20] Seybold, H. S., Wallboard Composition and Method of Making Same: U. S. Patent 2,705,198, Mar. 29, 1955.

[21] Chertkof, J. O., Lightweight Aggregate and Method of Producing the Same: U. S. Patent 2,727,827, Dec. 20, 1955.

A patent was issued covering the bonding of expanded perlite fines with clay and firing at 1,600° to 2,000° F. to form an aggregate without producing a glazed surface.[22]

Processing.—Operating details of perlite processing, together with an analysis of various types of furnaces and other equipment, were published.[23] Control of the four principal operational variables were explained. These variables were as follows: Nature of the perlite rock used; maximum temperature reached by the perlite particles; extent to which water has been driven from the particles before reaching their softening point; and size distribution of furnace feed.

An article discussed practical problems in the processing of perlite, including mining, milling and expanding.[24]

Use.—Details of modern ceiling construction prepared for use with perlite plaster, which is said to improve fire resistance of the structure, were outlined in an article.[25]

The fire-resistant qualities of a roof made with a slab of perlite concrete over 24-gage, corrugated-steel, roof deck were described.[26]

By adding diatomaceous earth to a perlite-cement mix a building block is produced which is relatively whiter. It is said to reflect more sunlight and to be more water-repellent than conventional perlite blocks.[27]

Modern construction design, in which perlite concrete and plaster are used, was outlined in a publication of the Perlite Institute.[28] Features described were: The control of heat and sound in roof decks; the nailability of perlite concrete; winter advantages of premixed perlite plaster; and perlite insulation for subfloor heating ducts.

WORLD REVIEW

Associate members of Perlite Institute, 45 West 45th St., New York, N. Y., in foreign countries include 2 firms in Australia, 2 in England, and 1 each in Mexico, New Zealand, and Venezuela.

NORTH AMERICA

Canada.—Production of expanded perlite in 1955 was 1.8 million cubic feet valued at $437,000 compared with 1.95 million cubic feet with a value of $585,000 in 1954. The total value of perlite, pumice, and vermiculite processed from imported raw materials in 1955 in Canada increased 8 percent from the previous year, indicating a gain in the use of competitive materials. Perlite was expanded in the following Canadian plants during 1955: Perlite Products, Ltd., Winnipeg, Manitoba; Perlite Industries Reg'd., Ville St., Pierre, Quebec; Montreal Perlite Industries, Montreal, Quebec; Canadian Perlite

[22] Hashimoto, Tadaichi (assigned to Research Counsel, Inc., Denver, Colo.), Lightweight Aggregates of Perlite Fines and Clay: U. S. Patent 2,728,733, Dec. 27, 1955.
[23] Stein, N. A., and Murdock, J. B., The Processing of Perlite: California Jour. Mines and Geol., vol. 51, No. 2, April 1955, pp. 105-116.
[24] Weber, Robert H., Processing Perlite—the Technologic Problems: Min. Eng., vol. 7, No. 2, February 1955, pp. 174-176.
[25] Red Topics, Diagonal Wires Increase Fire Rating: U. S. Gypsum Corp., issue 3, 1955.
[26] Concrete, Perlite Concrete on Steel Wins Hour Fire Rating: Vol. 63, No. 12, December 1955, p. 28.
[27] Rock Products, Whiter Block: Vol. 58, No. 4, April 1955, p. 241.
[28] The Perlite Torch, Double-Duty Roof Deck Controls Heat and Sound: Perlite Inst., vol. 5, No. 1, 1955, 4 pp.

457676—58——56

Corp., Montreal, Quebec; Gypsum, Lime & Alabastine (Canada) Ltd., Caledonia, Ontario; and Western Perlite Co., Ltd., Calgary, Alberta.

EUROPE

Iceland.—Perlite deposits in Iceland are said to have commercial possibilities, but no definite plans for development have been announced.

Northern Ireland.—A perlite deposit in County Antrim was explored.[29]

[29] Mining Journal (London), Development of Northern Ireland Perlite Deposits: Vol. 244, No. 6236, Feb. 25, 1955, p. 207.

Phosphate Rock

By E. Robert Ruhlman [1] and Gertrude E. Tucker [2]

DESPITE a prolonged labor strike in the Florida land-pebble field and political disturbances in North Africa, world production of phosphate rock was greater by 2 percent in 1955 than in 1954.

TABLE 1.—Salient statistics of the phosphate-rock industry in the United States, 1954–55

	1954				1955			
	Long tons		Value at mines		Long tons		Value at mines	
	Rock	P_2O_5 content	Total	Average	Rock	P_2O_5 content	Total	Average
Mine production	45,585,837	5,745,425	(1)	(1)	39,670,598	4,983,735	(1)	(1)
Marketable production [2]	13,821,100	4,359,955	[3] $86,669,081	[3] $6.27	12,265,248	3,886,732	[3] $75,379,250	[3] $6.15
Sold or used by producers:								
Florida:								
Land pebble	9,565,529	3,189,941	58,890,565	6.16	9,401,168	3,148,810	57,973,651	6.17
Soft rock	90,519	18,835	554,234	6.12	72,070	14,861	466,168	6.47
Hard rock	74,303	26,184	585,363	7.88	91,907	32,386	739,289	8.04
Total Florida	9,730,351	3,234,960	60,030,162	6.17	9,565,145	3,196,057	59,179,108	6.19
Tennessee	1,700,572	437,675	12,012,314	7.06	1,699,395	447,716	12,579,056	7.40
Western States:								
Idaho	878,920	231,833	4,299,824	4.89	1,122,012	297,122	5,550,745	4.95
Montana and Wyoming [4]	733,981	218,846	5,167,756	7.04	799,482	238,637	5,595,075	7.00
Total Western States	1,612,901	450,679	9,467,580	5.87	1,921,494	535,759	11,145,820	5.80
Total United States	13,043,824	4,123,314	81,510,056	6.25	13,186,034	4,179,532	82,903,984	6.29
Imports	122,016	(1)	[5] 3,081,430	[5] 25.25	117,256	(1)	[5] 2,702,955	[5] 23.05
Exports [6]	2,278,572	752,011	14,971,010	6.57	2,183,084	719,695	14,269,300	6.54
Apparent consumption [7]	10,887,268	(1)			11,120,206	(1)		
Stocks in producers' hands Dec. 31: [6]								
Florida	2,309,000	754,000	(1)	(1)	1,491,000	492,000	(1)	(1)
Tennessee [8]	463,000	124,000	(1)	(1)	229,000	65,000	(1)	(1)
Western States	[9] 596,000	[9] 160,000	(1)	(1)	[10] 1,085,000	[10] 274,000	(1)	(1)
Total stocks	[9] 3,368,000	[9] 1,038,000	(1)	(1)	[10] 2,805,000	[10] 831,000	(1)	(1)

[1] Data not available.
[2] See table 2 for kind of material produced.
[3] Derived from reported value of "sold or used."
[4] Includes a quantity from Utah.
[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 quantity of washer-grade ore (matrix).
[9] Revised figure.
[10] Tonnage reflects midyear stock adjustments and stocks reported in midyear by producers who did not report production to the Bureau of Mines previous to July 1, 1955.

[1] Commodity specialist.
[2] Statistical assistant.

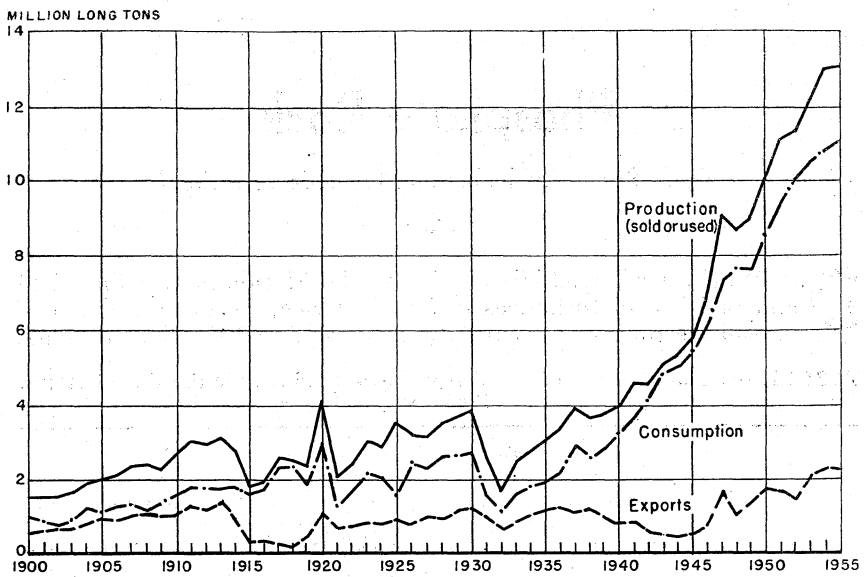

FIGURE 1.—Marketed production, apparent consumption, and exports of phosphate rock, 1900–55.

DOMESTIC PRODUCTION

Phosphate-rock ore mined in the United States in 1955 totaled 39.7 million long tons, a 13-percent decrease from the record production of more than 45.5 million tons in 1954. Total marketable production decreased 11 percent, although production in the Western States increased. Florida supplied 71 percent of the production; Western States, 17 percent; and Tennessee, 12 percent.

Nearly all the Florida land-pebble operations were interrupted by a labor strike beginning early in June. Full-scale land-pebble production was resumed in October. Sales of phosphate rock were not affected, however, as enough stocks were on hand to fill orders.

American Cyanamid Co. announced plans to build a 200,000-ton-per-year triple superphosphate plant at Brewster, Fla., adjoining its existing phosphate-rock facilities. Completion of the plant was scheduled for mid-1957. American Cyanamid purchased an additional 1,000 acres of land southeast of Bartow.[3]

International Minerals & Chemical Corp. purchased the Tennessee Valley Authority Godwin phosphate-rock washing and drying plant north of Columbia, Tenn. The transaction also included some 400 acres containing phosphate deposits in the same vicinity. I. M. C. C. planned to produce furnace-grade rock, acid-grade rock, and direct-application rock.[4]

Shea Chemical Corp. began constructing a second 20,000-ton-per-year elemental phosphorus electric furnace at its plant north of Columbia, Tenn. Shea also announced plans to construct a washing

---

[3] Mining World, vol. 17, No. 3, March 1955, p. 85.
[4] Mining Congress Journal, vol. 41, No. 7, July 1955, p. 62

and processing plant before beginning phosphate-rock mining operations.[5]

Montana Phosphate Products Co., Garrison, Mont., began a $2 million expansion program, which included a 10,700-foot haulage adit, a 4.7-mile railroad spur, and development of an open pit. The announced plans called for production of 1,000 tons per day by mid-1957.[6]

J. R. Simplot Co. announced plans to begin stripping and mining at its new Centennial mine in Clark County, Idaho, and Beaverhead County, Mont. Shipments were scheduled for mid-1956.[7]

San Francisco Chemical Co. was developing a new underground mine in Rich County, Utah.[8]

Central Farmers Fertilizer Co., owned by more than 15 midwest cooperatives, was again considering construction of an elemental phosphorus electric furnace at Georgetown, Idaho.[9]

The Potash Company of America announced plans to drive an exploratory crosscut for phosphate rock near Paris, Idaho.[10]

The National Fertilizer Association and the American Plant Food Council consolidated and formed the National Plant Food Institute.

TABLE 2.—Marketable production of phosphate rock in the United States, 1946–50 (average) and 1951–55, by States, in long tons

Year	Florida [1]	Tennessee [2]	Western States [3]	United States
1946–50 (average)	6,827,723	1,436,224	867,977	9,131,924
1951	8,211,820	1,424,516	1,138,696	10,775,032
1952	9,205,138	1,444,737	1,415,017	12,064,892
1953	9,331,002	1,518,912	1,653,916	12,503,830
1954	10,437,197	1,633,226	1,750,677	13,821,100
1955	8,747,282	1,465,902	2,052,064	12,265,248

[1] Salable products from washers and concentrators of land pebble and hard rock, and drier production of soft rock (colloidal clay).
[2] Salable products from washers and concentrators of brown rock, brown-rock ore (matrix) used directly, blue rock in 1946 and 1954–55, white rock in 1953–55, and a small quantity of apatite from Virginia in 1946–47.
[3] Mine production of ore (rock), plus a quantity of washer and drier production.

CONSUMPTION AND USES

Continuing the upward trend since 1945, apparent consumption of phosphate rock rose 2 percent above the 1954 figure and was 104 percent greater than in 1945.

Phosphate rock was sold or used primarily for ordinary superphosphate (38 percent in 1955 and 39 percent in 1954), triple superphosphate, including wet-process phosphoric acid (15 percent in 1955 and 13 percent in 1954), direct application to soil (6 percent in 1955 and 6 percent in 1954), and elemental phosphorus (22 percent in 1955 and 23 percent in 1954).

[5] Chemical and Engineering News, vol. 33, No. 16, Apr. 18, 1955, p. 1660.
[6] Mining World, Montana Phosphate Starts Open Pit to Mine Thin Ore Bed on 24° Slope: Vol. 17, No. 12, November 1955, pp. 44–46.
Western Mining and Industrial News, vol. 23, No. 6, June 1955, p. 26; vol. 23, No. 11, November 1955, p. 26.
[7] Engineering and Mining Journal, vol. 156, No. 11, November 1955, p. 138.
[8] Engineering and Mining Journal, vol. 156, No. 10, October 1955, p. 160.
[9] Commercial Fertilizer, vol. 90, No. 6, June 1955, p. 60.
[10] Chemical Week, vol. 77, No. 23, Dec. 3, 1955, p. 14.

TABLE 3.—Apparent consumption[1] of phosphate rock in the United States, 1946–50 (average) and 1951–55, in long tons

Year	Long tons	Year	Long tons
1946–50 (average)	7,532,664	1953	10,557,765
1951	9,511,545	1954	10,887,268
1952	10,032,406	1955	11,120,206

[1] Quantity sold or used by producers plus imports minus exports.

TABLE 4.—Phosphate rock sold or used by producers in the United States, 1946–50 (average) and 1951–55

Year	Long tons	Value at mines	
		Total	Average
1946–50 (average)	8,759,399	$47,725,426	$5.45
1951	11,095,204	66,158,078	5.96
1952	11,324,158	68,120,918	6.02
1953	12,517,923	76,597,075	6.12
1954	13,043,824	81,510,056	6.25
1955	13,186,034	82,903,984	6.29

TABLE 5.—Florida phosphate rock sold or used by producers, 1946–50 (average) and 1951–55, by kinds

Year	Hard rock			Soft rock [1]		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1946–50 (average)	64,707	$492,171	$7.61	82,730	$352,216	$4.26
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
1953	81,725	643,993	7.88	75,910	470,062	6.19
1954	74,303	585,363	7.88	90,519	554,234	6.12
1955	91,907	739,289	8.04	72,070	466,168	6.47

Year	Land pebble			Total		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1946–50 (average)	6,438,294	$34,136,842	$5.30	6,585,731	$34,981,229	$5.31
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
1953	9,009,220	54,498,217	6.05	9,166,855	55,612,272	6.07
1954	9,565,529	58,890,565	6.16	9,730,351	60,030,162	6.17
1955	9,401,168	57,973,651	6.17	9,565,145	59,179,108	6.19

[1] Includes material from waste-pond operations.

TABLE 6.—Tennessee phosphate rock [1] sold or used by producers, 1946–50 (average) and 1951–55

Year	Long tons	Value at mines	
		Total	Average
1946–50 (average)	1,362,187	$8,424,167	$6.18
1951	1,419,892	10,604,638	7.47
1952	1,452,508	10,874,760	7.49
1953	1,622,170	12,251,117	7.55
1954	1,700,572	12,012,314	7.06
1955	1,699,395	12,579,056	7.40

[1] Includes small quantity of Tennessee blue rock in 1946–47 and 1954–55, white rock in 1952–55, and Virginia apatite in 1946–47 and 1949.

TABLE 7.—Western States phosphate rock sold or used by producers, 1946–50 (average) and 1951–55

Year	Idaho [1]			Montana [2]		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1946–50 (average)	527,286	$2,409,054	$4.57	246,038	$1,713,858	$6.97
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
1953	1,070,773	4,090,599	3.82	658,125	4,643,087	7.06
1954	878,920	4,299,824	4.89	733,981	5,167,756	7.04
1955	1,122,012	5,550,745	4.95	799,482	5,595,075	7.00

Year	Wyoming			Total		
	Long tons	Value at mines		Long tons	Value at mines	
		Total	Average		Total	Average
1946–50 (average) [3]	38,158	$197,119	$5.17	811,482	$4,320,031	$5.32
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
1953	(2)	(2)	(2)	1,728,898	8,733,686	5.05
1954	(2)	(2)	(2)	1,612,901	9,467,580	5.87
1955	(2)	(2)	(2)	1,921,494	11,145,820	5.80

[1] Idaho includes Utah in 1946–48 and 1950–52, and Wyoming in 1949–50.
[2] Montana includes Utah and Wyoming in 1953–55.
[3] Includes Wyoming data for 1947–48 only.

TABLE 8.—Phosphate rock sold or used by producers in the United States in 1954–55, 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
1954								
Below 60	221,850	2	1,222,007	72	811,908	50	2,255,765	17
60 to 66	60,599	1	288,931	17	70,419	4	419,949	3
68 basis, 66 minimum	1,700,830	17	103,785	6	308,463	19	2,113,078	16
70 minimum	1,198,807	12	85,544	5	351,154	22	1,635,505	13
72 minimum	1,378,940	14			70,957	5	1,449,897	11
75 basis, 74 minimum	3,656,293	38	305	(2)			3,656,598	28
77 basis, 76 minimum	1,513,032	16					1,513,032	12
Total	9,730,351	100	1,700,572	100	1,612,901	100	13,043,824	100
1955								
Below 60	146,860	1	1,172,312	69	999,670	52	2,318,842	17
60 to 66	} 1,784,471	19	374,048	22	} 414,635	22	630,623	5
68 basis, 66 minimum			} [3] 153,035	[3] 9			} 3,308,181	25
70 minimum	859,014	9			353,601	18		
72 minimum	1,658,896	17			153,252	8	1,812,148	14
75 basis, 74 minimum	3,716,211	39	(3)	(3)	336	(2)	3,716,547	28
77 basis, 76 minimum	[4] 1,399,693	15					[4] 1,399,693	11
Total	9,565,145	100	1,699,395	100	1,921,494	100	13,186,034	100

[1] Bone phosphate of lime, $Ca_3(PO_4)_2$.
[2] Less than 0.5 percent.
[3] Some 75 basis, 74 minimum grade included with 70 minimum grade.
[4] Includes a small quantity of higher grade rock.

TABLE 9.—Phosphate rock sold or used by producers in the United States, 1954–55, by uses and States

(In long tons)

Uses	Florida		Tennessee		Western States		Total United States	
	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content	Rock	P_2O_5 content
1954								
Domestic:								
Agricultural:								
Ordinary superphosphate	4,912,435	1,668,767	77,113	24,297	79,628	25,457	5,069,176	1,718,521
Triple superphosphate	1,036,406	337,293	40,832	11,392	[1] 220,481	[1] 68,922	1,297,719	417,607
Nitraphosphate	12,851	4,403	---	---	---	---	12,851	4,403
Direct application to soil	543,003	165,922	166,829	49,700	64,184	20,539	774,016	236,161
Stock and poultry feed	124,747	39,074	18,617	5,585	893	286	144,257	44,945
Fertilizer filler	---	---	13,764	2,975	---	---	13,764	2,975
Other [2]	---	---	45,942	12,648	---	---	45,942	12,648
Total agricultural	6,629,442	2,215,459	363,097	106,597	365,186	115,204	7,357,725	2,437,260
Industrial:								
Elemental phosphorus, ferrophosphorus, phosphoric acid	696,866	224,505	1,333,158	329,888	934,130	236,671	2,964,154	791,064
Phosphoric acid (wet process)	439,056	141,789	---	---	(1)	(1)	439,056	141,789
Other [3]	---	---	4,317	1,190	---	---	4,317	1,190
Total industrial	1,135,922	366,294	1,337,475	331,078	934,130	236,671	3,407,527	934,043
Exports [4]	1,964,987	653,207	---	---	313,585	98,804	2,278,572	752,011
Grand total	9,730,351	3,234,960	1,700,572	437,675	1,612,901	450,679	13,043,824	4,123,314
1955								
Domestic:								
Agricultural:								
Ordinary superphosphate	4,618,100	1,587,070	[5] 209,628	[5] 58,557	126,097	39,696	4,953,825	1,685,323
Triple superphosphate	[1] 1,598,910	[1] 517,980	(5)	(5)	[1] 378,183	[1] 119,140	1,977,093	637,120
Nitraphosphate	(6)	(6)	---	---	---	---	(6)	(6)
Direct application to soil	661,702	203,886	144,076	42,951	19,769	6,324	825,547	253,161
Stock and poultry feed } Fertilizer filler }	189,309	56,685	21,028	4,960	1,071	342	211,408	61,987
					---	---		
Other [2]	11,556	3,900	99,000	25,000	---	---	110,556	28,900
Total agricultural	7,079,577	2,369,521	473,732	131,468	525,120	165,502	8,078,429	2,666,491
Industrial:								
Elemental phosphorus, ferrophosphorus, phosphoric acid	604,911	202,156	1,220,473	314,730	1,092,447	274,492	2,917,831	791,378
Phosphoric acid (wet process)	(1)	(1)	---	---	(1)	(1)	(1)	(1)
Other [3]	1,500	450	5,190	1,518	---	---	6,690	1,968
Total industrial	606,411	202,606	1,225,663	316,248	1,092,447	274,492	2,924,521	793,346
Exports [4]	1,879,157	623,930	---	---	303,927	95,765	2,183,084	719,695
Grand total	9,565,145	3,196,057	1,699,395	447,716	1,921,494	535,759	13,186,034	4,179,532

[1] Rock for phosphoric acid (wet process) included with triple superphosphate.
[2] Includes phosphate rock used in calcium metaphosphate, fused tricalcium phosphate, nitraphosphate, and other applications.
[3] Includes phosphate rock used in pig-iron blast furnaces, parting compounds, research, defluorinated phosphate rock, refractories, and other applications.
[4] As reported to the Bureau of Mines by domestic producers.
[5] Rock for triple superphosphate included with ordinary superphosphate.
[6] Included with "Other" agricultural.

TABLE 10.—Production, shipments, and stocks of superphosphates,[1] 1946–50 (average) and 1951–55, in short tons

[U. S. Bureau of the Census]

	1946–50 (average)	1951	1952	1953	1954	1955
Normal and enriched superphosphates:						
Production	1,619,949	1,708,825	1,765,000	1,678,459	1,644,515	1,596,115
Shipments	859,462	883,849	874,846	850,970	847,759	851,636
Stocks in manufacturers' hands Dec. 31	177,815	196,349	235,950	236,313	222,206	223,140
Concentrated superphosphates:						
Production	216,920	322,420	388,055	457,235	561,870	706,584
Shipments	209,331	313,323	375,112	433,097	500,194	632,327
Stocks in manufacturers' hands Dec. 31	31,598	29,860	39,200	51,304	101,557	150,233

[1] 100 percent available phosphoric acid.

STOCKS

Producers' stocks at the end of 1955 decreased 17 percent from the reported figures for 1954. The end-of-year stocks reported for 1954 and 1955 are not comparable.

PRICES

The prices of Florida land-pebble phosphate rock increased during the year and by the end of 1955 were about 3 percent higher than at the beginning of the year. Price changes quoted by the Oil, Paint and Drug Reporter are shown in table 11. Prices for Tennessee and Western States phosphate rock were not quoted in the trade journals. Price quotations of elemental phosphorus and some phosphorus compounds were published in the Oil, Paint and Drug Reporter.

TABLE 11.—Prices per long ton of Florida land pebble unground, washed, and dried phosphate rock, in bulk, carlots, at mine, in 1955, by grades

[Oil, Paint and Drug Reporter of dates listed]

Grades (percent B. P. L.) [1]	Jan. 3	June 13	Sept. 17	Nov. 7
68/66	$4.60	$4.68½	$4.82	$4.75
70/68	5.00	5.08	5.22	5.16
72/70	5.65	5.73½	5.87	5.81
75/74	6.65	6.73½	6.87	6.81
78/76	7.65	7.73½	7.87	7.81

[1] B. P. L. signifies bone phosphate of lime, $Ca_3(PO_4)_2$.

FOREIGN TRADE [11]

Imports.—Crude phosphate rock imported into the United States was 4 percent below 1954 imports. Curaçao (Netherland Antilles) supplied 84 percent of the imports. French Pacific Islands supplied the remaining imports, except for very small shipments from Mexico and the Netherlands. Imports of superphosphates, mainly from Canada, decreased 58 percent from 1954. Small quantities were imported from Brazil and the Netherlands. Imports of fertilizer-

[11] Figures on imports and exports (unless otherwise indicated) compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

grade ammonium phosphate, originating mostly in Canada, increased 43 percent. Other phosphatic fertilizer materials were imported from Belgium-Luxembourg and Peru.

TABLE 12.—Phosphate rock and phosphatic fertilizers imported for consumption in the United States, 1954–55

[U. S. Department of Commerce]

Fertilizer	1954		1955	
	Long tons	Value	Long tons	Value
Phosphates, crude, not elsewhere specified	122,016	[1] $3,081,430	117,256	$2,702,955
Superphosphates (acid phosphate):				
Normal (standard), not over 25 percent P_2O_5 content	1,170	[1] 99,898	456	[1] 24,786
Concentrated (treble), over 25 percent P_2O_5 content	2,795	192,771	812	52,027
Ammoniated	4	455	416	29,162
Total superphosphates	3,969	[1] 293,124	1,684	[1] 105,975
Ammonium phosphates, used as fertilizer	146,547	[1] 11,835,881	209,396	[1] 15,948,650
Bone dust, or animal carbon and bone ash, fit only for fertilizer	16,975	901,209	16,477	928,885
Guano	196	25,596	7,625	673,554
Slag, basic, ground or unground	34	3,333	2,281	11,676
Dicalcium phosphate (precipitated bone phosphate) all grades	5,142	283,747	1,172	68,166

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable to years before 1954.

Exports.—Total exports of phosphate rock in 1955 were 5 percent below 1954 exports; exports of hard rock, mostly to Brazil, decreased 74 percent; Florida land-pebble exports were 6 percent less. Land-pebble exports went mainly to Japan (48 percent), Netherlands (9 percent), Canada (9 percent), United Kingdom (8 percent), Italy (6 percent), and West Germany (5 percent). Shipments of "other phosphate rock," mainly to Canada, increased 5 percent in 1955 compared with 1954. Superphosphates, exported mostly to Canada, Brazil, Cuba, Colombia, and South Korea, decreased 5 percent compared with 1954.

TABLE 13.—Phosphate rock exported from the United States, 1954–55, by types of rock and countries of destination

[U. S. Department of Commerce]

Grade and country	1954		1955	
	Long tons	Value	Long tons	Value
Florida:				
High-grade hard rock:				
North America:				
Canada	2,888	$35,810	53	$982
El Salvador			45	672
Jamaica	44	934		
Total	2,932	36,744	98	1,654
South America:				
Brazil	5,905	97,433	2,545	36,966
Colombia	1,447	23,028		
Total	7,352	120,461	2,545	36,966
Total high-grade hard rock	10,284	157,205	2,643	38,620

TABLE 13.—Phosphate rock exported from the United States, 1954–55, by types of rock and countries of destination—Continued

[U. S. Department of Commerce]

Grade and country	1954		1955	
	Long tons	Value	Long tons	Value
Land pebble:				
North America:				
Canada	231,561	$1,816,967	167,102	$1,324,049
Costa Rica			45	965
Cuba	27,624	185,661	18,962	141,709
Mexico	19,114	136,086	40,956	278,048
Nicaragua			22	842
Total	278,299	2,138,714	227,087	1,745,613
South America:				
Brazil	36,945	417,160	29,253	297,020
Colombia			500	7,520
Peru	196	2,547		
Uruguay			16,547	177,410
Venezuela	303	6,160	312	6,538
Total	37,444	425,867	46,612	488,488
Europe:				
Austria	15,161	110,008	9,294	70,078
Belgium-Luxembourg	9,439	82,119		
Denmark	14,992	132,631	19,984	175,850
Germany, West	289,551	2,196,306	93,787	716,487
Italy	117,898	1,142,760	119,644	1,120,174
Netherlands	241,270	2,227,182	175,004	1,531,184
Poland and Danzig			16,552	171,536
Spain			65,963	580,505
Sweden	51,522	455,360	34,789	317,877
Trieste			3,303	25,433
United Kingdom	133,293	1,104,094	151,034	1,191,288
Total	873,126	7,450,460	689,354	5,900,412
Asia:				
Japan	788,991	6,054,112	914,322	7,036,407
Korea, Republic of	5,083	40,664	5,995	59,950
Philippines			451	6,025
Taiwan	40,252	605,936	14,043	123,579
Total	834,326	6,700,712	934,811	7,225,961
Africa: Union of South Africa	19,961	177,653	17,481	174,800
Total land pebble	2,043,156	16,893,406	1,915,345	15,535,274
Other phosphate rock: [1]				
North America:				
Canada	328,746	4,025,013	346,800	4,685,895
Cuba	267	3,460	134	1,650
El Salvador	946	13,157	312	4,032
Mexico			45	974
Panama	36	679		
Total	329,995	4,042,309	347,291	4,692,551
South America:				
Brazil	1,578	76,100	492	8,844
Colombia			1,033	21,313
Total	1,578	76,100	1,525	30,157
Asia: Japan			937	5,800
Total other phosphate rock	331,573	4,118,409	349,753	4,728,508
Grand total	2,385,013	21,169,020	2,267,741	20,302,402

[1] Includes colloidal matrix, soft phosphate rock, and Tennessee, Idaho, and Montana rock.

TABLE 14.—"Other phosphate material"[1] exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Long tons	Value	Year	Long tons	Value
1946–50 (average)	1,545	$205,160	1953	8,477	$178,168
1951	2,316	372,685	1954	5,243	456,330
1952	1,144	187,605	1955	4,923	556,779

[1] Class includes animal carbon, apatite, basic slag, bone-ash dust, bone meal, char dust, defluorinated phosphate rock, duplex basic phosphate, permanente thermosphos (granular), and tricalcium phosphate (fused).

TABLE 15.—Superphosphates (acid phosphates) exported from the United States, 1954–55, by countries of destination

[U. S. Department of Commerce]

Country	1954		1955	
	Long tons	Value	Long tons	Value
North America:				
Canada	173,273	$4,674,583	224,456	$5,111,822
Costa Rica	2,678	211,150	2,916	161,569
Cuba	26,819	855,708	25,784	750,581
Dominican Republic	2,344	137,051	3,428	209,532
El Salvador	446	27,040	395	29,565
Guatemala			135	10,409
Mexico	781	52,913	5,057	309,670
Nicaragua	45	2,875	54	3,700
Panama	6	515	54	4,074
Other North America	13	629	53	3,279
Total	206,405	5,962,464	262,332	6,594,201
South America:				
Argentina	498	22,997		
Brazil	[1] 73,475	[1] 2,188,349	70,584	2,618,256
Chile	45	4,814	29	2,789
Colombia	2,267	134,302	15,112	892,586
Ecuador	987	46,868	208	13,351
Peru	2,692	77,950	3,136	103,678
Uruguay	984	61,150	1,604	94,622
Venezuela	1,949	85,957	3,300	126,528
Total	[1] 82,897	[1] 2,622,387	93,973	3,851,810
Asia:				
Indonesia			125	7,665
Korea, Republic of	100,172	2,775,250	13,433	826,644
Philippines	1,156	37,713	278	18,576
Saudi Arabia	134	8,648	45	2,610
Other Asia	31	2,455	27	1,793
Total	101,493	2,824,066	13,908	857,288
Africa:				
Union of South Africa			2,493	133,750
Other Africa	39	3,560		
Total	39	3,560	2,493	133,750
Grand total	[1] 390,834	[1] 11,412,477	372,706	11,437,049

[1] Revised figure.

TECHNOLOGY

Results of further geologic investigations of the Phosphoria formation in Montana were published.[12]

The commercial reserves of phosphate rock in the United States contain an estimated 600,000 tons of uranium.[13]

The probable future importance of this source of uranium was discussed. Byproduct uranium was being recovered from phosphoric acid. Research was underway on uranium recovery from "leached-zone" phosphate rock and from superphosphate manufacture.[14]

Increased efficiency in Florida phosphate-mining operations was reported as a result of two-way radio communication.[15]

Recent accomplishments in phosphate-rock mining in Florida stressed the growing importance of mining research.[16]

Results of beneficiation tests disclosed that phosphate rock containing 27 percent P_2O_5 and 17 percent Fe could be treated to yield suitable acid-grade rock.[17]

Results of flotation experiments on phosphate rock with pure amine reagents were reported.[18]

Bulk processing, necessary for handling nearly 10 million tons of product in the land-pebble field of Florida, requires maximum efficiency and economy. The equipment in one plant was described as an example.[19]

A new process for producing phosphoric acid was reported to be more economical and to yield a more concentrated acid than conventional methods.[20] Basic data were published on densities of certain forms of phosphoric acid.[21]

A graphite furnace was found to be the most satisfactory for manufacturing tricalcium phosphate.[22] The graphite hearth showed little wear after 17 months of use.

During 1955 the Atomic Energy Commission declassified a number of reports dealing with the recovery of uranium from phosphate

---

[12] Lowell, W. R., Igneous Intrusions and Metamorphism in Some Phosphatic Rocks of Southwestern Montana: Econ. Geol., vol. 50, No. 7, November 1955, pp. 715–737.

[13] Barr, J. A., Jr., Uranium Production From Phosphate Rock: Pres. at Ann. Meeting, Florida Eng. Soc., Daytona Beach, Fla., Apr. 21, 1955.

[14] Barr, J. A., Jr., Ruch, J. W., and Borlik, R. F., Recovering Uranium As Byproduct in Phosphate Processing: Rock Products, vol. 58, No. 10, October 1955, pp. 96–102.

[15] Gutschick, D. A., Two-Way Radio Increases Efficiency at International's Florida Phosphate Operations: Pit and Quarry, vol. 47, No. 8, February 1955, pp. 59–60, 62.

[16] Ware, T. M., Operations Research and the Mine of Tomorrow, I: Eng. Min. Jour., vol. 156, No. 8, August 1955, pp. 75–78.

Dunlap, J. W., and Jacobs, H. H., How Operations Research Solved the Dragline Problems. II: Eng. Min. Jour., vol. 156, No. 8, August 1955, pp. 79–83.

[17] Banerjee, S. K., and Narayanan, P. I. A., Beneficiation of Phosphate Rock From Singhbhum, Bihar, Jour. Sci. Ind. Res. (Delhi, India), vol. 14B, No. 5, May 1955, pp. 242–245.

[18] Lentz, T. H., Terry, D. E., and Wittcoff, H., Pure Amines for the Flotation of Silica From Rougher Phosphate Concentrate: Ind. Eng. Chem., vol. 47, No. 3, March 1955, pp. 468–471.

[19] Pit and Quarry, Efficient Grinding Department—A Feature of Florida Phosphate Plant: Vol. 48, No. 1, July 1955, pp. 156–157.

[20] Nord, M., Improved H_3PO_4 Production: Chem. Eng., vol. 62, No. 10, October 1955, p. 246.

[21] Christensen, J. H., Reed, R. B., Egan, E. P., Jr., and Luff, B. B., Density of Aqueous Solutions of Phosphoric Acid: Ind. Eng. Chem., vol. 47, No. 6, June 1955, pp. 1277–1281.

[22] Almond, L. H., and Albrecht, W. L., How to Build a Graphite Furnace: Chem. Eng., vol. 62, No. 9, September 1955, pp. 179–182.

rock.[23] Microfilm and photostat copies of these reports were available from the Library of Congress, Washington, D. C.

The importance of organic phosphate compounds in biological reactions was discussed.[24]

Several new phosphate-coating techniques were described.[25]

New uses of phosphorus and many of its compounds continued to be reported.[26]

The subject of advisability of changing the reporting basis of phosphorus content of phosphatic fertilizers from the oxide (P_2O_5) to the elemental form (P) continued to be controversial.[27]

Among other topics discussed during 1955 were the prevention of air and water pollution and further recovery of byproducts in connection with phosphate processing.[28]

WORLD REVIEW

NORTH AMERICA

Canada.—Multi-Minerals, Ltd., explored the apatite-magnetite deposits near Nemegos, Ontario, and announced plans to produce apatite concentrate (34 percent P_2O_5) and magnetite concentrate (66 percent Fe).[29]

---

[23] Bailes, R. H., The Recovery of Uranium and Other Values From Florida Leach-Zone Material: Dow Chemical Co., Research Dept., Contract AT-30-1-gen-236, Progress Repts. for October 1952, 24 pp.; November 1952, 30 pp.; January 1953, 42 pp.
Bailes, R. H., The Recovery of Uranium From Phosphate, by Ion Exchange: Dow Chemical Co., Research Dept., Contract AT-30-1-gen-236, Summary Status Rept. No. 3, December 1949, 20 pp.
Bailes, R. H., The Recovery of Uranium From Phosphoric Acid Solutions: Dow Chemical Co., Research Dept., Contract AT-30-1-gen-236, Fluoride Process-Summary Status Rept. No. 2, December 1949, 19 pp.; Progress Repts. for September 1951, 60 pp.; October 1951, 83 pp.; December 1951, 58 pp.; January 1952, 76 pp.; March 1952, 96 pp.; May 1952, 74 pp.; October 1952, 63 pp.; January–February 1955, 72 pp.
Clements, D. F., Williams, W. B., McCullough, R. F., and Wrege, E. E., Uranium Production Process Designs for Leached-Zone Plants: International Minerals & Chemical Corp., Contract AT(49-1)-545, vol. 12, Dry Mining, Sulfuric Acid Digestion, Uranium and P_2O_5 Recovery, September 1953, 47 pp.; vol. 13, Wet Mining, Sulfuric Acid Digestion, Uranium Recovery Processes, September 1953, 56 pp.
Gross, J. H., Adam, J. B., and Bart, R., Leached Zone: International Minerals & Chemical Corp., Contract AT(49-1)-545, Digestion With Miscellaneous Reagents, February 1955, 19 pp.; Digestion With Sulfurous Acid, February 1955, 43 pp.; Effect of Roasting With Sulfuric Acid, February 1955, 30 pp.

[24] Todd, A. R., Phosphates in Vital Processes: Chem. and Ind. (London), No. 31, Aug. 11, 1956, pp. 802-807.

[25] Geyer, J. H., and Gehman, H., Advantages of Phosphate Coatings in Fastener Forming: Wire and Wire Products, vol. 30, No. 12, December 1955, pp. 1490–1493, 1528–1532.
Bourbon, R., and de Paulin, J. J. M., Phosphating Etch Primers: Metal Ind., vol. 87, No. 21, Nov. 18, 1955, pp. 424–427.
Metal Industry, vol. 87, No. 22, Nov. 25, 1955, p. 452.
Materials and Methods, Conversion Coatings: Vol. 42, No. 3, September 1955, p. 118.

[26] Miller, J. G., New Uses for Phosphates: Mines Mag., vol. 45, No. 3, March 1955, pp. 95–98.
Wall Street Journal, vol. 145, No. 54, Mar. 18, 1955, pp. 1, 10.

[27] Collings, G. H., Commercial Fertilizers: McGraw-Hill Publishing Co., Inc., New York, N. Y., 5th ed., 1955, 617 pp.

[28] Shervin, K. A., Effluents From the Manufacture of Superphosphate and Compound Fertilizer: Chem. and Ind. (London), No. 41, Oct. 8, 1955, pp. 1274–1281.
Miller, R. (assigned to The Chemical Foundation, Inc.), Process of Treating Phosphate Rock for Recovery of Fluorine Chemicals and Production of Fertilizers: U. S. Patent 2,728,634, Dec. 27, 1955.

[29] Janes, T. H., Phosphate in Canada, 1955 (Preliminary): Mines Branch, Dept. of Mines and Tech. Surveys, Ottawa, Canada, No. 50, 4 pp.
Northern Miner (Toronto), vol. 41, No. 26, Sept. 22, 1955, p. 2.

TABLE 16.—World production of phosphate rock, by countries,[1] 1946–50 (average) and 1951–55, in long tons[2]

[Compiled by Helen L. Hunt]

Country[1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	36	5	----	----	----	----
United States	9,131,984	10,775,032	12,064,892	12,503,830	13,821,100	12,265,248
West Indies:						
Jamaica (guano)	----	840	650	695	705	440
Netherland Antilles (exports)	81,444	105,452	105,214	94,579	123,960	108,745
Total	9,213,464	10,881,329	12,170,756	12,599,104	13,945,765	12,374,433
South America:						
Brazil	7,300	[3] 12,500	17,675	[3] 12,500	[3] 14,800	[3] 14,800
Chile:						
Apatite	28,104	36,595	45,044	58,242	[3] 54,000	[3] 54,000
Guano	29,881	[3] 29,500	[3] 29,500	[3] 29,500	[3] 29,500	[3] 29,500
Total	65,285	[3] 78,600	[3] 92,200	[3] 100,200	[3] 98,300	[3] 98,300
Europe:						
Austria	5,268	----	----	----	----	----
Belgium	57,557	127,027	58,052	35,329	25,860	20,778
France	86,280	110,502	100,389	85,590	82,815	58,108
Germany, West	309	----	----	----	----	----
Ireland	[3] 10,200	(4)	(4)	----	----	----
Spain	21,455	22,470	23,103	21,517	21,880	22,971
Sweden (apatite)	12,502	8,871	21,084	8,634	----	----
U. S. S. R.:						
Apatite[3]	1,447,000	2,260,000	2,460,000	2,760,000	3,100,000	3,445,000
Sedimentary rock[3]	649,000	1,035,000	1,130,000	1,205,000	1,330,000	1,425,000
Total[3]	2,290,000	3,590,000	3,820,000	4,120,000	4,600,000	5,000,000
Asia:						
British Borneo (guano)	408	649	696	632	620	402
China[3]	19,700	59,000	98,000	148,000	197,000	246,000
Christmas Island (Indian Ocean) (exports)	162,200	333,345	349,160	280,194	350,962	390,228
India (apatite)	1,163	416	445	4,359	2,292	[3] 2,400
Indochina	1,968	----	----	----	----	----
Indonesia	[3] 1,970	----	----	815	5,905	[3] 5,900
Israel	----	[5] 292	16,928	22,727	53,521	83,658
Japan	3,803	141	----	----	----	----
Jordan	[6] 2,772	[6] 6,530	23,424	39,368	73,816	161,015
North Korea	[3] 5,000	(4)	(4)	(4)	(4)	(4)
Philippines (guano)	8,583	4,745	4,164	630	1,800	148
Total[3]	208,000	405,000	493,000	507,000	706,000	910,000
Africa:						
Algeria	649,985	764,364	691,493	593,236	745,903	745,540
Angola (guano)	[3] [7] 600	928	----	----	----	----
British Somaliland (guano) (exports)	353	680	521	358	[3] 500	[3] 500
Egypt	352,340	492,081	513,968	476,531	526,247	636,468
French Morocco	3,254,956	4,642,322	3,890,681	4,090,377	4,940,236	5,244,712
French West Africa (aluminum phosphate)	4,409	24,113	[8] 63,531	[8] 92,713	[8] 77,457	[8] 111,068
Madagascar	----	----	1,284	1,531	1,319	1,827
Rhodesia and Nyasaland, Fed. of: Southern Rhodesia	[7] 22	----	----	----	----	----
Seychelles Islands (exports)	16,104	4,475	10,944	8,719	11,676	3,565
South-West Africa (guano)	1,273	773	1,649	1,579	811	1,736
Tanganyika Territory	278	452	166	149	60	103
Tunisia	1,571,893	1,652,395	2,228,882	1,691,394	1,794,567	2,563,082
Uganda	2,943	2,207	4,931	5,362	2,967	3,160
Union of South Africa	44,782	80,548	95,043	78,860	93,008	114,617
Total	[3] 5,900,000	7,665,338	7,503,093	7,040,809	[3] 8,194,800	[3] 9,426,400

See footnotes at end of table.

TABLE 16.—World production of phosphate rock by countries,[1] 1946–50 (average) and 1951–55, in long tons[2]—Continued

[Compiled by Helen L. Hunt]

Country[1]	1946–50 (average)	1951	1952	1953	1954	1955
Oceania:						
Angaur Island	108,945	[6] 142,556	[6] 82,580	[3] [6] 111,209	[6] 121,828	[6] 137,225
Australia	1,822	7,929	5,544	3,368	6,120	[3] 5,900
Makatea Island (French Oceania) (exports)	228,384	224,260	210,183	246,555	225,286	215,718
Mauru Island (exports)	522,203	928,056	1,145,658	1,159,758	1,178,157	1,401,259
New Zealand	2,249					
Ocean Island (exports)	174,261	252,402	245,602	282,364	292,202	308,852
Total	1,037,864	1,555,203	1,689,567	[3] 1,803,200	1,823,593	[3] 2,069,000
World total (estimate)[1]	18,700,000	24,200,000	25,800,000	26,200,000	29,400,000	29,900,000

[1] In addition to countries listed, Poland may produce phosphate rock; but data of output are not available, and no estimate by the author of the chapter has been included in the total.
[2] This table incorporates a number of revisions of data published in previous Phosphate Rock chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Data not available; estimate by senior author of chapter included in total.
[5] Production begun second half of December 1951.
[6] Exports.
[7] Average for 1947–50.
[8] Includes calcium phosphate, production of which is reported as follows: 1952, 21,100 tons; 1953, 41,100 tons; 1954, 5,400 tons; 1955, 8,300 tons.

SOUTH AMERICA

Brazil.—Phosphate-rock production was reported from Olinda, State of Pernambuco, and Serrote and Guaviruna, State of São Paulo. At Olinda a washing plant was being constructed for upgrading ore to acid grade (plus 31 percent P_2O_5), for use in the direct application, and manufacture of superphosphates. The 1955 annual production was reported as 12,000 tons from Olinda and 10,000 tons from the 2 deposits in São Paulo.[30]

EUROPE

According to reports by the Organization for European Economic Cooperation, consumption of phosphatic fertilizers in member countries totaled about 2.5 million tons in 1953–54. Approximately one-third of this was basic slag.[31]

Poland.—Output of the superphosphate industry in Poland, consisting of 12 plants with capacity of about 1.3 million tons, was limited to approximately 10 percent of capacity, because of a sulfuric-acid shortage. Large quantities of phosphatic fertilizers were imported from the U. S. S. R.[32]

U. S. S. R.—Production of both apatite and sedimentary-phosphate rock increased in 1955. According to reports, output of superphosphates in 1954 was above 1953, and total production of mineral fertilizers was 16 percent more.[33]

United Kingdom.—Monsanto Chemicals, Ltd., formed a new company, Monsanto Phosphates, Ltd., to manufacture sodium phos-

[30] United States, Rio de Janeiro, Brazil, State Department Dispatch 736, Enclosure 1, Dec. 6, 1955, p. 19.
[31] Chemical and Engineering News, vol. 33, No. 19, May 9, 1955, p. 1974.
[32] British Sulphur Corporation, The Suphuric Acid Industry in Poland: Quart. Bull., No. 8, March 1955, pp. 29-31.
[33] Chemical Engineering, vol. 62, No. 4, April 1955, p. 274.

phates and other phosphate chemicals. The new company will be responsible for Monsanto activities in East African phosphate deposits.[34]

ASIA

Israel.—Phosphate-rock mining in the Negev Desert continued to expand. New equipment purchased by the Negev Phosphate Co., Ltd., permitted mining at the rate of 10,000 tons per month.[35]

Jordan.—Output of phosphate rock in 1955 from the deposits near Amman was more than double the 1954 figure. Investigations of the Hesa deposits in southern Jordan were underway.[36] Exports totaled 148,200 long tons and went mainly to Italy, Yugoslavia, Japan, and Czechoslovakia.[37] The average price, f. o. b. Aqaba, was reported as $12.38 per long ton.[38]

AFRICA

French Morocco.—Output and exports of phosphate rock in 1955 were 6 percent greater than in 1954. The Office Cherifien des Phosphates, the wholly owned Moroccan Government company, continued operations at Khouribga and Louis-Gentil. Riots at Khouribga caused damage estimated at $3 million; as a result, mine production dropped one-third during the third quarter of 1955, compared with the 1954 quarterly average. Sales were maintained by drawing from stocks.[39]

Tunisia.—Production and exports of phosphate rock in Tunisia both increased in 1955. About 10 percent of exports were to Communist-dominated countries.

Phosphate rock was produced in 1955 by three private companies: Compagnie du Phosphate et du Chemin de Fer de Sfax-Gafsa, La Compagnie Tunisienne des Phosphates du Djebel M'Dilla, and La Société Pierrefitte Kalaa-Djerda. All operations were near the Algerian border and the ore was hauled 150 to 200 miles to the ports. Over 90 percent of the 1955 production contained 30 percent P_2O_5, the highest grade produced. Sfax-Gafsa, the largest producer in Tunisia, operated three mines near Gafsa and was installing a beneficiating plant to upgrade the ore. The Brafim mine (Sfax-Gafsa) was attacked by Algerians during October. Damage was not extensive, and production was resumed promptly.

The prices of Tunisian phosphate rock during 1954, including transaction and customs-formality taxes, were quoted as follows:

Grade (B. P. L.)	*Price (dollars per long ton)*
58–63	6.89
63–65	7.62
65–68	8.84

Wages for unskilled labor in the phosphate industry averaged $1.44 per day, about twice the wage paid in agriculture.

---

34 Chemical and Engineering News, vol. 33, No. 11, Mar. 14, 1955, p. 1053.
35 Chemical Age, vol. 73, No. 1898, Nov. 26, 1955, p. 1164.
36 Engineering and Mining Journal, vol. 156, No. 12, December 1955, p. 184.
37 Chemical Week, vol. 77, No. 23, Dec. 3, 1955, p. 28.
38 United States, Amman, Jordan, State Department Dispatch 306, Mar. 12, 1956, p. 2.
39 United States, Casablanca, French Morocco, State Department Dispatch 137, Jan. 19, 1956, pp. 3–4.

TABLE 17.—Exports of phosphate rock from Algeria, 1951–55, by countries of destination, in long tons [1]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
Europe:					
Belgium-Luxembourg	5,029	7,431		1,378	
Czechoslovakia	28,769	14,173		19,586	3,396
France	188,303	113,990	103,755	184,283	802,871
Germany, West	164,167	118,657	61,808	75,981	283,192
Hungary	12,194	11,712	11,860	9,842	5,904
Ireland	63,283	50,266	33,660	42,419	131,807
Netherlands	61,786	31,175			
Poland	49,211	35,678	36,130	33,266	66,159
Portugal	23,887	37,828	22,145	30,806	124,015
Rumania				9,744	
Spain	4,429	67,935	168,792	131,884	192,268
Switzerland				886	
United Kingdom	53,823	73,182	88,382	81,099	289,906
Yugoslavia	10,019	14,566		17,470	176,058
Asia:					
Indochina				7,874	2,018
Indonesia				4,458	55,805
Malaya				709	
French overseas territories	2,362	4,724	10,472		
Other countries	17,143	10,964	15,501	6,456	6,082
Total	684,405	592,281	552,505	658,141	2,139,481

[1] Compiled from Customs Returns of Algeria.

TABLE 18.—Exports of phosphate rock from Egypt, 1950–54, by countries of destination, in long tons [1]

[Compiled by Corra A. Barry]

Country	1950	1951	1952	1953	1954 [2]
Belgium-Luxembourg	20,487				(3)
Ceylon	27,899	33,939	33,909	31,749	34,948
Finland	18,014	36,985	23,325	10,137	(3)
Germany, West		8,986	37,156		(3)
Greece		9,183	11,732		(3)
India	46,524	12,199	28,498	5,100	(3)
Italy	113,535	57,523	38,976	39,894	(3)
Japan	224,170	179,759	173,593	202,585	(3)
Netherlands	9,549			49,030	(3)
New Zealand	15,230				(3)
Sweden	5,413	337			(3)
Union of South Africa		16,352	60,265	16,648	(3)
Yugoslavia	10,196	9,845		12,500	(3)
Other countries	985	4,153	8,675	5,486	353,893
Total	492,002	369,261	416,129	373,129	388,841

[1] Compiled from Customs Returns of Egypt.
[2] Preliminary figures; distribution by countries not available.
[3] Data not available.

Le Comptoir des phosphates Nord-Africains, Paris, France, sold all phosphate rock produced in Tunisia, Algeria, and French Morocco.[40]

[40] United States Embassy, Tunis, Tunisia, State Department Dispatches No. 28, Aug. 2, 1955, pp. 1-2; No. 72, Oct. 24, 1955, pp. 1-2; No. 131, Dec. 27, 1955, pp. 5-7; No. 163, Jan. 30, 1956, pp. 1, 4.

TABLE 19.—Exports of phosphate rock from French Morocco, 1951–55, by countries of destination, in long tons [1] [2]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
South America:					
Brazil	21,675	30,806	13,676	6,973	(3)
Chile			14,076	19,468	(3)
Uruguay	4,884	6,397	6,349	12,873	(3)
Europe:					
Belgium-Luxembourg	281,439	198,713	178,765	307,213	330,344
Denmark	266,795	209,863	238,684	216,406	199,371
Finland	90,996	96,445	37,736	52,557	23,916
France	531,490	400,785	484,822	600,718	665,328
Germany, West	228,773	316,194	230,672	377,878	468,016
Hungary	11,644				(3)
Ireland	29,007	34,674	53,323	62,202	(3)
Italy	527,902	470,451	526,170	654,934	751,559
Netherlands	296,081	308,438	80,186	262,134	231,773
Norway	38,200	50,362	51,834	77,062	(3)
Poland	173,973	94,541	119,026	135,611	205,260
Portugal	164,192	172,489	215,913	197,605	181,112
Spain	333,486	441,248	470,724	488,486	435,323
Sweden	310,530	232,953	225,109	287,323	249,774
Switzerland	34,873	15,924	17,197	25,033	(3)
United Kingdom	666,260	518,299	742,210	625,491	674,872
Yugoslavia				8,071	(3)
Asia:					
India				12,893	(3)
Japan			79,554	67,147	(3)
Taiwan				10,039	(3)
Africa: Union of South Africa	288,504	245,798	255,470	328,372	337,824
Other countries	46,374		6,024	29,053	449,751
Total	4,347,078	3,844,380	4,047,520	4,865,542	5,204,223

1 Compiled from Customs Returns of French Morocco.
2 This table incorporates a number of revisions of data published in the previous Phosphate Rock chapter.
3 Data not separately recorded.

Union of South Africa.—The concentrating plant at the Government-controlled FOSKOR apatite deposit in Eastern Transvaal began operations during the latter half of 1955.[41] A generalized flowsheet showed that magnetic separation and flotation were used to produce a 34-percent P_2O_5 product from an ore averaging 11 percent P_2O_5 up to 30 percent Fe_3O_4.[42]

Other African Countries.—The Société Pechiney continued to operate its open-pit mine at Pallo, near Thies, Senegal, French West Africa. Most of the ore was shipped crude, but some was dried. All output was exported from Dakar mainly to France.[43] Exploration continued near Athieme, Southern Dahomey, and on both sides of Lake Togo. The Togoland phosphates were reported to be uranium bearing.[44] Phosphate-rock deposits in the Lake Chiliva region of Nyasaland were estimated to contain 3 million tons of ore better in grade than the ore produced from Southern Rhodesian deposits.[45]

41 Chemical Age (London), vol. 73, No. 1891, Oct. 8, 1955, p. 792.
42 Mining Journal (London), Phosphate Mining Operations in South Africa: Vol. 244, No. 6241, Apr. 1, 1955, p. 351.
Holz, P., South Africa's First Phosphate Plant: Rock Products, vol. 58, No. 12, December 1955, pp. 84, 86, 88, 154.
43 United States, Dakar, French West Africa, State Department Dispatch 232, Apr. 25, 1956, p. 11.
44 Chemistry and Industry (London), No. 29, July 16, 1955, p. 909.
45 Fertiliser and Feeding Stuffs Journal (London), vol. 43, No. 8, Oct. 12, 1955, p. 349.

TABLE 20.—Exports of phosphate rock from Tunisia, 1951–55, by countries of destination, in long tons [1,2]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
North America:					
Canada	2,953	3,936	----------	9,804	6,456
South America:					
Brazil	----------	31,003	68,924	76,570	41,885
Chile	----------	15,230	5,413	----------	14,621
Uruguay	----------	1,699	2,953	----------	13,910
Europe:					
Belgium	106,208	68,009	35,658	20,700	14,731
Czechoslovakia	25,343	27,263	55,785	57,714	52,205
Denmark	----------	7,323	7,185	12,573	7,608
Finland	78,264	58,359	29,231	29,590	17,227
France	549,228	338,739	433,464	578,738	556,584
Germany	124,544	131,121	46,602	79,176	78,303
Greece	103,644	62,857	70,791	125,504	135,591
Hungary	----------	----------	----------	4,921	----------
Italy	419,739	402,293	469,567	444,446	463,955
Netherlands	105,564	69,234	4,144	131,845	132,974
Poland	----------	----------	----------	33,965	36,755
Portugal	8,553	25,909	----------	10,187	----------
Spain	236,895	167,504	87,711	118,523	131,550
Sweden	2,953	7,765	5,216	8,445	4,628
Switzerland	5,684	935	1,033	1,230	1,240
United Kingdom and Ireland	207,839	583,978	178,864	100,863	104,310
Yugoslavia	9,987	7,628	12,799	10,984	18,710
Asia:					
Indochina	----------	15,944	17,229	----------	20,865
Japan	----------	9,842	10,285	----------	----------
Turkey	11,318	15,312	12,554	30,509	48,301
Africa:					
Madagascar	----------	1,968	492	----------	408
Union of South Africa	60,973	69,592	----------	1,000	----------
Oceania:					
New Zealand	----------	17,749	17,619	----------	5,950
Other countries	5,905	30	3,502	49	11,663
Total	2,065,594	2,141,222	1,577,021	1,887,336	1,920,430

[1] Compiled from Customs Returns of Tunisia.
[2] Figures include finely ground phosphate.

OCEANIA

Lau Islands.—Exploration of phosphate-rock deposits on Ogea Driki Island in the Lau Group has disclosed 4 deposits with total reserves of about 200,000 tons. The rock has a high iron and alumina content (12 percent Fe_2O_3 and 26 percent Al_2O_3) and is unsuitable for superphosphate manufacture.[46]

Angaur Island.—The phosphate-rock mine on Angaur Island in the Palau Group was closed owing to depletion of the orebody.[47]

[46] Mining Journal (London), Mining and Mineral Prospects in Fiji: Vol. 244, No. 6237, Mar. 4, 1955, p. 235.
[47] Mining World, vol. 17, No. 9, August 1955, p. 73.

Platinum-Group Metals

By James E. Bell[1] and Kathleen M. McBreen[2]

FEATURES of the platinum-group metals in the United States in 1955 were record imports and record consumption. Total imports of platinum-group metals were 67 percent greater in 1955 than in 1954, and total domestic consumption rose 46 percent. The increase in consumption reflected the heavy requirements for platinum for catalytic use in petroleum refineries and increased demand for palladium for electrical contacts in expansion of dial-telephone systems. Larger sales of platinum for jewelry and decorative uses were a factor in the gain. Imports included substantial quantities of platinum and palladium acquired and stockpiled by the Government through exchange of surplus agricultural products with friendly countries by the Commodity Credit Corporation of the United States Department of Agriculture. The domestic-refinery production of platinum-group metals (new and secondary combined) was 3 percent greater in 1955 than in 1954.

TABLE 1.—Salient statistics of platinum-group metals in the United States, 1954–55, in troy ounces

	1954	1955
Production:		
Crude platinum from placers and byproduct platinum-group metals	[1] 24,235	[1] 23,170
Refinery production:		
New metal:		
Platinum	47,421	52,011
Palladium	4,605	6,123
Other	4,740	3,347
Total	56,766	61,481
Secondary metal:		
Platinum	31,330	32,901
Palladium	31,190	26,124
Other	3,179	5,311
Total	65,699	64,336
Consumption:		
Platinum	320,215	467,065
Palladium	234,537	351,663
Other	27,194	32,083
Total	581,946	850,811
Stocks in hands of refiners, importers, and dealers, Dec. 31:		
Platinum	135,631	146,215
Palladium	86,770	111,559
Other	34,194	36,097
Total	256,595	293,871
Imports for consumption:		
Unrefined materials	[2] 52,528	50,953
Refined metals	[2] 553,916	958,987
Total	[2] 606,444	1,009,940
Exports:		
Ore and concentrates	29	
Refined metals and alloys, including scrap	[3] 28,423	[3] 28,968
Manufactures (except jewelry)	(4)	(4)

[1] Includes Alaska.
[2] Revised figure.
[3] Due to changes in classifications data not strictly comparable to earlier years.
[4] Beginning Jan. 1, 1952, quantity not recorded.

[1] Commodity specialist.
[2] Statistical assistant.

Refinery production of platinum (new and secondary combined) in the United States was 8 percent greater in 1955 than in 1954, and imports of refined platinum rose 30 percent. Consumption of platinum in the United States, as measured by sales, increased 46 percent to an alltime record; stocks of refiners and dealers were up 8 percent. The chemical industry continued as the principal outlet for platinum, furnishing 75 percent of total sales in 1955 as compared with 67 percent in the preceding year. By quantity, sales of platinum for jewelry and decorative uses were 40 percent greater in 1955 than in 1954, but the percentage of total sales was nearly the same for both years.

Refinery production of palladium (new and secondary combined) in the United States in 1955 was 10 percent under that in 1954, but imports of refined palladium were 158 percent greater. Consumption of palladium in the United States, as measured by sales, rose 50 percent to an alltime high; stocks of refiners and dealers gained 29 percent. The electrical industry was again the principal market, taking 71 percent of the total sold, compared with 66 percent in 1954.

Refinery production of iridium, rhodium, and ruthenium (new and secondary combined) in the United States in 1955 was, respectively, 18, 15, and 29 percent greater than the rates in 1954; that of osmium dropped 37 percent. Imports of refined osmium and rhodium rose 165

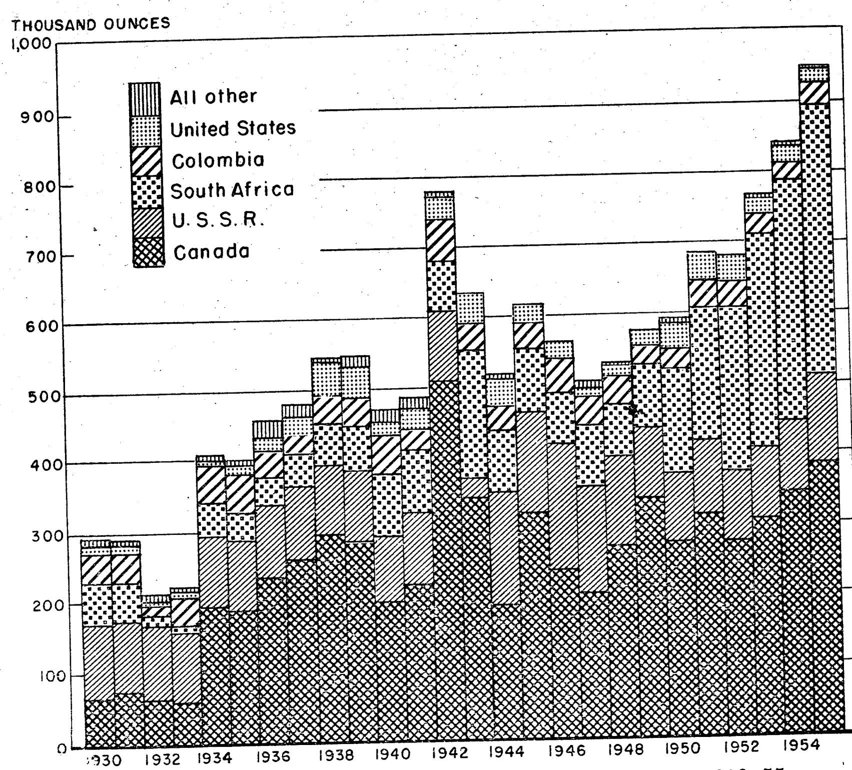

FIGURE 1.—World production of platinum-group metals, 1930–55.

and 35 percent, respectively, while imports of refined iridium and ruthenium were 37 and 52 percent less, respectively.

Under the Defense Minerals Exploration Administration, a test-drilling project at a placer-platinum deposit in the Goodnews Bay district of southwestern Alaska, begun in 1954, was resumed in 1955. No significant result was obtained, and the project was terminated.

Rustenburg Platinum Mines, Ltd., operating in the Union of South Africa, announced plans to increase the production capacity of its mining and milling plant 50 percent by mid-1957. This expansion would raise the company potential output of platinum-group metals to about 500,000 ounces annually.

During the year applications of platinum-group metals were displayed at the Royal Ontario Museum at Toronto, Canada,[3] and at the National Metal Congress and Exposition,[4] and the Exposition of the Chemical Industry, both at Philadelphia, Pa.[5]

GOVERNMENT REGULATIONS

The regulations established on March 23, 1953, by the Defense Materials System of the United States Department of Commerce, by which orders for platinum-group metals (among other commodities) for military or atomic-energy uses had priority ratings and took precedence over unrated orders, remained in effect throughout 1955.

All platinum-group metals and their manufactures required a validated license for export to Soviet Bloc countries, Communist China, Hong Kong, Macao, and Communist-controlled areas of Viet Nam and Laos in 1955.

Under the Defense Minerals Exploration Administration program, platinum-group metals were eligible for 75 percent financial assistance. No applications for aid were made in 1955. One contract was in force in Alaska.

CRUDE-PLATINUM PRODUCTION

Mine returns and refinery reports indicate a domestic recovery of 23,200 troy ounces in 1955, compared with 24,200 ounces in 1954. This metal comprises 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 present in small quantities in some gold and copper ores and recovered as byproducts during smelting and refining.

Purchases.—United States buyers reported the purchase of 60,900 ounces of crude platinum from Alaska, Colombia, and the Union of South Africa in 1955. The corresponding quantity for 1954 was 58,800 ounces.

---

[3] Canadian Mining Journal, vol. 70, No. 3, March 1955, p. 108.
[4] American Metal Market, vol. 62, No. 200, Oct. 15, 1955, pp. 1, 10.
[5] American Metal Market, vol. 62, No. 231, Dec. 2, 1955, p. 13.

RECOVERY OF REFINED PLATINUM-GROUP METALS

New Metals Recovered.—Reports from refiners indicate a domestic recovery of 61,500 ounces of new platinum-group metals in 1955, compared with 56,800 ounces in 1954. Of the total new metals refined in 1955, 87 percent was recovered from crude platinum, both domestic and foreign, and 13 percent as a byproduct of gold ores and copper ores; the corresponding figures for 1954 were 91 and 9 percent, respectively.

Secondary Metals Recovered.—The domestic recovery of platinum-group metals in 1955 from refining scraps, sweeps, etc., was 64,300 ounces, compared with 65,700 ounces in the preceding year. Substantial quantities of worn-out catalysts, spinnerets, laboratory equipment, and other items are returned to refiners for refining or reworking. The platinum-group metals recovered from this source (or their equivalent in refined metals) are returned to consumers. The platinum-group metals so recovered are not considered secondary production and are not included in the figures for secondary metals.

TABLE 2.—New platinum-group metals recovered by refiners in the United States, 1946–50 (average), 1951–53, and 1954–55, by sources, in troy ounces

	Platinum	Palladium	Iridium	Osmium	Rhodium	Ruthenium	Total
1946–50 (average)	55,892	6,050	2,018	704	551	241	65,456
1951	36,007	6,520	4,417	1,716	2,879	1,522	53,061
1952	41,810	6,746	2,426	879	397	217	52,475
1953	46,963	6,347	3,857	1,192	891	1,017	60,267
1954							
From domestic—							
Crude platinum	16,899	493	1,144	440	277	25	19,278
Gold and copper refining	1,375	3,908					5,283
Total	18,274	4,401	1,144	440	277	25	24,561
From foreign— Crude platinum; Nickel and copper refining	29,147	204	1,129	774	378	573	32,205
Total	47,421	4,605	2,273	1,214	655	598	56,766
1955							
From domestic—							
Crude platinum	13,149	57	1,618	230	312	11	15,377
Gold and copper refining	1,810	5,879					7,689
Total	14,959	5,936	1,618	230	312	11	23,066
From foreign— Crude platinum; Nickel and copper refining	37,052	187	438	459	12	267	38,415
Total	52,011	6,123	2,056	689	324	278	61,481

TABLE 3.—Secondary platinum-group metals recovered in the United States, 1946–50 (average) and 1951–55, in troy ounces

	Platinum	Palladium	Iridium	Others	Total
1946–50 (average)	45,746	28,428	1,694	3,169	79,037
1951	22,470	27,999	1,014	1,875	53,358
1952	28,628	25,540	1,030	3,403	58,601
1953	29,547	30,494	853	3,963	64,857
1954	31,330	31,190	734	2,445	65,699
1955	32,901	26,124	1,499	3,812	64,336

CONSUMPTION AND USES

Formerly better known as materials used chiefly for jewelry and luxury wares, today the platinum-group metals find their greatest application in the chemical and electrical industries. In recent years the United States has consumed about two thirds of the world output of these metals.

The platinum-group metals are used in industry because of their high melting points, chemical inertness, and catalytic activity; in addition, platinum and palladium are ductile and have excellent mechanical properties. The platinum-group metals are used in pure form and also when combined, clad, or alloyed with other metals. Platinum is the most abundant and widely used member of the group, and palladium is next in quantity used. Iridium, osmium, rhodium, and ruthenium are employed principally as alloys for hardening platinum and palladium. A comprehensive tabulation on the uses of the platinum-group metals is given on page 801 of the Platinum and Allied Metals chapter, Minerals Yearbook, 1943. Platinum and iridium are among the strategic and critical metals being stockpiled by the Government.

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. The recently developed use of platinum as a catalyst for producing high-octane gasoline from low-grade and natural gasoline was adopted by many additional oil refineries in 1955.[6] In this use, which is termed "platforming" or "re-forming," platinum is supported on pelleted alumina or other inert carrier.[7] Pure platinum and platinum-iridium alloys are used as insoluble anodes in various electroplating processes, and chemical laboratories have long used platinum for crucibles, electrodes, and other utensils and equipment. Platinum-gold and palladium-gold alloys are widely used in spinnerets for making rayon fiber from viscose. Fiberglass is produced in a similar way by extruding molten glass through banks of nozzles made of platinum-nickel or platinum-rhodium alloy, whence it emerges in fine streams that are stretched to filaments of minute diameter. Platinum alloys are employed also for handling molten glass in manufacturing light bulbs and optical glass. Platinum and platinum-rhodium are used for high-temperature thermocouples.

The platinum-group metals have many electrical applications based on their resistance to tarnish by oxidation or sulfidation, resistance to spark erosion, and high melting temperature. Large quantities of palladium are used for electrical contacts in relays, particularly for telephone service. Platinum, both pure and hardened with iridium or ruthenium, is used for contacts in voltage regulators, thermostats, relays, and contacts in 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 electronic tubes. The military importance of platinum lies in its

---

[6] Petroleum Refiner, vol. 34, No. 9, September 1955, pp. 174–178, 253–257. Petroleum Processing, vol. 10 No. 8, August 1955, pp. 1166–1176.

[7] Baker & Co., Inc., Platinum Metal Catalysts: Newark, N. J., 1953, 8 pp.

use in spark plugs and in high-duty electrical contacts for magnetos in motorized equipment, and as a catalyst in many chemical production processes.

In the jewelry and decorative arts platinum hardened with iridium or ruthenium is recognized as the ideal metal, particularly for gem-set jewelry. Palladium alloyed with ruthenium is gaining in acceptance for jewelry, particularly in Europe. Both platinum and palladium are beaten into leaf for signs, book bindings, and other decorative uses. Because of their strength, workability, and resistance to tarnish, platinum and palladium are used extensively for dentistry in cast and wrought forms and as pins and anchorages.

Osmium alloys and ruthenium alloys are used for the tips of fountain pens and for long-life phonograph needles. Rhodium electroplate provides a brilliant finish for jewelry and a surface of high reflectivity for reflectors. Techniques have been developed recently for heavy electroplating of rhodium with controlled thickness on most common

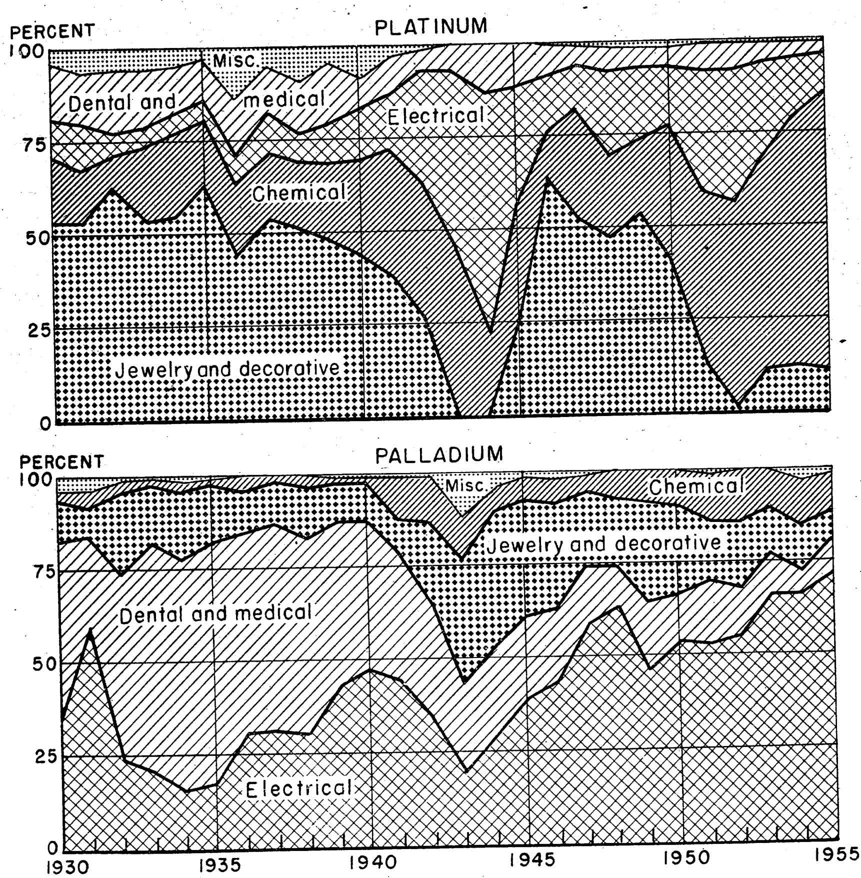

FIGURE 2.—Sales of platinum and palladium to various consuming industries in the United States, 1930–55, as percent of total.

metals, permitting manufacturers to utilize the wear and corrosion resistance of pure rhodium on many production items.

Sales of the platinum-group metals to consumers in the United States totaled 850,800 troy ounces in 1955, compared with 581,900 ounces in 1954—a 46-percent rise.

TABLE 4.—Platinum-group metals sold to consuming industries in the United States, 1954–55, in troy ounces

Industry	Platinum	Palladium	Iridium, osmium, rhodium, and ruthenium	Total
1954				
Chemical	214,068	14,963	11,741	240,772
Electrical	51,896	153,951	3,600	209,447
Dental and medical	14,167	28,670	310	43,147
Jewelry and decorative	37,749	27,408	5,689	70,846
Miscellaneous and undistributed	2,335	9,545	5,854	17,734
Total	320,215	234,537	27,194	581,946
1955				
Chemical	348,088	36,246	16,312	400,646
Electrical	48,683	250,714	4,407	303,804
Dental and medical	12,304	28,809	402	41,515
Jewelry and decorative	52,693	28,673	7,571	88,937
Missellaneous and undistributed	5,297	7,221	3,391	15,909
Total	467,065	351,663	32,083	850,811

Sales of platinum to domestic consumers totaled 467,100 ounces in 1955 and represented 55 percent of the total sales of platinum-group metals; the corresponding figures for 1954 were 320,200 ounces and 55 percent. The chemical industry was the largest user in 1955, taking 75 percent of the total platinum sales, followed by jewelry and decoration, with 11 percent. Sales for dental and medical, electrical, and miscellaneous uses were 3, 10, and 1 percent, respectively, of the total sold. The demand for platinum as a catalyst in oil refining continued strong; the demand for platinum for jewelry remained much below the averages for many previous years.

Sales of palladium to domestic consumers in 1955 were 351,700 ounces, or 41 percent of the total sales of platinum-group metals; corresponding figures for 1954 were 234,500 ounces and 40 percent. The distribution of consumption by uses was: Electrical 71 percent, chemical 10 percent, dental and medical 9, jewelry and decorative 8, and miscellaneous 2 percent. Expansion of dial telephone systems supplied most of the sharply increased 1955 demand for palladium, which is widely used for electrical contacts in automatic-telephone equipment.

Sales of iridium, osmium, rhodium, and ruthenium together in 1955 totaled 32,100 ounces, 4 percent of total sales of platinum-group metals, compared with 27,200 ounces and 5 percent in 1954. By quantity (ounces), sales of each of the 4 metals in 1955 were: Iridium 6,700, osmium 1,100, rhodium 19,200, and ruthenium 5,100.

STOCKS

Stocks of platinum-group metals in all forms in the hands of refiners, dealers, and importers increased 37,300 ounces to 293,900 in 1955, a 15-percent gain.

TABLE 5.—Stocks of platinum-group metals held by refiners, importers, and dealers in the United States, December 31, 1951–55, in troy ounces

Year	Platinum	Palladium	Iridium, osmium, rhodium, and ruthenium	Total
1951	138,977	138,099	36,815	313,891
1952	130,136	116,786	35,451	282,373
1953	138,846	110,211	31,991	281,048
1954	135,631	86,770	34,194	256,595
1955	146,215	111,559	36,097	293,871

PRICES

Despite strong demand, prices for platinum and palladium declined in the early months of 1955, owing in part to offerings by the Soviet Union. However, heavy requirements of platinum for catalytic use in oil refining and of palladium for electrical contacts in dial-telephone systems caused demand for these metals to run ahead of supply in the latter part of the year.

The published domestic retail prices of the platinum-group metals in 1955 were as follows per fine troy ounce: Platinum, $84 at the start of the year, declined to $80 early in February and decreased to $79 in April, after which it rose steadily, reaching $117 in December. Palladium, $21 at the start of the year, declined to $19 in the middle of February, rose to $21 late in May, and reached $24 by the middle of July, where it remained during the rest of the year. Iridium was $130–$135 until the middle of February, $90–$100 until the middle of August, then $100–$110 for the remainder of the year. Osmium was $140 until the middle of February and $80–$100 thereafter. Rhodium was $125 until the middle of February and $118–$125 thereafter. Ruthenium was $60–$65 until the middle of February and $45–$55 thereafter.

The United States purchased domestic and foreign crude platinum at prices ranging from $62.30 to $87.50 per ounce in 1955. This range resulted chiefly from fluctuations in the quotations for refined metals and variations in composition of the crude platinum in the content of other metals.

FOREIGN TRADE [9]

Imports.—Imports of platinum-group metals into the United States in 1955 were at a new record high—67 percent more than in 1954 and 59 percent over the previous record set in 1953. The principal sources were: Canada (358,500 ounces), Colombia (41,500 ounces), France (82,800 ounces), Netherlands (91,200 ounces), Soviet Union (16,800 ounces), Switzerland (117,500 ounces), United Kingdom (281,900 ounces), and West Germany (11,000 ounces). The metals imported from continental countries were reported to be largely of Soviet origin.

Imports of refined metals in 1955 totaled 959,000 troy ounces, compared with 553,900 ounces in 1954, and imports of unrefined metals totaled 51,000 ounces, compared with 52,500 ounces. Imports in 1955 of refined platinum, palladium, osmium, and rhodium were up 30, 158, 165, and 35 percent, respectively, but imports of iridium and ruthenium dropped 37 and 52 percent, respectively.

TABLE 6.—Platinum-group metals imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Troy ounces	Value	Year	Troy ounces	Value
1946–50 (average)	328, 225	$15, 298, 805	1953	634, 088	$39, 447, 072
1951	601, 423	36, 307, 916	1954	[1] 606, 444	[2] 35, 284, 842
1952	452, 818	25, 533, 898	1955	1, 009, 940	[2] 48, 162, 664

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to years before 1954.

Exports.—Exports of refined platinum (including scrap) were 17,100 ounces in 1955 and of other platinum-group metals (including scrap) 11,900 ounces. Corresponding quantities for 1954 were 17,000 and 11,400 ounces.

[9] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, 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, 1954–55, by countries, in troy ounces [1]

[U. S. Department of Commerce]

Country	Unrefined materials [2]				Refined metals						
	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	Total
1954											
North America:											
Canada			555	15	119,437	100,069	166		9,635	1,900	231,777
Mexico			3								3
Total			558	15	119,437	100,069	166		9,635	1,900	231,780
South America:											
Colombia	2,555	[3] 41,400		1		2	7		4		[3] 43,969
Venezuela		(4)									(4)
Total	2,555	[3] 41,400		1		2	7		4		[3] 43,969
Europe:											
Austria			11								11
France		[3] 700	886		[3] 15,158	25,258					42,002
Germany, West			2,733			8,097					10,830
Netherlands					[3] 7,791	17,260					[3] 25,051
Norway	118	475			5,696	5,054	191		293	558	12,385
Switzerland					[3] 71,433	13,112	51				[3] 84,596
U. S. S. R.					[3] 4,283						[3] 4,283
United Kingdom				1,868	[3] 121,253	19,971	17	199	3,265	3,710	[3] 150,283
Total	118	[3] 1,175	3,630	1,868	[3] 225,614	88,752	259	199	3,558	4,268	[3] 329,441
Asia: Philippines						16					16
Africa: Union of South Africa	41		10	1,097	30						1,178
Oceania: Australia		21	32	7							60
Grand total	2,714	[3] 42,596	4,230	2,988	[3] 345,081	188,839	432	199	13,197	6,168	[3] 606,444

1955											
North America:											
Canada			3,839		107,719	231,324			14,298	1,300	358,480
Mexico		39				72					111
Total		39	3,839		107,719	231,396			14,298	1,300	358,591
South America:											
Brazil			10								10
Colombia	407	40,674	434								41,515
Peru			5								5
Total	407	40,674	449								41,530
Europe:											
France			2,009		22,629	58,173					82,811
Germany, West			1,320			9,693					11,013
Netherlands					48,887	42,338					91,225
Norway					2,315	3,859					6,174
Switzerland					78,955	38,558					117,513
U. S. S. R.					12,992	3,810					16,802
United Kingdom					176,610	99,322	271	528	3,485	1,661	281,877
Total			3,329		342,388	255,753	271	528	3,485	1,661	607,415
Asia:											
India			1								1
Japan			504								504
Lebanon					150						150
Total			505		150						655
Africa: Union of South Africa				1,471	13						1,484
Oceania: Australia			240			25					265
Grand total	407	40,713	8,362	1,471	450,270	487,174	271	528	17,783	2,961	1,009,940

[1] On the basis of detailed in formation received by the Bureau of Mines from importers, certain items recorded by the U. S. Department of Commerce as "sponge and scrap" have been reclassified and included with "platinum refined metal" in this table.
[2] U. S. Department of Commerce categories are in terms of meta lcontent. It is believed, however, that in many instances gross weights are actually reported.
[3] Revised figure.
[4] Revised to none.

457676—58——58

TABLE 8.—Platinum-group metals (unmanufactured) imported for consumption in the United States, 1954–55 [1]

[U. S. Department of Commerce]

Material	1954		1955	
	Troy ounces	Value	Troy ounces	Value
Unrefined materials: [2]				
Ores and concentrates of platinum metals	2,714	$191,426	407	$29,000
Platinum grains and nuggets (including crude, dust, and residues)	[3] 42,596	[3] 2,666,197	40,713	2,786,644
Platinum sponge and scrap	4,230	[3] 366,519	8,362	[4] 653,386
Osmiridium	2,988	289,521	1,471	115,391
Total	[3] 52,528	[3 4] 3,513,663	50,953	[4] 3,584,421
Refined metals:				
Platinum	[3] 345,081	[3 4] 26,559,534	450,270	[4] 34,419,178
Palladium	188,839	[4] 3,467,875	487,174	8,185,243
Iridium	432	55,072	271	24,138
Osmium	199	[4] 20,025	528	38,096
Rhodium	13,197	1,336,047	17,783	1,787,418
Ruthenium	6,168	332,626	2,961	124,170
Total	[3] 553,916	[3 4] 31,771,179	958,987	[4] 44,578,243
Grand total	[3] 606,444	[4] 35,284,842	1,009,940	[4] 48,162,664

[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 "sponge and scrap" have been reclassified and included with "platinum refined metal" 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 weight is actually reported.
[3] Revised figure.
[4] Owing to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to years before 1954.

TABLE 9.—Platinum-group metals exported from the United States, 1946–50 (average) and 1951–55 [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
1946–50 (average)	86	$2,890	15,922	$1,103,241	16,129	$499,387	10,242	$357,197
1951	732	117,500	8,760	834,985	52,088	1,355,514	17,348	932,085
1952			6,026	567,623	17,697	512,608	(2)	1,186,775
1953	30	580	2,522	237,853	23,206	591,439	(2)	1,555,046
1954	29	2,367	[3] 16,980	[3] 1,218,250	11,443	287,400	(2)	[3] 1,730,626
1955			[4] 17,073	[4] 1,306,011	[4] 11,895	[4] 469,774	(2)	[4] 1,307,158

[1] Quantities are gross weight.
[2] Beginning Jan. 1, 1952, quantity not recorded.
[3] Revised figure.
[4] Owing to changes in classifications data not strictly comparable to earlier years.

Table 10.—Platinum-group metals exported from the United States, 1954–55, by countries of destination [1]

[U. S. Department of Commerce]

Destination	Ore and concentrates		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 [2]
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value	Value
1954							
North America:							
Canada			1,047	$100,913	5,924	$145,210	$1,128,866
Cuba			171	13,069	294	7,377	1,540
Mexico			314	26,342	956	16,389	7,959
Other North America							1,340
Total			1,532	140,324	7,174	168,976	1,139,705
South America:							
Brazil			7,112	630,286	731	16,475	80,307
Colombia					255	5,800	10,655
Venezuela	29	$2,367	106	9,026	261	5,683	6,641
Other South America			10	3,600	48	1,140	12,534
Total	29	2,367	7,228	642,912	1,295	29,098	110,137
Europe:							
Germany, West					646	10,660	
Italy			2	659	62	10,556	776
Norway			615	57,177	833	17,905	30,048
Spain					577	14,323	
United Kingdom			3,637	267,215	293	11,145	323,897
Other Europe			55	2,360	28	1,050	25,876
Total			4,309	327,411	2,439	65,639	380,597
Asia:							
Japan			[3] 3,876	[3] 102,481	535	23,687	[3] 11,886
Other Asia			29	3,782			74,955
Total			[3] 3,905	[3] 106,263	535	23,687	[3] 86,841
Africa			6	1,340			8,626
Oceania							4,720
Grand total	29	2,367	[3] 16,980	[3] 1,218,250	11,443	287,400	[3] 1,730,626
1955							
North America:							
Canada			2,003	177,175	4,592	108,952	1,044,477
Cuba			70	3,709	234	7,034	3,061
Dominican Republic							6,025
Mexico			517	40,608	950	21,907	6,789
Netherlands Antilles							35,170
Total			2,590	221,492	5,776	137,893	1,095,522
South America:							
Brazil			110	6,099	192	3,765	804
Colombia			632	29,335	200	3,500	21,468
Venezuela			63	2,577	203	6,220	3,018
Other South America			15	1,488	80	1,480	4,278
Total			820	39,499	675	14,965	29,568
Europe:							
France			101	11,511	41	1,693	98,374
Germany, West			1,394	140,651	1,758	68,000	
Italy							43,351
Netherlands			598	58,331	2	777	
United Kingdom			11,177	804,415	2,998	232,025	7,910
Other Europe			4	553			522
Total			13,274	1,015,461	4,799	302,495	150,157

See footnotes at end of table.

TABLE 10.—Platinum-group metals exported from the United States, 1954–55, by countries of destination [1]—Continued

[U. S. Department of Commerce]

Destination	Ore and concentrates		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 [2]
	Troy ounces	Value	Troy ounces	Value	Troy ounces	Value	Value
1955—Continued							
Asia:							
Japan			389	$29,559	641	$13,920	$19,261
Other Asia					4	501	9,548
Total			389	29,559	645	14,421	28,809
Africa							3,102
Grand total			[4] 17,073	[4] 1,306,011	[4] 11,895	[4] 469,774	[4] 1,307,158

[1] Quantities are in gross weight.
[2] Beginning Jan. 1, 1952, quantity not recorded.
[3] Revised figure.
[4] Due to changes in classifications data not strictly comparable to earlier years.

WORLD REVIEW

Canada.—Nearly all the output of platinum-group metals in Canada was recovered as a byproduct of nickel-copper mining in the Sudbury district, Ontario; a small quantity of crude platinum was recovered incidental to gold placer mining in British Columbia. According to the Dominion Bureau of Statistics, the total production in Canada in 1955 was 169,800 ounces of platinum and 211,800 ounces of other platinum-group metals; comparative figures for 1954 were 154,400 and 189,400 ounces, respectively. The increase in 1955 was due to greater production of nickel-copper ores in the Sudbury district, with a proportionately larger yield of byproduct metals.

Deliveries of platinum-group metals by the International Nickel Co. of Canada, Ltd., in 1955 were 445,300 ounces—a new high—compared with 263,200 ounces in 1954.

Continuing favorable exploration results in 1955 at a nickel-copper deposit containing significant quantities of platinum-group metals in the Kluane Lake district, Yukon Territory, discovered in 1952, were reported by the Hudson Bay Mining & Smelting Co., Ltd.[10]

Colombia.—The production of platinum-group metals in Colombia results from placer mining in the Choco district, mostly by dredging. The concentrate shipped averaged about 85 percent platinum-group metals, principally platinum. The South American Gold & Platinum Co., which supplies most of the output, recovered 29,000 ounces of crude platinum in 1955 compared with 25,300 ounces in 1954. Production figures for other operations were not available.

Union of South Africa.—The Union of South Africa ranked as leading producer of platinum-group metals of the world in 1954, surpassing Canada by a narrow margin, and held the lead again in 1955.

[10] Hudson Bay Mining & Smelting Co., Ltd., Annual Report to Stockholders: 1955.

TABLE 11.—World production of platinum-group metals, 1946–50 (average) and 1951–55, in troy ounces [1]

(Compiled by Berenice B. Mitchell)

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada:						
Platinum: Placer platinum and from refining nickel-copper matte	123,220	153,483	122,317	137,545	154,356	169,800
Other platinum-group metals: From refining nickel-copper matte	141,443	164,905	157,407	166,018	189,350	211,820
United States: Placer platinum and from domestic gold and copper refining	25,327	36,951	34,409	26,072	24,235	23,170
Total	289,990	355,339	314,133	329,635	367,941	404,790
South America: Colombia: Placer platinum	34,508	[2] 32,000	[2] 33,700	28,977	25,266	28,950
Europe: U. S. S. R.: Placer platinum and from refining nickel-copper ores (estimate)	130,000	100,000	100,000	100,000	100,000	125,000
Asia: Japan:						
Palladium from refineries	85 (both)	23	85	71	248	[3] 150
Platinum from refineries		245	484	987	1,347	628
Total	85	268	569	1,058	1,595	778
Africa:						
Belgian Congo: Palladium from refineries	63	----	----	----	[3] 176	----
Ethiopia: Placer platinum	722	266	100	566	230	[2] 200
Sierra Leone: Placer platinum	137	----	----	----	----	----
Union of South Africa:						
Platinum-group metals from platinum ores	30,695	58,323	72,701	299,177 (both)	338,162	381,732
Concentrates (platinum-group metal content from platinum ores)	59,666	132,575	159,820			
Osmiridium from gold ores	6,344	6,359	6,141	6,966	6,266	7,095
Total	97,627	197,523	238,762	306,709	344,834	389,027
Oceania:						
Australia:						
Placer platinum	3	8	----	----	23	[2] 10
Placer osmiridium	75	33	51	59	16	[2] 30
New Guinea	[4] 2	5	2	6	5	10
New Zealand: Placer platinum	3	8	4	2	1	----
Papua: Placer platinum	(5)	[6] 2	5	----	4	(5)
Total	83	56	62	67	49	55
World total (estimate)	550,000	675,000	700,000	775,000	850,000	950,000

[1] This table incorporates a number of revisions of data published in previous Platinum chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[2] Estimate.
[3] Includes platinum.
[4] Average for 2 years only, as 1949 was the first year of commercial production.
[5] Less than 0.5 ounce.
[6] Year ended June 30 of year stated.

According to the Department of Mines, the production of platinum-group metals in the Union of South Africa in 1955 was 389,000 ounces. The average analysis of 363,844 ounces of platinum-group metals exported from the Union in 1955 was reported as follows:[11] Platinum 60.98 percent, palladium 33.35, osmium and osmiridium 0.08, rhodium 2.38, ruthenium 0.59, and gold 2.62.

Platinum-group metals were recovered in the Union of South Africa from the following two sources: As an osmiridium byproduct of

[11] Pretoria, Union of South Africa. Industrial Quarterly Report: Fourth Quarter, 1954, p. 14.

gold mining on the Rand and as the principal product of underground-mining operations on the Merensky Reef, a horizon of the ultra-basic Bushveld igneous complex in the Transvaal.

During the past 2 decades the output of osmiridium on the Rand has averaged around 6,000 ounces annually. The composition of the osmiridium is variable, the metals contained ranging within the following limits:

Metal:	*Range (percent)*
Osmium	44. 5–24. 0
Iridium	40. 5–21. 5
Ruthenium	17. 0– 9. 0
Platinum	19. 0– 4. 0
Rhodium	1. 0– 0. 5
Gold	15. 0– 0. 0

The Merensky Reef has been located at various points many miles apart in the Brits, Rustenburg, and Potgietersrust districts, and the quantity of platinum ore it contains is believed to be large. All mining operations on the Merensky Reef are carried on by Rustenburg Platinum Mines, Ltd., a coalition of several former producers. In the area being mined by the Rustenburg Co., the reef is consistent in value, containing about 10 to 12 dwt. of platinum-group metals per ton over a width of about 12 inches; copper and nickel present in the ore are recovered as byproducts. Run-of-mine ore, which averages about 5 dwt. of platinum-group metals per ton, is crushed, hand-sorted, ground, and passed over corduroy cloth, where approximately 30 percent of the values in the platinum-group metal is recovered in a high-grade product locally termed "platinum-mineral concentrate." The tailing from the corduroy cloths is treated by flotation with recovery of copper and nickel sulfides containing the balance of the platinum-group metals. The flotation product is smelted locally to matte, most of which (along with the "platinum-mineral concentrate") is shipped to the Johnson, Matthey & Co., Ltd., refinery in England for recovery of the platinum-group metals. About 25 percent of the matte is treated locally to recover electrolytic nickel and copper; residue from this operation is shipped to England also for recovery of platinum-group metals. A more detailed description of production and recovery methods was given in the 1954 chapter.

Rustenburg Platinum Mines, Ltd., announced plans to expand its production facilities 50 percent by mid-1957. Already the world's largest producer of platinum-group metals, with an annual output of around 380,000 ounces, the expansion would place the company's future production level at over 500,000 ounces annually.

U. S. S. R.—Before the First World War Russia was by far the world's largest producer of platinum-group metals, averaging over 200,000 ounces annually; most of it was crude platinum produced by placer mining in the Ural Mountains. Since then, the Ural production is believed to have decreased steadily, but this decline has been offset by the increasing production of byproduct platinum-group metals, largely palladium, from the Noril'sk copper-nickel mine in Siberia. In the absence of any accurate data, the output of platinum-group metals in the U. S. S. R. is estimated at 125,000 ounces annually.

Potash

By E. Robert Ruhlman [1] and Gertrude E. Tucker [2]

DOMESTIC production of potash continued its upward trend and reached a new high in 1955. The total supply of potash (K_2O equivalent) available in the United States was more than 2.4 million short tons.

The American Potash Institute, organized to "promote the efficient and profitable use of potash in agriculture," celebrated its 20th anniversary in 1955.

TABLE 1.—Salient statistics of the potash industry in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Production of potassium salts (marketable) ____ short tons__	2,006,252	2,474,870	2,866,462	3,266,429	3,322,395	3,505,505
Approximate equivalent K_2O ________ short tons__	1,101,537	1,420,323	1,665,113	1,911,891	1,948,721	2,064,808
Sales of potassium salts by producers _______ short tons__	2,012,014	2,451,913	2,757,252	2,965,986	3,270,006	3,400,835
Approximate equivalent K_2O ________ short tons__	1,104,359	1,408,408	1,598,354	1,731,607	1,918,157	2,003,578
Value at plant ____________	$40,303,000	$51,007,000	$59,852,000	$65,403,000	$71,819,000	$76,551,000
Average per ton ________	$20.03	$20.80	$21.71	$22.05	$21.96	$22.51
Imports of potash materials short tons__	109,068	574,361	357,437	250,557	225,230	329,389
Approximate equivalent K_2O ________ short tons__	55,454	313,617	188,441	133,587	119,220	177,052
Value ____________________	$4,848,433	$18,543,112	$12,714,434	$9,952,663	$8,387,265	$11,769,071
Exports of potash materials short tons__	123,520	124,211	101,200	88,208	117,386	229,303
Approximate equivalent K_2O [1] ________ short tons__	67,617	68,654	56,281	49,109	66,476	130,226
Value ____________________	$7,531,853	$7,593,646	$4,836,659	$3,936,415	$5,463,452	$9,202,965
Apparent consumption of potassium salts [2] short tons__	1,997,563	2,902,063	3,013,489	3,128,335	3,377,850	3,500,921
Approximate equivalent K_2O ________ short tons__	1,092,196	1,653,371	1,730,514	1,816,085	1,970,901	2,050,404

[1] Estimate by Bureau of Mines.
[2] Quantity sold by producers, plus imports, minus exports.

PRODUCTION AND SALES

The domestic production of marketable potassium salts reached a new high in 1955 of more than 3.5 million short tons, a 6-percent increase above 1954 and over double the production in 1945. The sales of domestic marketable salts increased 4 percent in quantity and 7 percent in value.

Production of high-analysis materials (60–62 percent K_2O minimum, including refined KCl, 93–96 percent KCl, lower grade muriate, and manure salts) was 91 percent of the total potassium salts produced in the United States in 1955. Production of lower grade muriate (48–50 percent K_2O minimum) was reported by 1 company.

[1] Commodity specialist.
[2] Statistical assistant.

The output of sulfate of potash and sulfate of potash-magnesia increased in 1955. Manure-salts production was 6 percent below 1954.

California, New Mexico, and Utah continued to be the major producing States of domestic marketable potassium salts; over 91 percent came from the Permian deposits in Eddy County, N. Mex.

TABLE 2.—Potassium salts produced in the United States, 1946–50 (average) and 1951–55, by grades, in short tons

Grade	1946–50 (average)	1951	1952	1953	1954	1955
Muriate of potash:						
60–62 percent K_2O minimum [1]	1,505,763	2,047,793	2,468,436	2,926,398	} 3,033,185	3,195,935
48–50 percent K_2O minimum	143,415	155,797	150,959	81,801		
Manure salts	146,333	19,775	8,409	4,628		
Sulfate of potash and sulfate of potash-magnesia	210,741	251,505	238,658	253,602	289,210	309,570
Total	2,006,252	2,474,870	2,866,462	3,266,429	3,322,395	3,505,505

[1] Includes refined potash and some 93–96 percent KCl.

TABLE 3.—Potassium salts produced, sold, and in producers' stocks in the United States, 1946–50 (average) and 1951–55

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)
1946–50 (average)	7	2,006,252	1,101,537	7	2,012,014	1,104,359	$40,303,000	40,326	18,719
1951	9	2,474,870	1,420,323	9	2,451,913	1,408,408	51,007,000	62,597	32,302
1952	10	2,866,462	1,665,113	10	2,757,252	1,598,354	59,852,000	170,608	98,244
1953	10	3,266,429	1,911,891	10	2,965,986	1,731,607	65,403,000	471,939	279,168
1954	10	3,322,395	1,948,721	10	3,270,006	1,918,157	71,819,000	[1] 526,398	[1] 312,020
1955	10	3,505,505	2,064,808	10	3,400,835	2,003,578	76,551,000	[2] 630,962	[2] 373,195

[1] Revised figure as reported by producers.
[2] Figure reflects losses in handling.

The plant locations of potash-producing companies in the United States in 1955, by States, were as follows:

California:
- The American Potash & Chemical Corp., Trona, San Bernardino County.
- A. M. Blumer, Davenport, Santa Cruz County.

Maryland: North American Cement Corp., Security, Washington County.

Michigan: The Dow Chemical Co., Midland, Midland County.

New Mexico (all mines and plants are in Eddy County near Carlsbad):
- Duval Sulphur & Potash Co.
- International Minerals & Chemical Corp.
- Potash Company of America.
- The Southwest Potash Corp.
- United States Potash Co., Inc.

Utah: Bonneville, Ltd., Wendover, Tooele County.

Mine production of crude potassium salts in the Carlsbad region of New Mexico reached a new high of over 10.9 million short tons, a 10-percent increase over 1954. The calculated grade (K_2O equivalent) of the crude salts mined decreased in 1955 to 19.71 percent compared with 19.91 in 1954 and 20.97 percent in 1953.

All five operating companies in the Carlsbad region mined sylvinite (potassium and sodium chlorides) and processed the ore to yield various grades of muriate. International Minerals & Chemical Corp. also mined langbeinite and processed it to yield potassium sulfate and potassium-magnesium sulfate.

TABLE 4.—Production and sales of potassium salts in New Mexico, 1946–50 (average) and 1951–55, 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
1946–50 (average)	4,945,732	1,029,058	1,706,818	925,559	1,713,066	928,658	$33,608,000
1951	6,615,891	1,349,572	2,138,439	1,223,139	2,126,391	1,217,617	43,428,000
1952	7,852,732	1,644,034	2,530,596	1,468,029	2,439,042	1,411,125	52,483,000
1953	9,100,671	1,908,280	2,937,960	1,721,435	2,661,587	1,552,831	58,076,000
1954	9,975,460	1,985,626	3,007,724	1,763,378	2,954,043	1,732,240	64,367,000
1955	10,956,466	2,159,010	3,196,799	1,883,766	3,097,771	1,826,118	69,058,000

[1] Sylvite and langbeinite.

Expansion at existing New Mexico potash mines and plants costing over $7 million was either underway or announced in 1955. The Potash Company of America program began during 1955. International Minerals & Chemical Corp., Southwest Potash Corp., and United States Potash Co., Inc., planned expansion of mining and processing facilities.[3]

The National Potash Co. was incorporated in Delaware in 1955 by Freeport Sulphur Co. and Pittsburgh Consolidation Coal Co. to develop the potash deposits in Lea County, N. Mex., outlined during a drilling program by Freeport Sulphur Co. Sinking on two 15-foot circular shafts, to reach a depth of 1,800 feet, began during the latter part of May. It was estimated that 18 months would be required for completion of both shafts. Plans called for expenditure of $19 million for a mine and refinery with an annual capacity of 240,000 tons of K_2O.[4]

The Farmers Chemical Resources Development Corp. was formed by National Farmers Union, Kerr-McGee Oil Industries, Inc., and Phillips Chemical Co. to develop the potash deposits controlled by the National Farmers Union in Eddy and Lea Counties. Additional core drilling was planned before development.[5]

Flanders Mining Co. began to explore for potash in Eddy County, N. Mex., and applied for prospecting permits in other States.[6]

Bonneville, Ltd., announced a $300,000 expansion program for its potash refinery and storage facilities at Wendover, Utah.[7]

[3] American Metal Co., Ltd., Annual Report: 1955, pp. 12–13.
Mining World, vol. 17, No. 10, September 1955, p. 97.
Rock Products, vol. 58, No. 1, January 1955, p. 77; No. 4, April 1955, p. 62.
[4] Mining Congress Journal, vol. 41, No. 4, April 1955, p. 113.
Rock Products, vol. 58, No. 7, July 1955, p. 68.
[5] Mining World, vol. 17, No. 6, May 1955, p. 101.
[6] Engineering and Mining Journal, vol. 156, No. 7, July 1955, p. 148.
Western Mining and Industrial News, vol. 23, No. 6, June 1955, p. 4.
[7] Pit and Quarry, vol. 47, No. 8, February 1955, p. 15.

Calunite Corp. began mining operations at the alunite deposits near Marysvale, Utah. The material was added to N–P–K fertilizers and marketed in California.[8]

The Delhi Oil Corp. was reported to be considering the development of potash deposits about 9 miles northwest of Moab, Utah.[9] This company has been exploring for potash in the Moab area during the past several years.

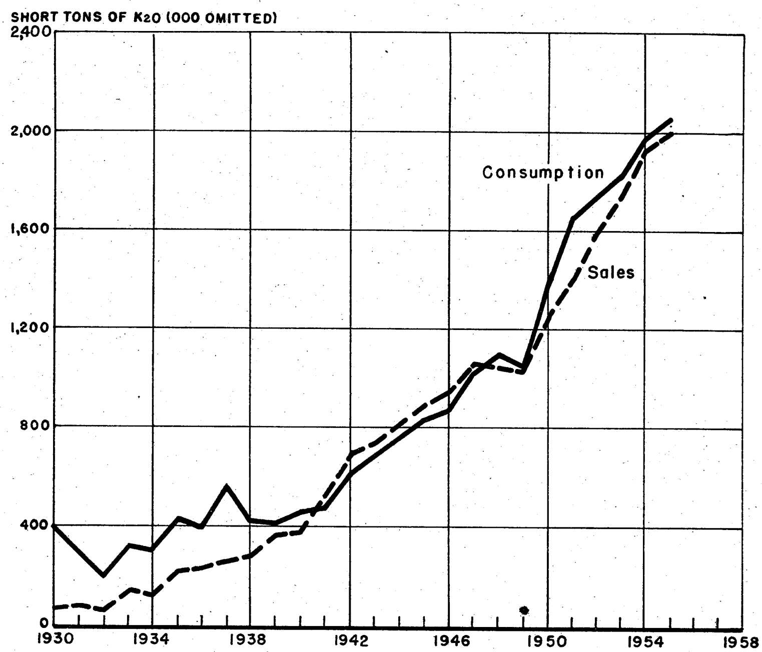

FIGURE 1.—Comparison of apparent domestic consumption of potash (K_2O) and sales of domestic producers of potash in the United States, 1930–55.

The United States Department of the Interior revised its leasing regulations to encourage potash production from fringe areas and to change the dating of leases to the first day of the month following approval instead of the time of the original application.[10]

CONSUMPTION AND USES

The apparent consumption of K_2O in 1955 (producers' sales plus imports minus exports) was 4 percent greater than in 1954. The apparent consumption and sales of domestic producers, as reported to the Bureau of Mines, are shown in figure 1. The sales of domestic potash materials in 1955 were 97 percent of apparent consumption, the same as in 1954.

---

[8] Mining World, vol. 17, No. 3, March 1955, p. 99.
[9] Mining Magazine, vol. 45, No. 9, September 1955, p. 17.
Western Industry, vol. 20, No. 9, September 1955, p. 90.
[10] Oil, Paint and Drug Reporter, vol. 167, No. 20, May 16, 1955, p. 42.

According to the American Potash Institute (press notice, March 16, 1956):

Deliveries of potash in North America during 1955 amounted to 3,744,143 tons of salts containing an equivalent of 2,201,279 tons K_2O, according to the American Potash Institute. This was an increase of 141,636 tons K_2O or 7% over 1954. Deliveries by the seven leading domestic producers were 1,997,770 tons K_2O, an increase of nearly 5% over last year. Imports were 203,509 tons K_2O, an increase of 35% over last year.

Deliveries for agricultural purposes in the continental United States for 1955 were 1,875,438 tons K_2O, an increase of 40,628 tons over 1954. Canada received 88,600 tons K_2O, Cuba 10,687 tons, Puerto Rico 21,773 tons, and Hawaii 18,159 tons. Exports to other countries amounted to 72,047 tons K_2O.

In this country, agricultural potash was delivered in 47 states and the District of Columbia. Illinois with over 192,000 tons K_2O was the leading state followed in order by Ohio, Indiana, Georgia, Florida, and Virginia, each taking more than 100,000 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 over 95% of deliveries. Muriate of potash continued to be by far the most popular material, comprising nearly 94% of the total K_2O delivered for agricultural purposes, and sulphate of potash and sulphate of potash magnesia over 6%.

Deliveries for chemical purposes in 1955 were 170,427 tons of muriate of potash containing an equivalent of 107,256 tons K_2O, and 13,558 tons of sulphate of potash containing 6,959 tons K_2O. The total chemical deliveries of 114,215 tons K_2O were 5% of all potash deliveries, and 22,406 tons or 24% more than in 1954.

The deliveries of agricultural and chemical potash in North America, 1944–55, are shown in figure 2 and the deliveries by States in 1955 are given in table 6.

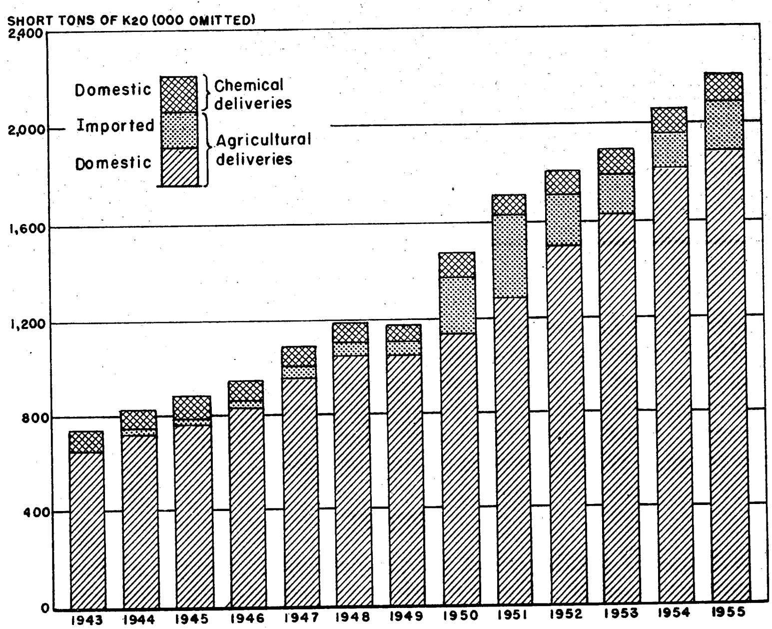

FIGURE 2.—Potash deliveries by use groups in North America, 1943–55 (American Potash Institute).

TABLE 5.—Apparent consumption [1] of potassium salts in the United States, 1946–50 (average) and 1951–55, in short tons

Year	Potassium salts	Approximate equivalent K_2O	Year	Potassium salts	Approximate equivalent K_2O
1946–50 (average)	1,997,563	1,092,196	1953	3,128,335	1,816,085
1951	2,902,063	1,653,371	1954	3,377,850	1,970,901
1952	3,013,489	1,730,514	1955	3,500,921	2,050,404

[1] Quantity sold by producers, plus imports, minus exports.

TABLE 6.—Deliveries of potash salts in 1955, by States of destination, in short tons of K_2O

[American Potash Institute]

State	Agricultural potash	Chemical potash	State	Agricultural potash	Chemical potash
Alabama	62,792	25	Montana	63	31
Arizona	934		Nebraska	1,738	37
Arkansas	34,825		Nevada	1	1,335
California	15,825	6,170	New Hampshire	28	41
Colorado	780	24	New Jersey	31,207	2,034
Connecticut	4,846	279	New Mexico	63	
Delaware	10,124	567	New York	38,052	74,425
District of Columbia	414		North Carolina	99,687	71
Florida	117,229	533	North Dakota	3,534	
Georgia	129,535	271	Ohio	187,408	3,788
Idaho	662		Oklahoma	2,837	329
Illinois	192,750	1,974	Oregon	3,653	160
Indiana	147,950	1,142	Pennsylvania	39,470	1,707
Iowa	54,039	417	Rhode Island	1,773	
Kansas	2,980	163	South Carolina	61,386	
Kentucky	34,644	352	South Dakota	192	
Louisiana	24,506	306	Tennessee	64,195	
Maine	11,146	125	Texas	44,092	5,797
Maryland	80,956	1,035	Utah	133	123
Massachusetts	14,181	150	Vermont	564	
Michigan	54,422	1,014	Virginia	112,446	459
Minnesota	50,954	25	Washington	7,248	21
Mississippi	28,525	48	West Virginia	1,331	6,069
Missouri	44,159	1,015	Wisconsin	55,159	101
			Total	1,875,438	112,163

STOCKS

Stocks (K_2O equivalent) reported by producers at the end of 1955 were 20 percent more than in 1954. Year-end stocks in the potash industry are not entirely unsold output but include large inventories in anticipation of orders for the spring planting season which begins in February. Producers' stocks on hand at year end for 1946–50 (average) and 1951–55 are included in table 3.

PRICES

The domestic producers of potash continued the price plan used for the previous season. Quoted prices varied with date of order. The port prices quoted by two Carlsbad producers in the 1954–55 season were discontinued.

The American Potash & Chemical Corp. issued its price schedule for agricultural-grade Trona potash for the 1955–56 season on May 31, 1955. The prices for muriate of potash, 60 percent K_2O minimum,

f. o. b. Trona, Calif., in bulk, in carlots of not less than 40 tons, were as follows: Standard grade, 44.5 and 46.5 cents per unit of K_2O for contracts made prior to July 1, 1955 and for July 1, 1955 through May 31, 1956, respectively; and granular, 46 and 48 cents per unit for the same periods. The prices for Trona sulfate of potash, f. o. b. Trona, Calif., in bulk, in carlots of not less than 40 tons, was quoted for the 2 periods as 75.5 and 78.5 cents per unit K_2O.

Price schedules for New Mexico potash for agricultural purposes for 1955–56 were issued in May and June 1955, as shown in table 7.

TABLE 7.—Prices of agricultural potash quoted by producers, f. o. b. Carlsbad, N. Mex., for 1955–56 season, in bulk, minimum carlots of 40 tons

Salt	Grade	Brand	Producer	Cents per unit K_2O	
				Period 1[1]	Period 2[1]
Muriate of potash	62–63 percent K_2O	Sunshine State	U. S. P.	36.5	40
Do[2]	60 percent K_2O minimum, standard.	Red Muriate	P. C. A.	36	38
Do[3]	do	International	I. M. & C. C.	36	38
Do[4]	do	High-K	S. W. P. C.	36	38
Do[5]	60 percent K_2O minimum	Duval Muriate of Potash.	D. S. & P. C.	36	38
Do[6]	60 percent K_2O granular	Red Muriate	P. C. A.	36	38
Do[7]	59–61 percent K_2O granular	Sunshine State	U. S. P.	36.5	40
Do[8]	60 percent K_2O minimum, granular.	International	I. M. & C. C.	36	38
Do[9]	do	Duval granular muriate.	D. S. & P. C.	36	38
Manure salts	Run-of-mine 20 percent K_2O minimum.	Sunshine State	U. S. P.	17	21
Do	Run-of-mine 22 percent K_2O minimum.	High-K	S. W. P. C.	17.65	18.6
Do	Run-of-mine 20 percent K_2O minimum.	International	I. M. & C. C.	18	21
Sulfate of potash	50 percent K_2O minimum	do	do	64	67
Sulfate of potash-magnesia.	22 percent K_2O 18 percent MgO.	Sul Po-mag	do	[10] $13.45	[10] $14.00

[1] Prices under period 1 applied to contracts made before July 1, 1955; period 2, orders accepted between July 1, 1955 through May 1956.
[2] Potash Company of America quoted muriate of potash, 60 percent K_2O minimum, standard, in new multiwall paper bags, 100 lb. each, at $26.00 and $27.20 per ton for the 2 periods, respectively.
[3] International Minerals & Chemical Corp. quoted muriate of potash, 60 percent K_2O minimum, in 5-ply bags, 100 lb. each, at $26.00 and $27.20 per ton for the 2 periods, respectively.
[4] Southwest Potash Corp. quoted muriate of potash, 60 percent K_2O minimum, in new multiwall bags, 100 lb. each, at $26.00 and $27.35 per ton, respectively.
[5] Duval Sulphur & Potash Co. quoted muriate of potash, 60 percent K_2O minimum, in new multiwall bags, 100 lb. each, at $26.00 and $27.20 per ton, respectively.
[6] Potash Company of America quoted muriate of potash, 60 percent K_2O granular, in new multiwall bags, at $26.25 and $27.45 per ton for the 2 periods, respectively.
[7] United States Potash Co., Inc., quoted muriate of potash, granular, 60 percent K_2O minimum, in 5-ply bags, 100 lb. each, at $26.50 and $28.60, respectively.
[8] International Minerals & Chemical Corp. quoted muriate of potash, 60 percent K_2O, granular, in 5-ply bags, 100 lb. each, at $26.25 and $27.45, respectively.
[9] Duval Sulphur & Potash Co. quoted muriate of potash, 60 percent K_2O minimum, granular, in new multiwall paper bags, 100 lb. each, at $26.25 and $27.45 per ton, respectively.
[10] Per short ton.

FOREIGN TRADE[11]

Imports.—The imports of fertilizer and chemical potash materials were 46 percent more than in 1954 but much less than in 1951, the highest year since World War II. The average value per ton of imports of fertilizer-grade potash material at the port of origin was $28.99, 60 cents less than in 1954. West Germany, East Germany, France, and Spain continued to be the principal supplying countries.

[11] Figures on United States imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

As a result of the findings by the United States Treasury Department to the effect that imported potash from East Germany, West Germany, and France "was being or was likely to be" sold in the United States at less than its fair value, the United States Tariff Commission held public hearings on January 25–27 regarding East German imports and on February 8–9 on West German and French imports, to determine if the domestic industry "was being or was likely to be" injured. The findings in both cases, released on February 25, 1955, and March 3, 1955, were "no injury to the domestic potash industry." The Tariff Commission, however, suggested that a close check of imports be maintained to assure that the Antidumping Act is not violated.

Exports.—Exports of potash materials increased 95 percent in 1955 over 1954. Countries in the Western Hemisphere received 65 percent of the exports; Japan, 26 percent; and New Zealand, 8 percent.

TABLE 8.—Potash materials imported for consumption in the United States, 1954–55

[U. S. Department of Commerce]

Material	Approximate equivalent as potash (K_2O) (percent)	1954				1955			
		Short tons	Approximate equivalent as potash (K_2O)		Value	Short tons	Approximate equivalent as potash (K_2O)		Value
			Short tons	Percent of total			Short tons	Percent of total	
Used chiefly in fertilizers:									
Muriate (chloride)	59.0	147,344	86,933	72.9	$3,746,611	241,461	142,462	80.5	$6,277,161
Potassium nitrate, crude	40.0	732	293	.2	70,777	1,118	447	.2	118,681
Potassium-sodium nitrate mixtures, crude	14.0	13,228	1,852	1.6	599,230	19,300	2,702	1.5	794,902
Potassium sulfate, crude	50.0	53,623	26,812	22.5	1,943,206	54,527	27,264	15.4	1,981,483
Total fertilizer		214,927	115,890	97.2	6,359,824	316,406	172,875	97.6	9,172,227
Used chiefly in chemical industries:									
Bicarbonate	46.0	38	17		9,266	16	7		3,949
Bitartrate:									
Argols	20.0	6,139	1,228		620,536	7,640	1,528		967,156
Cream of tartar	25.0	361	90		122,081	345	86		135,289
Carbonate	61.0	18	11		1,852	-------	-------		-------
Caustic	80.0	191	153		48,516	217	174		77,129
Chlorate and perchlorate	36.0	121	44		29,021	342	123		80,352
Chromate and dichromate	40.0	-------	-------	2.8	-------	4	2	2.4	1,186
Cyanide	70.0	838	587		559,609	795	557		552,778
Ferricyanide	42.0	241	101		152,266	288	121		176,941
Ferrocyanide	44.0	701	308		258,890	661	291		259,437
Nitrate	46.0	867	399		95,940	1,222	562		140,459
Permanganate	29.0	10	3		2,763	3	1		894
Rochelle salts	22.0	-------	-------		-------	1	(1)		486
All other	50.0	778	389		126,701	1,449	725		200,788
Total chemical		10,303	3,330	2.8	2,027,441	12,983	4,177	2.4	2,596,844
Grand total		225,230	119,220	100.0	8,387,265	329,389	177,052	100.0	11,769,071

[1] Less than 1 ton.

TABLE 9.—Potash materials imported for consumption in the United States, 1954–55, 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: Argols of wine lees (20)	Bitartrate: Cream of tartar (25)	Carbonate (61)	Caustic (hydroxide) (80)	Chlorate and perchlorate (36)	Cyanide (70)	Muriate (chloride) (59)	Potassium nitrate, crude (40)	Potassium sodium nitrate mixtures, crude (14)	Potassium sulfate, crude (50)	All other[1]	Total: Short tons	Total: Value
1954													
South America: Chile					44				13,228			13,272	$611,416
Europe:													
Belgium-Luxembourg						6				3,519	134	3,659	225,926
Czechoslovakia						5						5	3,278
France	1,690			44	8	102	20,781			11,865	42	34,532	1,349,160
Germany:													
East							32,910			16,939	40	49,889	1,489,267
West			18	64		460	69,583	732		21,300	844	93,001	3,008,443
Italy	1,254	120				6						1,380	181,839
Netherlands		11				13					1,560	1,584	403,702
Portugal	417											417	50,227
Spain		230					24,070					24,300	582,243
Sweden				83	55	2						140	48,466
Switzerland					14							14	3,228
United Kingdom						244					15	259	180,893
Total	3,361	361	18	191	77	838	147,344	732		53,623	2,635	209,180	7,526,672
Africa:													
Algeria	2,398											2,398	214,585
French Morocco	219											219	22,201
Tunisia	161											161	12,391
Total	2,778											2,778	249,177
Grand total	6,139	361	18	191	121	838	147,344	732	13,228	53,623	2,635	225,230	8,387,265
1955													
North America: Canada						24						24	16,717
South America: Chile					33				19,252			19,285	799,907

For footnotes, see bottom of table.

TABLE 9.—Potash materials imported for consumption in the United States, 1954–55, by countries, in short tons—Continued

(Figures in parentheses in column headings indicate, in percent, approximate equivalent as potash (K_2O))

[U. S. Department of Commerce]

Country	Bitartrate		Carbonate	Caustic (hydroxide)	Chlorate and perchlorate	Cyanide	Muriate (chloride)	Potassium nitrate, crude	Potassium sodium nitrate mixtures, crude	Potassium sulfate, crude	All other[1]	Total	
	Argols of wine lees (20)	Cream of tartar (25)	(61)	(80)	(36)	(70)	(59)	(40)	(14)	(50)		Short tons	Value
Europe:													
Belgium-Luxembourg											208	208	94,287
Czechoslovakia						48						48	35,209
Denmark						3						3	2,223
France	1,477				45	60	60,155	1,008	13	13,007	73	75,838	2,564,536
Germany:													
East							77,063			5,648	75	82,786	2,198,987
West				13		541	83,455	110	35	35,872	1,327	121,353	3,975,723
Italy	2,281	91				2						2,374	289,812
Netherlands						15	725				1,926	2,666	453,413
Portugal	900											900	132,815
Spain		254					20,063					20,317	578,053
Sweden				204	106							310	99,362
Switzerland					158							158	38,750
United Kingdom						102					33	135	92,568
Total	4,658	345		217	309	771	241,461	1,118	48	54,527	3,642	307,096	10,555,738
Asia: Japan											2	2	552
Africa:													
Algeria	2,310											2,310	311,035
French Morocco	336											336	50,463
Tunisia	336											336	34,659
Total	2,982											2,982	396,157
Grand total	7,640	345		217	342	795	241,461	1,118	19,300	54,527	3,644	329,389	11,769,071

[1] Approximate equivalent as potash (K_2O)—1954: 43 percent; 1955: 40 percent.

TABLE 10.—Potash materials exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Fertilizer		Chemical		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	104,613	$3,472,929	18,907	$4,058,925	123,520	$7,531,854
1951	109,139	4,023,434	15,072	3,570,212	124,211	7,593,646
1952	94,678	3,320,689	6,522	1,515,970	101,200	4,836,659
1953	83,412	2,893,946	4,796	1,042,469	88,208	3,936,415
1954	111,184	4,133,527	6,202	1,329,925	117,386	5,463,452
1955	222,499	7,958,862	6,804	1,244,103	229,303	9,202,965

TABLE 11.—Potash materials exported from the United States, 1954–55, by countries of destination

[U. S. Department of Commerce]

Country	Fertilizer				Chemical			
	1954		1955		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
North America:								
Canada	74,089	$2,642,484	82,283	$2,913,931	3,634	$603,758	3,740	$632,985
Costa Rica	512	25,888	496	21,748			19	5,135
Cuba	8,207	263,294	20,960	701,081	145	43,020	95	24,904
Dominican Republic	670	22,750	300	10,984	5	1,190		
El Salvador	350	14,729	366	13,790	5	1,330	(1)	500
Guatemala			10	631	41	10,771	21	4,680
Honduras			12	678	5	1,075	4	1,735
Jamaica			150	5,400				
Mexico	4,525	138,557	7,650	178,749	322	103,440	310	85,357
Other North America	80	5,550	72	3,916			5	5,400
Total	88,433	3,113,252	112,299	3,850,908	4,157	764,584	4,194	760,696
South America:								
Argentina	177	7,251	53	2,667	15	4,788	52	7,881
Brazil	16,325	741,692	26,761	1,123,038	1,304	320,895	409	80,461
Chile					13	3,725	22	4,865
Colombia	200	7,848	3,375	180,966	94	27,698	101	28,145
Ecuador	55	1,937	215	11,330	28	8,072	22	7,345
Peru	220	4,917			6	2,470	27	10,544
Uruguay							178	20,316
Venezuela	589	26,796	727	33,263	86	27,071	81	31,484
Other South America					15	11,283	5	6,434
Total	17,566	790,441	31,131	1,351,264	1,561	406,002	897	197,475
Europe:								
Belgium-Luxembourg					14	8,843	16	7,962
France							27	9,581
Germany, West					82	20,188		
Italy							2	1,942
Netherlands	3,307	152,000					41	10,296
Norway					3	1,136		
Sweden	165	7,260			172	11,842	1,156	50,940
Switzerland					1	592		
Turkey							24	7,268
United Kingdom					8	18,730	8	31,519
Other Europe					5	1,898	13	4,835
Total	3,472	159,260			285	63,229	1,287	124,343

[1] Less than 1 ton.

TABLE 11.—Potash materials exported from the United States, 1954–55, by countries of destination—Continued

[U. S. Department of Commerce]

Country	Fertilizer				Chemical			
	1954		1955		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Asia:								
India					7	$6,743	58	$14,671
Japan	10	$612	60,177	$2,186,894			5	1,000
Korea, Republic of					33	9,167	82	24,973
Pakistan					1	990	2	664
Philippines	1,663	67,779	50	2,855	85	29,146	99	28,622
Taiwan							24	8,549
Other Asia	40	2,183	15	883	17	5,992	27	7,842
Total	1,713	70,574	60,242	2,190,632	143	52,038	297	86,321
Africa:								
Belgian Congo					(1)	540	52	26,677
Union of South Africa					51	39,481	66	39,569
Other Africa							4	2,297
Total					51	40,021	122	68,543
Oceania:								
Australia					5	4,051	7	6,725
New Zealand			18,827	566,058				
Total			18,827	566,058	5	4,051	7	6,725
Grand total	111,184	4,133,527	222,499	7,958,862	6,202	1,329,925	6,804	1,244,103

[1] Less than 1 ton.

TECHNOLOGY

Scintillometers were used to trace potassium-bearing rock formations. This geophysical technique permitted tracing buried acid-basic rock contacts.[12]

A new mineral, galeite—$Na_2SO_4 \cdot Na(FCl)$—was discovered in Searles Lake, Calif. Galeite occurs as minute white hexagonal crystals in the potash-bearing brine.[13]

Details of the Poetsch method for shaft sinking, as used by the Potash Company of America at its Carlsbad mine, were described.[14] Following two unsuccessful attempts by regular methods, the freezing method was successful in sinking through quicksand and water-bearing formations.

The two circular shafts of Southwest Potash Corp. were sunk, using a Riddell mucking machine. Water flow, which reached a maximum of 200 gallons per minute, was controlled by grouting and concrete procedures.[15]

Technical papers presented at the 1955 International Ore Dressing Congress, held at Goslar, Harz, West Germany, included: Intergrowth of German Potash Minerals, by R. Kühn; Ore-Dressing Problems in the German Potash Industry, by R. Bachmann; and descriptions of the flotation plants of the German potash industry.[16]

[12] PreCambrian, vol. 28, No. 1, January 1955, p. 17.
[13] Rocks and Minerals, No. 249, November–December 1955, p. 585.
[14] Latz, J. E., Shaft-Sinking Problems: Eng. and Min. Jour., vol. 156, No. 10, October 1955, pp. 96–99.
[15] Herbert, I. A., How Southwest Potash Corp. Sank and Sealed Two Concrete Shafts: Eng. and Min Jour., vol. 156, No. 5, May 1955, pp. 76–81.
[16] Mine and Quarry Engineering, Ore-Dressing Congress: Vol. 21, No. 11, November 1955, pp. 454–462.

Bonneville, Ltd., collected brines from the western end of the Great Salt Flats by means of a network of 50 miles of canals, 3 feet wide and 14 feet deep. From the canals, the brine was pumped into a series of evaporation ponds. The crystallized brines, containing about 2 parts sodium chloride to 1 part potassium chloride, were hauled to the flotation plant in 20-cubic-yard bottom-dump wagons. The haul varied from 2 to 5 miles. The flotation plant produced 85 to 90 percent potassium chloride, which was further upgraded by a fresh-water wash before marketing.[17]

The trend toward more seasonal sales of potash and the consequent increased storage of finished product by the producer resulted in the construction of larger storage buildings. The new storage building of the International Minerals & Chemical Corp., 500 feet long, 150 feet wide, and 70 feet high, was completed in 1955. New fabrication techniques used in its construction were more economical and permitted more rapid construction.[18]

The overall activities of the European fertilizer industry were documented by the publication "Fertilisers, 1952–55" published by the Organisation for European Economic Cooperation. The publication included data on production, consumption, foreign trade, and prices.[19]

Potassium fixation in soils remained an important agronomic problem. Methods of determining factors that cause fixation and the availability of fixed potassium ions to crops were investigated.[20]

Soils in California initially containing ample supplies of potash largely have become deficient. A cooperative agreement between the potash industry and the University of California encouraged use of potash fertilizers in California.[21]

Use of powdered granite as a source of potash improved certain crops, according to recent experiments by Dartmouth College.[22]

RESERVES

A map showing reported potash occurrences in the United States was published.[23] The various types of potash minerals, a brief text, and a bibliography on the various localities were given.

WORLD REVIEW

Table 12, World Production of Potash has been revised to show the K_2O equivalent of marketable production for all producing countries and the K_2O equivalent of crude ore production when available. The world total is marketable production and does not include any crude-ore figures.

---

[17] Pit and Quarry, Utah Concern Makes Potash From Brine at Bonneville Flats: Vol. 47, No. 12, June 1955, pp. 136, 138.

[18] Chafetz, A. B., and Seedorff, W. A., Cost-Cutting Construction Ideas for Huge Bulk-Storage Buildings: Eng. and Min. Jour., vol. 156, No. 4, April 1955, pp. 92–93.

[19] Fertiliser and Feeding Stuffs Journal (London), vol. 43, No. 5, Aug. 31, 1955, pp. 185–186.

[20] Schuffelen, A. C., and vander Marela, I. H. W., Potassium Fixation in Soils: Internat. Potash Inst., Berne, Switzerland, Potash Symposium, 1955, 201 pp.
Journal, American Ceramic Society, vol. 38, No. 10, October 1955, p. 188.

[21] McCollam, M. E., Development of Potash Use in California: Commercial Fertilizer, vol. 90, No. 5, May 1955, pp. 23–24.

[22] Rock Products, Powdered Granite as Fertilizer: Vol. 38, No. 1, January 1955, p. 77.

[23] Byrd, M. F., Potash Occurrences in the United States: Geol. Survey, Mineral Investigations, Resource Appraisals Map M. R. 3, 1955.

The world consumption of potash as reported by the Food and Agriculture Organization of the United Nations for the years ended June 30, 1954 and 1955, is shown in table 13.

TABLE 12.—World production of potash (marketable, unless otherwise stated) in equivalent K_2O, by countries,[1] 1946–50 (average) and 1951–55, in short tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America: United States	1,101,537	1,420,323	1,665,113	1,911,891	1,948,721	2,064,808
Crude (including brines)[3]	1,205,037	1,546,756	1,841,118	2,098,736	2,170,969	2,340,052
South America: Chile	[4] 1,251	(5)	(5)	(5)	(5)	(5)
Europe:						
France (Alsace)	791,833	960,730	1,022,539	996,575	[6] 1,198,200	[6] 1,311,800
Crude [3]	883,548	1,088,941	1,162,750	1,135,657	1,361,734	1,490,764
Germany:						
East [6]	985,400	1,510,000	1,440,000	1,488,000	1,488,000	1,582,000
Crude [3] [6]	1,134,200	1,740,000	1,670,000	1,720,000	1,720,000	1,820,000
West	585,887	1,211,439	1,445,128	1,459,309	1,783,394	1,870,848
Crude [3]	695,520	1,459,363	1,712,659	1,742,752	2,134,072	2,226,666
Spain	175,660	190,556	199,613	202,764	243,166	235,343
Asia:						
India	2,665	2,912	4,704	1,567	1,653	[6] 1,600
Israel	22,393	----------	----------	3,415	[6] 12,000	11,905
Japan	148	[6] 250	173	283	454	461
Africa: Eritrea	128	2,094	1,323	----------	----------	----------
Oceania: Australia	774	37	26	----------	----------	----------
World total (marketable) (estimate)[1]	3,800,000	5,600,000	6,100,000	6,400,000	7,000,000	7,500,000

[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 totals.
[2] This table incorporates a number of revisions of data published in previous Potash chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[3] To avoid duplication of figures, data on crude potash are not included in the total.
[4] Average for 1947–50.
[5] Data not available; estimate by senior author of chapter included in total.
[6] Estimate.

NORTH AMERICA

Canada.—Near Floral, Saskatchewan, the Potash Company of America, Ltd., had sunk its shaft 36 feet by the end of the year. Other work included erection of a large hoist at the shaft site, completion of transmission lines, and placing of orders for a headframe and a new type of sinking cage.[24]

The Continental Potash Corp. acquired the property of Western Potash Corp. near Unity, Saskatchewan, and reported that an additional $17 million would be required to complete development of the mine and to construct a mill with a capacity of 1,000 tons per day. Work had not been resumed by the end of 1955, and the shaft depth remained at 1,200 feet.[25]

Compana, Ltd., expanded its exploration permit to cover 500,000 acres in the Unity area. Duval Sulphur & Potash Co. continued exploration on the 4 areas reported in the 1954 Potash chapter. Two other United States potash producers were given exploration permits: International Minerals & Chemical Corp. had a total of 600,000 acres southeast of Yorkton and southwest of Quill Lake; and United States

[24] Northern Miner, vol. 41, No. 11, June 16, 1955, p. 17; No. 28, Oct. 6, 1955, p. 18; No. 40, Dec. 29, 1955, p. 8.
[25] Engineering and Mining Journal, vol. 156, No. 7, July 1955, p. 171.
Foreign Service Dispatch No. 188, Toronto, Canada, Mar. 14, 1956, p. 14.

TABLE 13.—World consumption of agricultural potash in short tons of equivalent K_2O for years ended June 30, 1954 and 1955 [1]

Country	1953–54	1954–55 [2]
Europe:		
Austria	40,374	58,737
Belgium	158,598	153,055
Denmark	167,702	158,688
Finland	57,611	55,100
France	496,506	580,974
Germany:		
East	440,800	440,800
West	914,550	936,700
Ireland	40,577	43,309
Italy	41,537	44,080
Netherlands	178,965	170,810
Norway	51,343	52,896
Spain	82,209	125,628
Sweden	81,729	93,711
United Kingdom	282,566	275,332
Eastern Europe	342,000	342,000
Other countries	64,288	64,787
Total	3,441,355	3,596,607
North and Central America:		
Canada	84,744	84,744
Cuba	22,040	22,040
United States	1,789,648	1,800,668
Other countries	64,435	68,743
Total	1,960,867	1,976,195
South America	49,475	50,178
Asia: Japan	357,436	407,740
Other countries	59,724	85,898
Total	417,160	493,638
Africa	52,594	55,593
Oceania	36,629	42,108
World total	5,958,080	6,214,319

[1] Modified from An Annual Review of World Production and Consumption of Fertilizers: United Nations, Food and Agriculture Organization, Rome, Italy, November 1955.
[2] Preliminary figures.

Potash Co., Inc., was exploring in the area from Saskatoon to Quill Lake. In addition, Poplar Oils, Ltd., was granted permits on 100,000 acres near Saskatoon.[26]

EUROPE

The third congress of the International Potash Institute was held in Rome, Italy, from September 12–14, 1955.[27]

France.—The Société des Mines Domaniales de Potasse d'Alsace, operator of the Kali-Sainte-Therese and Midona potash mines in France, was conducting exploration for potash in French Morocco.[28]

Exports of potash materials, 1950–54, are shown in table 14. Data for 1955 are not available. European countries continued to be the major market for French potash.

Germany, East.—The Government-controlled potash sales agency was unable to meet all its export obligations during the 1954–55 fertilizer year.[29]

[26] Canadian Mining Journal, vol. 76, No. 3, March 1955, pp. 98, 100; No. 4, April 1955, p. 100; No. 10, October 1955, p. 128.
Northern Miner, vol. 41, No. 18, July 28, 1955, p. 20.
[27] Fertiliser and Feeding Stuffs Journal, vol. 43, No. 7, Sept. 28, 1955, p. 278.
[28] Foreign Service Dispatch No. 21, Casablanca, French Morocco, Aug. 1, 1955.
[29] Oil, Paint and Drug Reporter, vol. 167, No. 10, Mar. 17, 1955, pp. 5, 64.

TABLE 14.—Exports of potash materials from France, 1950–54, by countries of destination, in short tons [1] [2]

[Compiled by Corra A. Barry]

Country	1950	1951	1952	1953	1954
North America:					
Canada	27,240	21,911	20,975	34,167	11,514
Cuba	10,366	6,232	9,019		3,215
United States	55,506	74,219	70,363	54,789	28,606
South America:					
Argentina		380	147		
Brazil	20,737	18,337	16,892	45,897	24,245
Colombia		11,822	3,142		5,219
Europe:					
Austria	18,432	18,632	14,323	6,618	8,706
Belgium-Luxembourg	168,595	105,769	185,555	144,394	164,451
Denmark	57,553	27,788	16,905	12,603	13,979
Finland		9,796	10,196	3,674	4,277
Italy	34,794	33,367	19,441	24,707	38,798
Netherlands	245,988	195,322	227,490	208,256	153,589
Norway	29,862	12,486	17,653	11,344	12,494
Sweden	49,522	21,677	26,731	76,245	15,043
Switzerland	30,889	29,883	27,570	32,367	33,827
United Kingdom	208,150	170,904	131,832	172,374	258,787
Yugoslavia	252	7,186	5,022	9,480	89
Asia:					
Ceylon	13,197	21,158	9,762	23,626	31,139
China	6,568	7,379			10,913
India and Burma	2,675	7,203		5,075	10,360
Japan	86,234	50,007	60,130	155,649	178,742
Philippines		3,178			
Turkey					8,083
Africa:					
Algeria	21,939	25,224	16,359	17,186	21,059
Oceania:					
Australia and New Zealand	27,925	20,583	32,818	18,933	22,666
Other countries	70,606	67,283	59,201	92,139	97,492
Total	1,187,030	967,726	981,526	1,149,523	1,157,293

[1] Compiled from Customs Returns of France. Figures include salts, carbonate, chloride and nitrate of potash.
[2] This table incorporates a number of revisions of data published in the previous Potash chapter.

Germany, West.—Production and consumption of potash in West Germany continued to increase in 1955. Domestic use represented about half of the total production. Exports decreased 7 percent from 1954. Other European countries received 62 percent of West Germany's total potash exports.

Spain.—Exports of potash were 3 percent less in 1954 than in 1953, as shown in table 16. Domestic consumption of agricultural potash continued to increase. Potasas Ibericas S. A. installed additional flotation equipment in the beneficiation plant at Sallent. The Instituto Nacional de Industria completed exploration and began development of the Navarra potash deposits.[30]

United Kingdom.—Imperial Chemical Industries, Ltd., announced its decision to abandon attempts to develop the potash deposits of North Yorkshire. During the past 7 years the company has spent about $1.1 million on research to develop a brine-solution method of recovering the sylvite from depths of 3,500 to 4,500 feet. Fisons, Ltd., also interested in the North Yorkshire potash, had not announced its future plans.[31]

[30] Foreign Service Dispatch, Madrid, Spain, Nov. 17, 1955.
[31] Chemical and Engineering News, vol. 33, No. 11, Mar. 14, 1955, p. 1053.
Fertiliser and Feeding Stuffs Journal, vol. 42, No. 6, Mar. 16, 1955, p. 267.

TABLE 15.—Exports of potash materials from West Germany, 1951–55, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
North America:					
Canada	7,220	6,425	21,643	24,465	36,695
Puerto Rico		11,657	1,654	3,031	2,353
United States	204,934	85,224	51,445	91,057	104,350
South America:					
Brazil	12,196	1,929	8,295	25,874	45,290
Europe:					
Austria		11,910	38,832	48,345	42,077
Belgium-Luxembourg	19,260	145,505	162,527	148,544	100,216
Denmark	57,022	150,733	218,357	251,995	162,202
Greece	13,240			3,318	2,205
Ireland	19,395	11,947	19,130	36,079	43,930
Italy	14,904	8,406	28,417	21,763	33,274
Netherlands	7,253	211,586	216,998	236,468	168,070
Portugal	1,819	2,204			
Sweden		11,791	62,543	56,082	43,811
Switzerland	3,685	18,221	20,947	19,287	20,285
United Kingdom	114,091	126,588	259,961	193,729	220,352
Yugoslavia			8,965	19,931	33,069
Asia:					
Ceylon	4,795	831	1,036	3,416	6,882
Formosa	19,324			1,323	11,464
India	5,998	685	2,174	5,322	8,656
Indonesia	1,651		2,016	1,542	3,844
Japan	94,392	54,758	200,862	210,706	206,121
Korea		7,167		9,331	16,610
Turkey	1,213	3,582	9,733	9,370	
Africa:					
Union of South Africa and Federation of Rhodesia	13,150	11,279	18,650	15,987	46,956
Oceania:					
Australia and New Zealand		5,387	8,203	27,030	16,829
Other countries	18,724	27,277	44,531	60,088	35,849
Total	634,266	915,092	1,406,919	1,524,083	1,411,390

[1] Compiled from Customs Returns of West Germany. 1951 includes chloride and sulfate only. 1952 through 1955 includes crude salts, chloride, sulfate, magnesium sulfate, and beet ash.

TABLE 16.—Exports of potash materials from Spain, 1950–54, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1950	1951	1952	1953	1954
North America:					
United States	32,419	88,274	43,497	40,339	19,786
Europe:					
Belgium-Luxembourg	48,715	48,064	54,456	74,689	58,081
Ireland	5,500	5,368	5,557	5,243	
Italy		14,946	10,367	14,545	15,041
Netherlands	5,907	4,189	10,086	9,199	21,924
Norway	11,473	13,297	9,190	8,047	23,115
Portugal	8,859	10,979	8,736	7,021	8,662
Sweden	4,409				
United Kingdom	63,262	39,222	46,878	59,800	24,605
Asia:					
China		5,115	10,023	2,645	
Japan	20,139	43,216	21,253	55,191	98,337
Korea			5,376		
Other countries	5,574	2,954	13,149		
Total	206,257	275,624	238,568	276,719	269,551

[1] Compiled from Customs Returns of Spain.

ASIA

Israel.—The Mifalei Yam Hamelah, B. M. (Dead Sea Works, Ltd.), was producing at the rate of 30,000 tons of potassium chloride per year at the close of 1955 and further expansion was planned. Reserve estimates placed the potassium chloride in the Dead Sea at 2.2 billion short tons.[32]

The new potassium sulfate plant near Haifa Bay began operation in mid-1955. Plans called for export of nearly all the 14,000 tons produced per year.[33]

Jordan.—Plans for a potash plant on the Dead Sea were not complete by the end of 1955. Tentative arrangements were made for participation by other Arab countries.[34]

---

[32] Chemical and Engineering News, vol. 21, No. 12, Mar. 21, 1955, p. 1202; No. 41, Oct. 10, 1955, p. 4318.
[33] Agricultural Chemicals, vol. 10, No. 8, August 1955, p. 75.
[34] Chemical Week, vol. 77, No. 24, Nov. 12, 1955, p. 42.

Pumice

By L. M. Otis [1] and Annie L. Marks [2]

THE USE of pumice and related pumiceous materials for lightweight aggregate and railroad ballast has greatly increased the importance of this commodity group which, except for a sharp decline in 1952, has shown an annual production increase since 1944. The value has not kept pace with production, however, owing largely to the rapidly increasing use of low-quality, low-price grades of pumice in large volume for railroad ballast, road surfacing, and similar purposes.

In previous years the Bureau of Mines has used the title "Pumice and Pumicite" for its chapter covering pumice and materials of similar composition, texture, and origin. However, many authorities do not accept the term pumicite on the theory that unconsolidated, minute particle-size pumice is not entitled to a name distinct from that of pumice in consolidated form.

This chapter gives statistics on pumice, pumicite, volcanic cinders, scoria, tuff, lapilli, and cinder. Definitions of these types of volcanic products are not concise, and this fact, together with local terminology, makes it difficult to segregate statistics on the various classes of material covered. Definitions of these materials and discussion of their genesis, structure, and composition were outlined in a National Research Council circular.[3]

DOMESTIC PRODUCTION

North Dakota reported pumice production for the first time in 1955, making 16 producing States plus the Territory of Hawaii. These materials were mined from 73 deposits by 64 different producers during 1955, compared with 85 working mines in 1954. The quantity produced in 1955 was nearly 10 percent greater than in the previous year, while total value increased 13 percent.

California, with 29 separate operations, continued to lead in producing the largest tonnage of pumice. New Mexico, with 9 active units, was second in tons produced, followed in order by Hawaii, Oregon, and Idaho. All output came from open-pit mines.

---

[1] Commodity specialist.
[2] Statistical assistant.
[3] Wentworth, Chester K., and Williams, Howel, The Classification and Terminology of the Pyroclastic Rocks: Bull. Nat. Res. Council Circ. 89, Rept. of the Committee on Sedimentation, 1930–32, pp. 19–52.

TABLE 1.—Pumice [1] sold or used by producers in the United States,[2] 1946–50 (average) and 1951–55

Year	Short tons	Value	Year	Short tons	Value
1946–50 (average)	561, 256	$2, 227, 935	1953	1, 348, 136	$2, 526, 040
1951	749, 942	2, 752, 907	1954	1, 647, 397	2, 974, 318
1952	597, 044	2, 266, 981	1955	1, 804, 488	3, 369, 006

[1] Includes volcanic cinder as follows—1953: 699,831 short tons valued at $565,846; 1954: 690,056 tons, $475,424; 1955: 961,526 tons, $926,816.
[2] Includes Alaska (1951 only) and Hawaii (1953–55).

TABLE 2.—Pumice sold or used by producers in the United States, 1953–55, by States

State	1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
Arizona	(1)	(1)	80, 883	$125, 927	92, 136	$372, 735
California	433, 105	$647, 910	566, 664	651, 638	797, 306	1, 099, 459
Hawaii	(1)	(1)	(1)	(1)	130, 306	75, 906
Idaho	85, 224	159, 833	94, 434	183, 924	(1)	(1)
Kansas	(1)	(1)	23, 433	92, 899	2, 320	59, 710
Montana	(1)	(1)	175	920	(1)	(1)
New Mexico	528, 649	759, 840	363, 926	1, 060, 096	393, 597	780, 339
Oregon	73, 080	173, 822	67, 852	177, 515	(1)	(1)
Utah	(1)	(1)	3, 588	3, 788	2, 041	20, 011
Wyoming	648	1, 898	(1)	(1)	(1)	(1)
Other States [2]	227, 430	782, 737	446, 442	677, 611	386, 782	960, 846
Total	[3] 1, 348, 136	[3] 2, 526, 040	[4] 1, 647, 397	[4] 2, 974, 318	[5] 1, 804, 488	[5] 3, 369, 006

[1] Included with "Other States" to avoid disclosure of individual company operations.
[2] Includes States indicated by footnote 1, and Colorado, Nebraska, Nevada, North Dakota (1955 only), Oklahoma (1953–54), Oregon (1955 only), Texas, and Washington.
[3] Includes 699,831 short tons of volcanic cinders, valued at $565,846, from California, Hawaii, Nevada, and New Mexico.
[4] Includes 690,056 short tons of volcanic cinders, valued at $475,424, from Arizona, California, Hawaii, Nevada, and New Mexico.
[5] Includes 961,526 short tons of volcanic cinders, valued at $926,816 from California, Hawaii, New Mexico, Nevada, and Texas.

Mine and Plant Developments.—U. S. Pumice Supply Co. announced expansion of its pumice-processing facilities, including 10 new sawing units, at its plant at Lee Vining, Calif.[4]

Cal-Lite Corp. opened a new plant at Fontana, Calif., for producing pumice blocks at the eventual rate of 6,000 per hour.[5]

Pumice, Inc., Idaho Falls, Idaho, built a pumice-processing plant at Ammon.[6]

CONSUMPTION AND USES

The physical and chemical properties of pumice are similar in many respects to those of other lightweight aggregates: its cellular structure with many air spaces provides effective insulation against heat and sound; it is inert chemically and withstands elevated temperatures and atmospheric conditions.

[4] Mining and Industrial News, U. S. Pumice Supply Expands at Lee Vining: Vol. 23, No. 1, January 1955, p. 19.
[5] Rock Products, Pumice Block Plant: Vol. 58, No. 5, May 1955, p. 139.
[6] Western Industry (news item), vol. 20, No. 1, January 1955, p. 136.

The principal uses for pumice in 1955 were for insulation, as lightweight aggregate for concrete and plaster, and as an abrasive. It is a fire retardant when admixed in plaster. Miscellaneous uses included: Insecticide carrier, brick manufacture, filtration, sweeping compound, absorbent, and soil conditioner. Lower quality material was used as railroad ballast and for surfacing roads.

During 1955, 44 percent of all pumice consumed was used as aggregate and admixtures in concrete (compared with 43 percent in 1954), 2 percent in abrasives, and less than 1 percent in acoustic plaster; the remainder was used principally as railroad ballast and for road surfacing and for various miscellaneous purposes. Consumption for abrasives was double that of 1954; acoustic plaster used 30 percent less than in the previous year. Average values per ton in 1955 were: Abrasives $16.94, acoustic plaster $21.65, concrete admixture and aggregate $2.52, other uses $0.76.

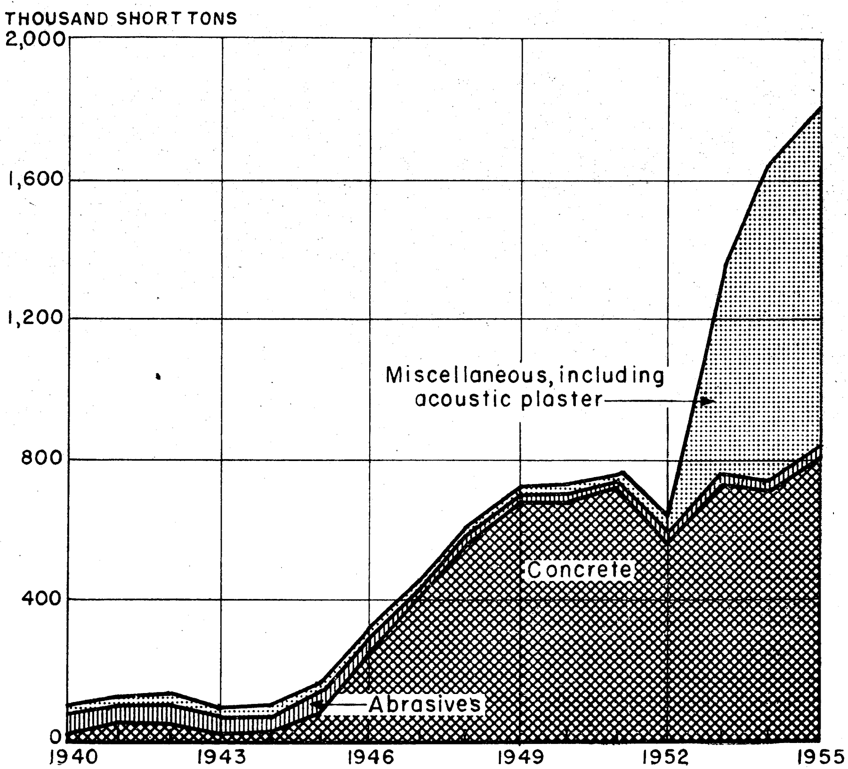

FIGURE 1.—Pumice trends by uses, 1940–55.

TABLE 3.—Pumice [1] sold or used by producers in the United States, 1953–55, by uses

Use	1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
Abrasive:						
Cleansing and scouring compounds and hand soaps	19,816	$140,900	9,641	$322,220	19,979	$418,637
Other abrasive uses	3,172	83,673	6,681	99,995	12,474	131,181
Acoustic plaster	7,506	171,336	4,712	158,505	3,313	71,726
Concrete admixture and concrete aggregate	713,931	1,649,993	705,951	1,709,892	799,360	2,007,987
Other uses [2]	603,711	480,138	920,412	683,706	969,362	739,475
Total	1,348,136	2,526,040	1,647,397	2,974,318	1,804,488	3,369,006

[1] Includes volcanic cinders as follows—1953: 699,831 short tons valued at $565,846; 1954: 690,056 tons, $475,424; 1955: 961,526 tons, $926,816.
[2] Insecticide, insulation, brick manufacture, filtration, railroad ballast, roads, (surfacing and ice control), absorbents, soil conditioner, and miscellaneous uses.

PRICES

Prices for domestic and imported refined pumice are quoted regularly in trade publications. The Oil, Paint, and Drug Reporter quoted the following 1955 year-end prices: Domestic, ground, coarse to fine, bags, ton lots, 3.625 cents per pound; Italian, silk-screen, coarse, bags, ton lots, 6.5 cents a pound; same but fine 4 cents a pound; Italian, sun dried, coarse, bags, ton lots, 2.5 cents a pound; same but fine, 3.5 cents a pounds. The E&MJ Metal and Mineral Markets year-end prices for 1955 were: Per pound, f. o. b. New York or Chicago, in barrels, powdered, 3 to 5 cents; lump, 6 to 8 cents. These quoted prices were generally unchanged from the previous year.

TABLE 4.—Crude and prepared pumice [1] sold or used by producers in the United States in 1955

	Short tons	Value	
		Total	Average per ton
Crude	673,818	$390,050	$0.58
Prepared	1,130,670	2,978,956	2.63
Total	1,804,488	3,369,006	1.87

[1] Includes 961,526 short tons of volcanic cinder valued at $926,816.

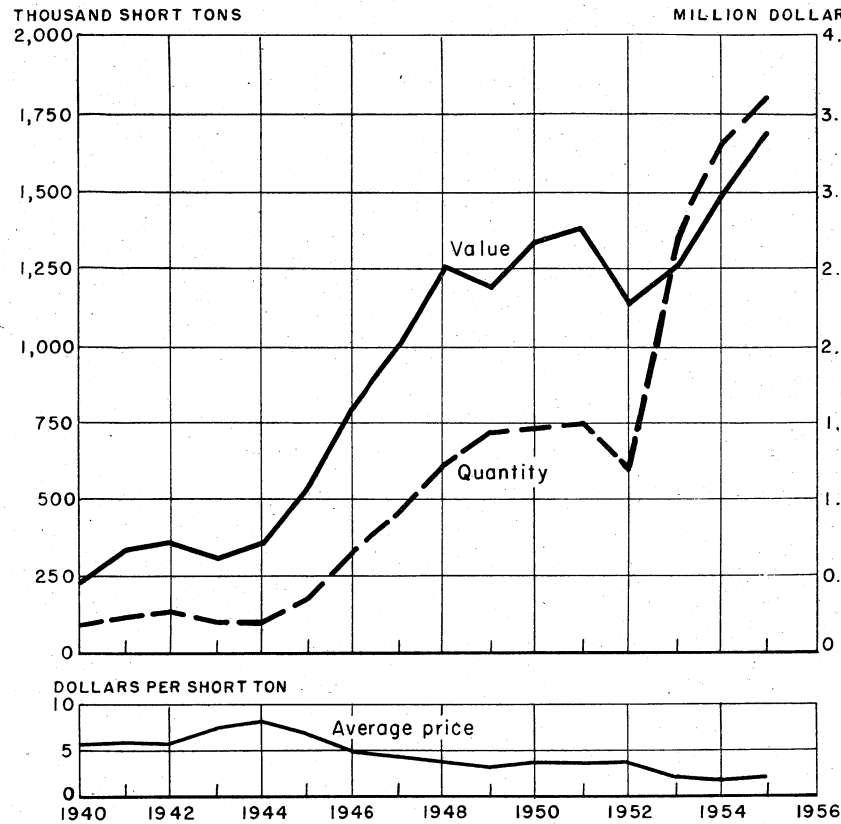

FIGURE 2.—Total value, quantity and price per ton of pumice, 1940–55.

FOREIGN TRADE [7]

Greece was the principal exporter of crude pumice to the United States shipping 19,895 tons; Italy supplied 9,992 tons of crude, together with 1,497 tons of manufactured pumice. Direct shipments of pumice from Italy to North America were being readied for Eastern and Great Lakes ports.

The duties on imported pumice were as follows: 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; manufactured articles made of pumice, 17½ percent ad valorem.

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

TABLE 5.—Pumice [1] imported for consumption in the United States, 1954–55, by countries

[U. S. Department of Commerce]

Country	Crude or unmanufactured								Wholly or partly manufactured			
	Valued at $15 or less per ton				Valued over $15 per ton							
	1954		1955		1954		1955		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
South America: Ecuador							21	$954				
Europe:												
Azores					7	$313						
Greece	13,306	$44,614	19,895	$68,518								
Italy	7,123	63,645	9,814	88,513	515	8,564	178	5,118	950	$20,541	1,497	$38,971
Portugal							6	409				
Trieste							24	1,027				
Total	20,429	108,259	29,709	157,031	522	8,877	208	6,554	950	20,541	1,497	38,971
Grand total	20,429	108,259	29,709	[2] 157,031	522	8,877	229	[2] 7,508	950	[2] 20,541	1,497	[2] 38,971

[1] Exclusive of "manufactures, n. s. p. f."
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data are not comparable to those for earlier years.

TABLE 6.—Pumice imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Class	1946–50 (average)		1951		1952		1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Crude or unmanufactured	9,980	$84,555	15,752	$182,737	21,986	$135,305	32,712	$166,079	20,951	$117,136	29,938	[1] $164,539
Wholly or partly manufactured	859	19,738	750	18,041	478	9,792	943	19,975	950	[1] 20,541	1,497	[1] 38,971
Manufactures, n. s. p. f.	(2)	381	(2)	2,591	(2)	6,301	(2)	5,415	(2)	[1] 6,720	(2)	[1] 4,371
Total		104,674		203,369		151,398		191,469		[1] 144,397		[1] 207,881

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data are not comparable to those for earlier years.
[2] Quantity not recorded.

TECHNOLOGY

Pumice was used as a filler in a patented plaster composition, when mixed with a binder such as gypsum, hydraulic cement or methyl cellulose.[8] Its use as a catalyst support for the removal of saponifiable sulfur compounds from hydrocarbons was patented. Activated carbon, as the catalyst, is deposited on the pumice.[9]

The binding of pumice with cement into lightweight aggregate masses is covered in a patent.[10]

The use of pumice as a carrier in certain herbicidal compositions was described.[11]

Pumice as a wallboard composition is the subject of a patent.[12]

The composition and use of pumice in a household cleanser was explained.[13]

Various fillers for roofing cement include pumice.[14]

A method was devised for making a flue liner in which a pumice aggregate unit is treated with hydraulic cement, sodium silicate, and calcium chloride.[15]

A patent cites the use and method of making abrasive articles using pumice.[16]

A herbicidal composition using pumice was developed.[17]

Cyanogen was manufactured by using a catalyst of silver ammonium nitrate deposited on pumice or other suitable porous carrier.[18]

Pumice was mentioned as a diluent for use with chemicals to control undesired vegetation.[19]

Pumice is cited as a suitable solid carrier for an oil-in-water emulsion of hexachlorobutadiene herbicide.[20]

It was used as a support for urea or thiourea in promoting chemical reactions.[21]

To produce a rough floor or roof finish, angular particles of pumice in a concrete aggregate were allowed to protrude after the final surfacing.[22]

Pumice was employed as a suitable carrier in a new sulfur herbicide.[23]

---

8 Heijmer, G. B., Plaster Composition: U. S. Patent 2,700,615, Jan. 25, 1955.

9 Mottern, H. O. (assigned to Standard Oil Development Co.), Removal of Saponifiable Sulfur Compounds From Hydrocarbons: U. S. Patent 2,700,690, Jan. 25, 1955.

10 Willson, C. D., Cement-Bound Lightweight Aggregate Masses: U. S. Patent 2,703,289, Mar. 1, 1955.

11 Sharp, D. B. (assigned to Monsanto Chemical Co., St. Louis, Mo.), Herbicidal Compositions: U. S. Patent 2,703,751, Mar. 8, 1955.

12 Seybold, H. G., Wallboard Composition and Method of Making Same: U. S. Patent 2,705,198, Mar. 29, 1955.

13 Houser, A. C., Abrasive Cleanser and Method of Scouring Surfaces: U. S. Patent 2,708,157, May 10, 1955.

14 Hampton, R. R. (assigned to Southport Paint Co., Savannah, Ga.), Roofing Cement: U. S. Patent 2,708,170, May 10, 1955.

15 Frese, V. (assigned to R. McCleery, Seattle, Wash.), Flue Liner and Method of Making Same: U. S. Patent 2,709,835, June 7, 1955.

16 Price, J. E., and Grove, K. D. (assigned to American Viscose Corp., Wilmington, Del.), Abrasive Articles and Method of Making: U. S. Patent 2,711,365, June 6, 1955.

17 Barrous, K. C. (assigned to Dow Chemical Co., Midland, Mich.), Method and Composition for the Control of Plant Growth: U. S. Patent 2,711,949, June 28, 1955.

18 Moje, W. (assigned to E. I. du Pont de Nemours & Co., Wilmington, Del.), Manufacture of Cyanogen: U. S. Patent 2,712,493, July 5, 1955.

19 Swezey, A. W. (assigned to Dow Chemical Co., Midland, Mich.), Method and Composition for the Control of Undesired Vegetation: U. S. Patent 2,712,991, July 12, 1955.

20 Patrick, T. M., Jr. (assigned to Monsanto Chemical Co., St. Louis, Mo.), Herbicidal Composition: U. S. Patent 2,713,535, July 19, 1955.

21 Axe, W. N. (assigned to Phillips Petroleum Co. of Delaware), Separation Process: U. S. Patent 2,716,113, Aug. 23, 1955.

22 Burke, W. T., Method of Concrete-Floor Construction: U. S. Patent 2,721,369, Oct. 25, 1955.

23 Schlesinger, A. H., and Mowry, D. T. (assigned to Monsanto Chemical Co., St. Louis, Mo.), Organic Sulfur Compounds and Herbicides Containing Same: U. S. Patent 2,723,191, Mar. 8, 1955.

Processing.—A description of pumice mining and processing in Idaho was published.[24] Idaho production was sold in Idaho, Utah, Wyoming, and Montana. The market for pumice as a pozzolan was also discussed.

Attempts were made experimentally to shape fine-grained pumice into blocks or bricks by fusing the outside particles of pumice in a mold, without adding a binder.[25] The pumice was heated to near fusion temperature in a rotary kiln, discharged to a verticle kiln, and flash-heated to further raise the temperature to incipient fusion, then dropped to a mold and compacted.

Use.—Precast concrete was used very extensively for construction work in Germany. Pumice was used as the base material in 73 percent of concrete produced. The pumice was mined in the Neuwied and Reinland-Pfalz area.[26]

The physical and chemical properties of pumice as they affect its uses as a lightweight aggregate were discussed in an article, which also touched upon the economics of the industry.[27]

A new plant was designed to dry, grind, and classify pumice to produce a pozzolan used to improve the quality of concrete employed in making an atmospheric-stream-cured building block.[28] Details of the drying unit cover the principle of keeping the mass to be dried in a fluid state by forcing heated air through grids in the floor of the drying chambers.

A new Pumice Institute has been announced for the purpose of unifying efforts of pumice producers to develop technical data and information for architects, structural engineers, and builders on the uses of pumice in construction.

WORLD REVIEW

NORTH AMERICA

Canada.—Of 24 Canadian plants producing various commercial lightweight aggregates in 1955, only 1, McCleery and Weston, Ltd., of Vancouver, B. C., used pumice. Commercial pumice aggregate was prepared from imported material. It was valued in 1955 at $117,000 (Can.), compared with $56,300 (Can.) in 1954.

El Salvador.—A U. S. Foreign Service Despatch states that a plant to make lightweight building block, using pumice as the aggregate, is planned for El Salvador.

EUROPE

Italy.—Of the total pumice production of 141,000 tons in 1954, 44,000 short tons was exported. The United States was the principal foreign customer. An article gave a breakdown of Italian pumice exports for 1954.[29]

---

[24] McDivitt, James F., Pumice Development in Idaho: Pit and Quarry, vol. 47, No. 7, January 1955, pp. 130–131, 135–136.
[25] Pit and Quarry, Texas Research Group Makes Fused-Pumice Units: Vol. 47, No. 11, May 1955, p. 278.
[26] Concrete, Precast Concrete Continues to Play a Stellar Role in German Reconstruction: Vol. 63, No. 4, April 1955, pp. 18–19.
[27] Palmieri, Mario, Properties of Pumice as an Aggregate in Lightweight Concrete: Concrete, vol. 63, No. 4, April 1955, pp. 38–39.
[28] Pit and Quarry, Fluidization Unit Dries, Classifies and Cools Volcanic Cinders in El Paso Plant: Vol. 48, No. 6, December 1955, pp. 102–104, 106.
[29] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 4, October 1955, p. 44.

457676—58——60

TABLE 7.—World production of pumice, by countries,[1] 1946–50 (average) and 1951–55, in short tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
Egypt	1,186	408	441	761	441	154
France:						
Pumice	17,218	16,535	12,621	11,464	11,574	9,921
Pozzolan	41,323	155,921	172,560	232,903	259,043	242,508
Greece [3]	38,154	71,650	34,133	91,271	72,989	73,304
Italy:						
Pumice	38,077	88,057	95,017	192,132	} 141,039	198,614
Pumicite	16,764	48,502	53,517	37,148		
Pozzolan	609,907	1,324,789	1,379,936	1,392,703	1,399,650	1,452,282
New Zealand	8,176	9,827	10,765	2,254	9,916	8,670
Spain	[4] 594	1,229	732	612	----------	----------
United States (sold or used by producers)	561,256	749,942	597,044	[5] 1,348,136	[5] 1,647,397	[5] 1,804,488
World total (estimate) [1]	1,400,000	2,500,000	2,400,000	3,400,000	3,600,000	3,800,000

[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 senior author of chapter included in total.
[2] This table incorporates a number of revisions of data published in previous Pumice chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] These figures include the following tonnages of Santorini earth: 1946–50 (average), 28,726 tons; 1951: 49,604 tons; 1952: 20,424 tons; 1953: 44,092 tons; 1954: 38,581 tons; 1955: 40,234 tons.
[4] Average 1948–50.
[5] Includes in 1953: 560,502 tons; 1954: 690,056 tons; and 1955: 961,526 tons of volcanic cinder and scoria used for railroad ballast or similar purposes.

Quartz Crystal (Electronic Grade)

By Waldemar F. Dietrich[1] and Gertrude E. Tucker[2]

CONSUMPTION of raw electronic-grade quartz crystal was nearly the same as in 1954. Owing to increased yield of piezoelectric units per pound of raw quartz, the production of piezoelectric units increased 12 percent over 1954. No domestic production of electronic-grade quartz crystal was reported to the Bureau of Mines. Imports, principally from Brazil, continued adequate for United States consumption.

PRODUCTION AND CONSUMPTION

United States consumption of raw quartz crystal for the production of piezoelectric units in 1955, as reported to the Bureau of Mines, was only 300 pounds more than in 1954. The 1954–55 consumption rates reflect the leveling off of requirements for piezoelectric units for military and civilian uses, and the recession of purchases for the National Stockpile. Raw-quartz purchases continued in the following weight groups: 80–100 grams; 100–200 grams; 200–300 grams; 300–500 grams; 500–700 grams; 700–1,000 grams; 1,000–2,000 grams; and greater than 2,000 grams. Most cutters used crystals ranging from 200 to 500 grams, but there was increased demand for crystals in the two lighter weight groups.

Production of piezoelectric units in 1955 increased 12 percent over 1954, owing to a nearly equal percentage increase in the yield of finished units per pound of raw quartz consumed. The 1955 average yield of 30.5 units per pound of quartz was the highest ever reported to the Bureau of Mines by producers and was believed to be attributable to the preponderance of small units and improvements in crystal-cutting techniques.

There were quartz-crystal cutters and producers of piezoelectric units in 20 States and the Territory of Hawaii, as shown in table 1. Pennsylvania accounted for 31 percent of the United States consumption of raw quartz and 33 percent of the production of piezoelectric units; 44 of the 46 quartz consumers also produced piezoelectric units; and, in addition, there were 12 producers of piezoelectric units who did not cut raw quartz.

Pilot-plant production of synthetic quartz crystals continued, but synthetic crystals did not enter the market at prices competitive with natural crystals.

---

[1] Chief, Branch of Ceramic and Fertilizer Materials.
[2] Statistical assistant.

TABLE 1.—Consumption of electronic-grade quartz and production of piezo-electric units in the United States in 1955, by States

State	Consumption of electronic-grade quartz [1]		Production of piezoelectric units [2]	
	Number of consumers	Pounds consumed	Number of producers	Number of units produced
California	7	6,600	10	156,600
Connecticut and Massachusetts	4	2,200	6	54,000
Illinois and Nebraska	[3] 4	[3] 19,300	4	555,200
Iowa	1	1,400	1	79,200
Kansas and Missouri	5	22,700	5	937,800
Maryland, New Jersey, Ohio, and Virginia	9	28,500	9	841,500
New York	4	1,500	4	
Pennsylvania	7	41,900	8	1,332,600
Texas	1	3,100	3	32,100
Other States	[4] 4	[4] 7,000	[5] 6	[5] 100,500
Total	46	134,200	56	4,089,500

[1] Includes a small quantity of reworked scrap previously reported as consumption.
[2] For radio oscillators, telephone resonators, filters, and miscellaneous purposes.
[3] Includes Illinois only.
[4] Includes Florida, Hawaii, Nebraska, and Wisconsin.
[5] Includes Florida, Hawaii, Louisiana, Oklahoma, Washington, and Wisconsin.

PRICES

There were no important changes in the resale prices of quartz crystal sold domestically in 1955, compared with 1954. Best-quality crystals weighing 201–300 grams sold for about $12 per pound in 1955; selected 301- to 500-gram, class 1 crystals, were $17–$18 per pound; and larger crystals brought prices as high as $90 per pound.

The Brazilian Government "Tabela," or schedule of the minimum allowable declared value of electronic-grade quartz crystal for export from Brazil, was virtually unchanged from 1952. The Tabela for 1952 was published in the Radio-Grade Quartz chapter of Minerals Yearbook, 1952.

FOREIGN TRADE[3]

In 1955 imports for consumption of electronic- and optical-grade quartz crystal increased 15 percent in quantity and decreased 11 percent in value compared with 1954. Brazil continued to be the principal supplier, furnishing 675,565 pounds (96 percent) of the 1955 imports. Imports from France, the Netherlands, and Japan were 18,318, 10,069, and 550 pounds, respectively. Most of the imports from countries other than Brazil are believed to have originated in Madagascar. The average declared value of total imports per pound, port of export, declined from $2.55 in 1954 to $1.98 in 1955 and was the lowest on record, reflecting the increased use of small crystals in the 80- to 100-gram and 100- to 200-gram weight groups.

Imports of quartz crystal from Brazil ("lasca," valued at less than 35 cents per pound) totaled 219,637 pounds, valued at $34,656.

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

Lasca is obtained from the rejects of electronic-grade crystal mining and preparation and is imported mainly for use as fusing-grade quartz.

TABLE 2.—Estimated imports for consumption of electronic- and optical-grade quartz crystal, consumption of raw electronic-grade quartz, and production of piezoelectric units in the United States, 1946–50 (average) and 1951–55

Year	Estimated imports of electronic- and optical-grade quartz crystal [1]			Consumption of raw electronic-grade quartz (pounds)	Piezoelectric units	
	Pounds	Value	Value per pound		Production (number)	Number per pound of raw quartz
1946-50 (average)	450,800	$2,112,500	$4.69	92,500	1,314,600	14.2
1951	843,200	2,045,600	2.43	282,300	3,290,000	11.7
1952	1,049,300	2,881,600	2.75	502,500	6,181,500	12.3
1953	[2] 1,119,200	[2] 2,240,200	2.00	399,200	7,217,700	18.1
1954	[2] 613,100	[2] 1,562,800	2.55	133,900	[3] 3,653,800	[3] 27.3
1955	[2] 704,500	[2] 1,393,500	1.98	134,200	4,089,500	30.5

[1] Figures for 1946–50 (average) and 1951–52 derived from U. S. Department of Commerce reports of total Brazilian pebble imports, corrected by deducting the imports of fusing-grade quartz from Brazil as estimated from industry advices and Brazilian Government statistics.
[2] Imports of Brazilian pebble, valued at 35 cents or more per pound.
[3] Revised figure.

Imports into the United States in 1955 from West Germany totaled 5,732 pounds, valued at $329; and from Madagascar, 2,204 pounds, valued at $490. The quality and use of these materials were undetermined.

Exports of quartz crystal in 1955 were valued at $65,906 and reexports at $658,222. The total value of exports and reexports was 2 percent less than in 1954; they principally comprised ornamental quartz to Japan and minor quantities of piezoelectric quartz to Japan and other countries.

The term "exports" refers to commodities produced or manufactured in the United States and those of foreign origin that have been changed in the United States to enhance their value; "reexports" refers to commodities of foreign origin that enter the United States as imports and are exported without being changed. The valuation of exports and reexports is based on the actual selling price, or cost if not sold, while the valuation of imports is based on the declared value at the port of export. Therefore, no direct comparison of the different classifications can be made.

TECHNOLOGY

In a review of the history of quartz-crystal synthesis, with special reference to the work of the Brush Electronics Co. Division of Clevite Corp., the growth of crystals on V-bar seeds is discussed.[4] The growth rate on the V-bar seed, is more rapid than on seeds cut in other directions, and it was claimed that both the yield of crystals per complete growing cycle and the yield of piezoelectric crystal blanks per pound of quartz was greater. Thus, the V-bar form supplemented

[4] Bechmann, Rudolph, and Hale, D. R., Electronic-Grade Synthetic Quartz: Brush Strokes (Cleveland, Ohio), vol. 4, No. 1, September 1955, 8 pp.

other advantages of synthetic crystals, such as the existence of more crystallographic faces for accurate and rapid orientation and freedom from optical and electrical twinning and other flaws. These advantages were said to compensate for the higher price of synthetic quartz, which was expected to decrease with increasing production. At the company pilot plant, 2-chamber autoclaves of 3.7-cu.-ft. volume were used. These autoclaves produced about 90 pounds of crystals per run; each run lasted about 6 weeks. The growing temperature was 350° C. According to a verbal communication to the Bureau of Mines by Dr. Bechmann, the operating pressure was about 8,000 p. s. i. The company also experimented with stationary, vertical, welded-pipe autoclaves of 1.95-cu.-ft. volume, operated at pressures as low as 1,200 p. s. i. at a temperature of 285° C.[5] Most of the research and development work of the Brush Co. has been done under Signal Corps contracts.

The Bell Telephone Laboratories, Inc., continued studies on the growth of quartz hydrothermally at relatively high pressures and temperatures under Signal Corps contracts.[6] Pressures were usually at 18,000 p. s. i. and temperatures about 400° C. at the top and 440° C. at the bottom of the stationary, vertical autoclaves. Results suggested that a significant increase in growth rate is possible, compared with previous high-pressure experiments, by improved design of the equipment.

The Bell Telephone Laboratories, Inc., also grew three groups of crystals in which the additives germanium, aluminum, iron, and selenium were introduced in the crystal to alter crystal properties.

Synthetic-quartz-crystal research continued in the United Kingdom.[7] A small pilot plant produced crystals weighing about 50 grams to study the properties of synthetic quartz in electronic circuits. Some results of British research were published on the use of materials other than fusing-grade quartz as the source material.[8] It was found that flint and quartzite and other substances rich in silica may be used, with some modification of practice, if free from critical proportions of harmful impurities, chief of which is alumina.

The temperature coefficient of frequency of AT-type quartz resonators was reported.[9] Several papers were presented on the properties of electronic-grade natural and synthetic quartz crystals.[10]

Data were published on the dielectric constant and power loss of quartz at frequencies of 1 to 90 kilocycles per second and temperatures of 20° to 400° C.[11]

---

[5] Hale, D. R., Jaffe, Hans, and Charbonnet, W. H., Laboratory and Pilot-Plant Growth of Quartz at Moderate Pressure: Unpub. paper pres. at 9th Ann. Frequency-Control Rev. of Tech. Prog., Asbury Park, N. J., May 26, 1955.

[6] Walker, A. C., Growth of Quartz at High Temperatures and Pressures: Unpub. paper pres. at 9th Ann. Frequency-Control Rev. of Tech. Prog., Asbury Park, N. J., May 26, 1955.

[7] Mitchell, H. T., Research and Development in the United Kingdom: Unpub. paper pres. at 9th Ann. Frequency-Control Rev. of Tech. Prog., Asbury Park, N. J., May 26, 1955.

[8] Brown, C. S., Kell, R. C., Middleton, P., and Thomas, L. A., Influence of Impurities on the Growth of Quartz Crystals From Flint and Quartzite: Nature (London), vol. 175, 1955, pp. 602–603; Chem. Abs., vol. 49, No. 20, Oct. 25, 1955, p. 13726a.

[9] Bechmann, Rudolph, Influence of the Order of Overtone on the Temperature Coefficient of Frequency of AT-Type Quartz Resonators: Proc. Inst. Radio Eng., vol. 43, No. 11, November 1955, p. 1667.

[10] Arnold, George, Jr., Optical Absorption Spectra Studies of Natural and Synthetic Quartz; Bechmann, Rudolph, Frequency-Temperature Behavior of Resonators of Natural and Synthetic Quartz; Hammond, D. L., Effects of Impurities on the Resonator and Lattice Properties of Quartz; Mingens, C. R., and Frost, A. D., Frequency Spectra in Quartz Resonators; Wrigley, W. B., Methods of Measuring the Equivalent Electrical Parameters of Quartz Crystals: Unpub. papers pres. at 9th Ann. Frequency-Control Rev. of Tech. Prog., Asbury Park, N. J., May 26, 1955.

[11] Stuart, M. R., Dielectric Constant of Quartz as a Function of Frequency and Temperature: Jour. Appl. Phys., vol. 26, No. 12, December 1955, pp. 1399–1404.

WORLD REVIEW

Brazil.—Exports of raw quartz crystal from Brazil in 1955 totaled 659,000 pounds of piezoelectric (electronic)-grade crystal, 1,290,000 pounds of lasca (fusing-grade), and 106,000 pounds of refugo (waste).[12] In 1954, 736,000 pounds of raw quartz crystal and 653,000 pounds of lasca were exported.[13]

Madagascar.—The production of quartz crystal in Madagascar in 1955 was reported as 28,700 pounds of piezoelectric (electronic)-grade crystal valued at 39 million Metropolitan francs[14] ($111,000); 22,000 pounds of ornamental crystal valued at 1 million Metropolitan francs ($2,900); and 42,800 pounds of fusing-grade (fonte) quartz valued at 1.1 million Metropolitan francs ($3,100).[15]

---

[12] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 6, June 1956, p. 36.
[13] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 3, March 1956, p. 31.
[14] In 1955, 1 Metropolitan franc was valued at United States $.002856.
[15] Work cited in footnote 12.

Salt

By R. T. MacMillan[1] and Annie L. Marks[2]

MORE SALT was produced in the United States in 1955 than in any previous year. The total output exceeded 22.7 million tons and represented an increase of 10 percent over the 1954 production and 9 percent over the previous record output in 1953. Salt in brine showed the largest percentage gain, although the production of evaporated and rock salt also increased. The most notable increases were in Texas and Louisiana.

TABLE 1.—Salient statistics of the salt industry in the United States, 1946–50 (average) and 1951–55 [1]

	1946-50 (average)	1951	1952	1953	1954	1955
Sold or used by producers:						
Dry salt:						
Evaporated (manufactured) short tons	3, 245, 845	3, 654, 808	3, 641, 885	3, 702, 305	3, 731, 087	3, 986, 967
Rock salt do	3, 676, 963	4, 662, 194	4, 567, 531	4, 478, 655	4, 824, 708	5, 293, 282
Total do	6, 922, 808	8, 317, 002	8, 209, 416	8, 180, 960	8, 555, 795	9, 280, 249
Value	$45, 101, 979	$58, 425, 022	$59, 757, 322	$65, 407, 021	$73, 405, 616	$80, 952, 078
Average per ton	$6. 51	$7. 02	$7. 28	$7. 99	$8. 58	$8. 72
In brine:						
Short tons	9, 035, 460	11, 890, 129	11, 335, 798	12, 608, 043	12, 113, 608	13, 423, 894
Value	$7, 892, 748	$11, 309, 978	$11, 252, 767	$12, 869, 646	$32, 180, 276	$42, 436, 769
Total salt:						
Short tons	15, 958, 268	20, 207, 131	19, 545, 214	20, 789, 003	20, 669, 403	22, 704, 143
Value [2]	$52, 994, 727	$69, 735, 000	$71, 010, 089	$78, 276, 667	$105, 585, 892	$123, 388, 847
Imports for consumption:						
Short tons	5, 192	4, 329	7, 056	137, 308	160, 770	185, 653
Value	$42, 539	$46, 831	$44, 230	$473, 472	[3] $878, 961	[3] $1, 206, 265
Exports:						
Short tons	289, 193	439, 114	349, 971	249, 521	[4] 385, 259	407, 131
Value	3, 377, 079	$3, 501, 904	$3, 458, 363	$2, 327, 656	[4] 3, 085, 652	$3, 023, 025
Apparent consumption: [5] short tons	15, 674, 267	19, 772, 346	19, 202, 299	20, 676, 790	[4] 20, 444, 914	22, 482, 665

[1] Includes Hawaii (1952-55 only) and Puerto Rico.
[2] Values are f. o. b. mine or refinery and do not include cost of cooperage or containers.
[3] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to earlier years.
[4] Revised figure.
[5] Quantity sold or used by producers, plus imports, minus exports.

DOMESTIC PRODUCTION

Despite a small decrease in production in 1955, Michigan easily maintained its position as the leading salt-producing State, accounting for 22 percent of the United States production. New York, Texas, and Louisiana ranked very close for second, third, and fourth places, respectively, each supplying approximately 16 percent of the salt produced. These States, with Ohio, California, and Kansas, furnished over 90 percent of the 1955 production.

[1] Commodity specialist.
[2] Statistical assistant.

In 1955 salt was produced at 86 facilities in the United States, Hawaii, and Puerto Rico. Nine of these facilities had an annual production of over 1 million tons each; their combined production was over half of the United States total; 4 had a production between 500,000 and 1 million tons; and 31 produced 100,000 to 500,000 tons. Of the 42 facilities that produced less than 100,000 tons, 25 produced less than 10,000. Nearly 60 percent of the salt was produced in the form of brine.

TABLE 2.—Salt sold or used by producers in the United States, 1953–55, by States

State	1953			1954			1955		
	Quantity		Value	Quantity		Value	Quantity		Value
	Short tons	Percent of total		Short tons	Percent of total		Short tons	Percent of total	
California	1,123,365	5	$6,263,059	1,185,844	6	$6,126,194	1,314,535	6	$6,751,420
Kansas	905,227	4	7,480,556	876,667	4	7,778,406	910,866	4	8,432,325
Louisiana	3,061,234	15	9,189,526	3,088,686	15	11,101,456	3,562,636	16	15,406,993
Michigan	5,127,387	25	22,171,988	5,063,633	24	29,396,812	4,975,442	22	31,668,351
New Mexico	62,087	(1)	216,364	50,669	(1)	333,255	49,738	(1)	596,780
New York	3,322,659	16	17,351,111	3,412,636	17	22,754,118	3,779,547	16	25,214,191
Ohio	3,040,237	15	7,484,795	2,748,993	13	12,358,521	2,905,028	13	14,768,761
Puerto Rico	13,692	(1)	131,490	8,758	(1)	98,110	10,496	(1)	112,399
Texas	2,845,190	14	5,010,624	2,864,312	14	9,310,339	3,583,242	16	12,867,094
Utah	154,088	1	772,035	166,506	1	1,020,061	195,726	1	1,339,085
West Virginia	419,907	2	1,490,592	471,516	2	2,885,696	638,390	3	3,476,352
Other States [2]	713,930	3	714,527	731,183	4	2,422,924	778,497	3	2,755,096
Total	20,789,003	100	78,276,667	20,669,403	100	105,585,892	22,704,143	100	123,388,847

[1] Less than 1 percent.
[2] Includes Alabama, Colorado (1955 only), Hawaii, Nevada, Oklahoma, and Virginia.

TABLE 3.—Salt sold or used by producers in the United States,[1] 1954–55, by methods of recovery

Method of recovery	1954		1955	
	Short tons	Value	Short tons	Value
Evaporated:				
Bulk:				
Open pans or grainers	397,391	$9,344,207	399,316	$9,460,720
Vacuum pans	2,028,947	26,410,712	2,134,209	29,224,014
Solar	1,020,473	4,402,010	1,167,772	5,218,943
Pressed blocks	284,276	4,929,057	285,670	5,069,998
Rock:				
Bulk	4,765,093	27,308,023	5,235,743	30,940,880
Pressed blocks	59,615	1,011,607	57,539	1,037,523
Salt in brine (sold or used as such)	12,113,608	32,180,276	13,423,894	42,436,769
Total	20,669,403	105,585,892	22,704,143	123,388,847

[1] Includes production in Hawaii and Puerto Rico.

New salt-producing facilities were reported under construction in Utah at the edge of Great Salt Lake due south of Stansbury Island. The initial capacity of the new plant was expected to be 120,000 tons of crude salt per year produced by solar evaporation of the lake brine.

After production begins, probably in 1959, bulk crude salt will be shipped by rail to Pacific Northwest plants for production of chlorine, caustic soda, and chemicals. A royalty of 10 cents per ton of salt shipped will be paid to the State of Utah.[3]

CONSUMPTION AND USES

The uses most commonly associated with salt as a food seasoning and preservative absorbed relatively minor proportions of the total production. For instance, it is estimated that only about 3 percent of the total output was consumed as "table" salt. Another 3 percent was consumed by the canning, baking, dairy, fishing, flour, and other food-processing industries. About 10 percent was shipped to meat packers, feed dealers, and mixers.

As in previous years, the major consumers of salt in 1955 were the chemical industries. These (of which soda ash and chlorine are the most important) composed over 70 percent of the total sales. Chlorine production alone absorbed approximately 36 percent of the salt production, while soda ash consumed 29 percent. Historically, soda ash has been the largest single consumer of salt, followed by chlorine.

Large quantities of salt also were used for ice control on streets and highways.

TABLE 4.—Evaporated salt sold or used by producers in the United States, 1953–55, by States

State	1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
California	(1)	(1)	(1)	(1)	1,105,772	$6,120,822
Kansas	370,569	$5,285,805	356,045	$5,474,151	361,612	5,819,536
Louisiana	121,410	1,580,290	124,558	1,831,480	110,218	1,743,445
Michigan	820,660	11,912,341	816,736	13,449,085	857,265	14,234,709
New York	532,924	7,832,362	529,602	8,734,524	568,497	9,655,884
Ohio	498,438	5,175,816	482,906	5,361,838	509,905	6,113,567
Puerto Rico	13,692	131,490	8,758	98,110	10,496	112,399
Texas	111,851	1,910,250	107,946	1,799,139	117,237	2,016,600
Other States [2]	1,232,761	7,801,140	1,304,536	8,337,659	345,965	3,156,713
Total	3,702,305	41,629,494	3,731,087	45,085,986	3,986,967	48,973,675

[1] Included with "Other States" to avoid disclosure of individual company operations.
[2] Includes California (1953-54), Hawaii, Nevada, New Mexico, Oklahoma, Utah, and West Virginia.

TABLE 5.—Rock salt sold by producers in the United States, 1946–50 (average) and 1951–55

Year	Short tons	Value	Year	Short tons	Value
1946–50 (average)	3,676,363	$16,387,267	1953	4,478,655	$23,777,527
1951	4,662,194	23,589,552	1954	4,824,708	28,319,630
1952	4,567,531	24,121,865	1955	5,293,282	31,978,403

[3] Chemical and Engineering News, vol. 33, No. 46, Nov. 14, 1955, pp. 4908–4909.

TABLE 6.—Pressed-salt blocks sold by original producers of the salt in the United States, 1946–50 (average) and 1951–55

Year	From evaporated salt		From rock salt		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	273,579	$3,064,423	68,177	$646,962	341,756	$3,711,385
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
1953	293,014	4,603,864	62,247	853,521	355,261	5,457,385
1954	284,276	4,929,057	59,615	1,011,607	343,891	5,940,664
1955	285,670	5,069,998	57,539	1,037,523	343,209	6,107,521

The increased consumption of salt as a basic raw material reflected the high level of industrial activity throughout the year. The most notable increase was for chlorine production, which required 35 percent more salt than in 1954. On the other hand, salt consumed by the soda ash industry showed a 9-percent drop. Table 7 shows the use pattern in 1955, compared with 1954.

TABLE 7.—Salt sold or used by producers in the United States, 1954–55, by classes and consumers or uses, in thousand short tons

Consumer or use	1954				1955			
	Evaporated	Rock	Brine	Total	Evaporated	Rock	Brine	Total
Chlorine	593	1,076	4,395	6,064	658	1,285	6,228	8,171
Soda ash	(1)		(1)	7,384	(1)	(1)	6,690	6,707
Textile and dyeing	51	130		181	57	155		212
Soap (including detergents)	32	8		40	37	8		45
All other chemicals	(1)	444	(1)	671	192	446	434	1,072
Meat packers, tanners, and casing manufacturers	(1)	551	(1)	975	(1)	559	(1)	998
Fishing	23	10		33	27	13		40
Dairy	74	4		78	58	17		75
Canning	156	33		189	173	34		207
Baking	27	3		30	104	4		108
Flour processors (including cereal)	(1)	(1)		9	(1)	(1)		56
Other food processing	201	21		222	81	31		112
Ice manufacturers and cold storage companies	(1)	76	(1)	139	(1)	50	(1)	96
Feed dealers	216	177		393	574	277		851
Feed mixers	513	129		642	168	52		220
Metals	56	73		129	(1)	94	(1)	173
Ceramics (including glass)	(1)	(1)		13	(1)	(1)		16
Rubber	(1)	(1)	(1)	91	(1)	(1)	(1)	138
Oil	(1)	51	(1)	95	(1)	68	(1)	133
Paper and pulp	(1)	86	(1)	115	(1)	74	(1)	109
Water softener manufacturers and service companies	(1)	320	(1)	564	(1)	228	(1)	342
Grocery stores	542	150		692	542	144		686
Railroads	30	88		118	24	90		114
Bus and transit companies	(1)	(1)		26	(1)	(1)		32
State, counties and other political subdivisions (except Federal)	(1)	1,104	(1)	1,140	(1)	1,274	(1)	1,341
U. S. Government	13	18		31	18	24		42
Miscellaneous	(1)	164	(1)	605	(1)	210	(1)	608
Undistributed [2]	1,204	109	7,718		1,274	156	72	
Total	3,731	4,825	12,113	20,669	3,987	5,293	13,424	22,704

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Comprises uses for which data may not be shown separately; also includes some exports and consumption in Territories and possessions.

TABLE 8.—Distribution (shipments) of evaporated and rock salt in the United States, 1954–55, by States of destination, in short tons

Destination	1954		1955	
	Evaporated	Rock	Evaporated	Rock
Alabama	21,579	85,738	20,835	196,659
Arizona	15,404	10,390	17,071	15,366
Arkansas	13,406	69,625	11,569	62,744
California	477,522	84,540	526,195	83,242
Colorado	53,018	22,073	71,927	23,408
Connecticut	13,968	20,514	12,179	27,165
Delaware	6,272	7,187	6,156	6,614
District of Columbia	5,534	2,618	5,460	2,436
Florida	13,557	40,554	13,226	45,706
Georgia	25,046	62,617	24,556	67,161
Idaho	20,144	1,490	25,137	2,056
Illinois	221,431	309,568	228,013	319,945
Indiana	114,748	92,358	128,002	112,350
Iowa	119,146	115,002	126,477	123,777
Kansas	51,408	209,108	49,950	210,393
Kentucky	30,231	107,940	32,780	137,594
Louisiana	19,206	135,035	17,844	138,525
Maine	12,538	88,478	9,813	102,459
Maryland	40,156	81,032	42,860	87,156
Massachusetts	53,049	88,998	53,363	105,749
Michigan	127,233	284,094	136,607	267,250
Minnesota	125,085	98,383	133,468	58,625
Mississippi	10,158	33,090	10,093	39,930
Missouri	71,481	70,381	77,081	75,003
Montana	22,187	2,472	26,430	2,657
Nebraska	64,409	64,972	61,107	62,296
Nevada	6,600	108,838	7,649	122,262
New Hampshire	4,280	86,765	4,559	106,259
New Jersey	113,915	123,572	116,221	139,397
New Mexico	8,178	34,993	12,701	27,730
New York	188,864	813,485	197,546	920,557
North Carolina	58,182	93,368	64,957	94,571
North Dakota	14,968	16,180	21,266	12,593
Ohio	216,063	284,904	233,022	312,626
Oklahoma	31,564	27,909	31,482	32,518
Oregon	183,274	239	109,234	295
Pennsylvania	135,969	135,563	141,150	148,722
Rhode Island	10,606	11,236	11,097	11,955
South Carolina	12,915	23,159	14,294	24,918
South Dakota	25,990	16,960	24,162	18,040
Tennessee	39,688	79,833	38,536	90,162
Texas	95,892	250,811	101,403	274,211
Utah	49,489	(1)	44,338	(1)
Vermont	6,214	39,685	6,408	51,073
Virginia	86,669	77,729	99,194	69,964
Washington	239,401		369,720	
West Virginia	171,210	57,817	171,874	92,258
Wisconsin	136,766	75,132	137,546	67,466
Wyoming	13,685	1,101	15,682	912
Other [2]	132,789	277,172	144,727	298,527
Total	3,731,087	4,824,708	3,986,967	5,293,282

[1] Included with "Other" to avoid disclosure of individual company operations.
[2] 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 the price of rock and table salt advanced slightly in September and again in October. From January to August rock salt, paper bags, carlots, works, was quoted at $0.98 per hundred pounds; table salt, vacuum common fine, was quoted at $1.12 per hundred pounds. In September the price of these grades was increased to $0.99 and $1.17, respectively; again in October the price was increased to $1.01 and $1.19 per hundred pounds for rock and vacuum common fine, respectively.

The average value of salt in brine showed a sharp increase for the second consecutive year. This was due in part to the efforts of the industry to assign more realistic values to salt in this form. In most instances brine was produced and consumed by the same company, making it necessary to assign an arbitrary value to it for bookkeeping purposes. The average value per ton of salt in brine in 1955 was $3.16, compared with $2.66 in 1954 and approximately $1.00 in 1953.

Under the provisions of a recent ruling of the Internal Revenue Service [4] regarding depletion allowance of the Internal Revenue Code,[5] "salt produced in brine for electrolytic manufacturing purposes has the same value as crude rock salt at the mouth of the mine." The average value of rock salt in 1955 was $8.72 per ton.

FOREIGN TRADE [6]

In 1955 imports of salt into the United States increased for the third consecutive year, but the total was less than 1 percent of the domestic production. The main supplier was Canada, with smaller amounts coming from the Bahamas, Dominican Republic, and Jamaica.

Exports of salt from the United States increased slightly, compared with 1954, owing mainly to larger shipments to Japan. The bulk of the salt exported was shipped to Canada.

TABLE 9.—Salt imported for consumption in the United States, 1954–55, by countries

[U. S. Department of Commerce]

Country	1954		1955	
	Short tons	Value	Short tons	Value
North America:				
Bahamas	140,835	$794,123	21,078	$67,936
Canada	875	13,104	143,093	1,024,331
Dominican Republic	18,989	71,166	16,637	98,232
Jamaica			4,816	15,480
Mexico	71	568	29	286
Total	160,770	[1] 878,961	185,653	[1] 1,206,265
Grand total	160,770	[1] 878,961	185,653	[1] 1,206,265

[1] Owing to changes in tabulating procedures by U. S. Department of Commerce, data known to be not comparable with earlier years.

[4] Bureau of Internal Revenue, Ruling 55-350: Bull. 23, June 6, 1955.

[5] Bureau of Internal Revenue, Internal Revenue Code: Regulations 118, sec. 39.23 (m)—1, 1939.

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

TABLE 10.—Salt imported for consumption in the United States, 1946–50 (average) and 1951–55, 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
1946–50 (average)	1,698	$23,575	3,060	$17,413	435	$1,551
1951	2,991	37,245	1,338	9,586		
1952	2,488	29,538	4,568	14,692		
1953	2,550	26,428	134,758	447,044		
1954	946	[1] 13,672	159,824	865,289		
1955	8,109	[1] 116,409	177,544	[1] 1,089,856		

[1] Owing to changes in tabulating procedures by U. S. Department of Commerce, data known to be not comparable with earlier years.

TABLE 11.—Salt exported from the United States, 1954–55, by countries

[U. S. Department of Commerce]

Country	1954		1955	
	Short tons	Value	Short tons	Value
North America:				
Canada	[1] 304,266	[1] $2,145,233	304,057	$1,981,164
Central America:				
Canal Zone	515	29,372	491	31,250
Costa Rica	250	11,179	280	10,030
El Salvador	223	9,814	184	7,218
Guatemala	153	6,857	73	2,944
Honduras	190	6,162	372	12,048
Nicaragua	154	3,700	196	7,075
Panama	76	2,226	359	11,010
Mexico	5,689	180,109	7,375	196,069
West Indies:				
Cuba	9,885	279,577	10,244	285,113
Dominican Republic	174	16,947	329	25,278
Netherlands Antilles	420	29,561	309	23,515
Other North America	69	5,490	18	3,852
Total	[1] 322,064	[1] 2,726,227	324,287	2,596,566
South America	140	15,076	41	8,665
Europe	7	2,190	4	5,040
Asia:				
Japan	60,866	271,500	82,392	375,797
Philippines	1,889	51,659	137	11,643
Other Asia	143	7,379	104	11,304
Total	62,898	330,538	82,633	398,744
Africa	30	3,381	41	4,309
Oceania	120	8,240	125	9,701
Grand total	[1] 385,259	[1] 3,085,652	407,131	3,023,025

[1] Revised figure.

TABLE 12.—Salt shipped to possessions and other areas administered by the United States, 1953–55 [1]

[U. S. Department of Commerce]

Territory	1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
American Samoa	3	$138	31	$1,406	52	$2,171
Guam	68	6,099	55	4,964	99	7,772
Puerto Rico	8,827	618,488	9,489	768,551	9,784	703,222
Virgin Islands	82	6,813	75	7,565	84	7,128
Wake					(2)	412
Total	8,980	631,538	9,650	782,486	10,019	720,705

[1] Salt is also shipped to the Territories of Alaska and Hawaii, but no record has been kept of these shipments since March 1948.
[2] Less than 1 ton.

TECHNOLOGY

A comprehensive article comparing 1955 technology in saltmaking with practices of 30 years previously appeared in a trade press.[7] Greater steam economy and increased use of power were most notable improvements. Two specific advances were noted: (1) Forced circulation of the brine in the evaporator units which permitted smaller units for a given production and (2) elimination of tube scaling with encrusted calcium sulfate. This is accomplished by carrying a considerable concentration of suspended calcium sulfate crystals in the evaporator brine, so that calcium sulfate thrown out of solution can grow on these crystals rather than on the heating tubes.

Efficiency in utilizing steam has been increased by employing more effects in the evaporator circuit. Quadruple- and some quintuplet-effect evaporators were reported in use.

Thermocompression-type evaporation has been developed for areas where fuel is relatively expensive, but it is not employed in the United States.

Production of grainer salt has been the least efficient of the common saltmaking processes; however, market demand for coarse salt, with its characteristic crystal structure, required continued operation of grainers. Several processes have been developed that produce flake salt by employing principles of flash evaporation and direct steam injection, thus eliminating heat-transfer surfaces. They are more efficient than the grainer process.

A system has been perfected by which dry bulk salt may be blown through pipelines with compressed air. The process eliminates the need for bags or containers and maintains a clean product.[8]

The biological importance of trace elements in human and animal nutrition has attracted much scientific interest. In accordance with this trend, a new company was reported to be producing from sea water a free-flowing table salt containing, in addition to sodium chloride, trace amounts of all the known sea-water minerals.[9] A submerged combustion process was employed to evaporate the brine. Calcium

[7] Badger, W. L., and Standiford, F. C., Engineering in Salt Manufacture: Chem. Eng., vol. 62, No. 3, March 1955, pp. 173–177; vol. 62, No. 4, April 1955, pp. 180–183.
[8] Chemical Age (London), vol. 72, No. 1872, May 28, 1955, p. 1198.
[9] Chemical and Engineering News, vol. 33, No. 22, May 30, 1955, p. 2329.

and magnesium chlorides were converted to carbonates to reduce the tendency for the salt to be hygroscopic.

Improvements in methods for producing salt from brine wells were described in an article.[10] Wells are drilled into the salt bed and two concentric pipes introduced. Water to dissolve the salt is introduced through the annular space, and brine is removed from the central tube. This long-established practice has been modified as, after a period of operation of several wells in the same formation, the cavities dissolved in the salt bed become connected. When this occurs, water is introduced in one well, and brine is removed from the other. Rates of removal of 200 gallons of brine per minute are commonly attained. After aeration, chlorination, and settling to remove iron, hydrogen sulfide, and other impurities, the brine is ready for the evaporator.

WORLD REVIEW

NORTH AMERICA

Canada.—Canadian production of salt in 1955 was nearly 30 percent larger than in 1954. A major factor in this increase was establishment of Canada's second rock-salt mine at Ojibway, southern Ontario. The mine initiated production in the last half of 1955.[11]

Mexico.—The output of salt was estimated at 247,000 short tons in 1954, substantially the same as 1953.[12]

Two American firms were reported to be developing a salt-producing area in the lowlands near Bahia Sebastian Vizcaino.

ASIA

Japan.—Salt is produced in Japan exclusively by evaporation of sea water. Production in 1955 was less than one-third of requirements. Imports to make up the deficiency were reported to be 1,922,000 short tons.

[10] Hester, A. S., and Diamond, H. W., Salt Manufacture: Ind. Eng. Chem., vol. 47, No. 4, April 1955, pp. 672–683.
[11] Collins, R. K., Salt in Canada, 1955 (Preliminary): Dept. of Mines and Tech. Surveys, Ottawa, 4 pp.
[12] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, p. 49.

457676—58——61

TABLE 13.—World production of salt by countries [1] 1946–50 (average) and 1951–55, in short tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	724,922	963,557	973,207	959,898	963,357	1,253,870
Costa Rica	8,234	6,002	2,500	4,289	4,519	4,960
Guatemala	10,789	13,295	13,199	16,736	12,804	17,313
Honduras	4,093	5,126	5,291	[3] 11,500	[3] 11,000	[3] 11,000
Mexico	150,485	181,881	189,597	246,763	246,917	[3] 248,000
Nicaragua	10,098	13,546	14,568	15,400	16,035	11,250
Panama	5,324	6,532	7,155	4,764	7,692	11,401
Salvador	20,365	[3] 30,000	[3] 20,000	38,250	41,116	[3] 42,000
United States:						
Rock salt	3,676,963	4,662,194	4,567,531	4,458,393	4,824,708	5,293,282
Other salt	12,281,306	15,544,937	14,977,421	16,330,610	15,844,695	17,410,861
West Indies:						
British:						
Bahamas	62,272	57,100	89,618	165,347	149,357	59,149
Leeward Islands: Antigua (exports)	5,932	7,710	6,553	5,934	4,664	15,475
Turks and Caicos Islands	42,528	23,520	18,368	11,046	[3] 11,000	[3] 11,000
Cuba	60,404	56,199	62,788	57,027	60,305	70,649
Dominican Republic:						
Rock salt	2,632	2,502	2,869	4,183	47,573	19,763
Other salt	14,468	8,920	18,457	15,064	15,948	[3] 17,000
Haiti	[3] 12,500	[3] 28,000	33,510	33,510	33,510	33,510
Netherlands Antilles	1,342	[3] 3,300	2,920	[3] 3,300	[3] 3,300	[3] 3,300
Total [3]	17,095,000	21,614,000	21,006,000	22,382,000	22,299,000	24,534,000
South America:						
Argentina	412,533	462,970	540,132	498,775	[3] 550,000	552,478
Brazil	783,283	1,371,763	860,483	839,192	744,416	1,055,845
Chile:						
Rock salt	51,882	53,933	56,262	39,129	[3] 50,000	[3] 50,000
Other salt	20,993	384	1,076	1,345		
Colombia:						
Rock salt	109,383	121,348	183,896	163,305	190,117	193,052
Other salt	31,259	41,926	42,561	53,191	39,943	37,599
Ecuador	26,644	36,064	44,553	15,831	38,581	54,304
Peru	66,632	75,502	87,758	84,860	92,494	95,279
Venezuela	63,988	42,902	127,923	80,012	91,948	68,504
Total [1] [3]	1,583,000	2,223,000	1,961,000	1,792,000	1,814,000	2,124,000
Europe:						
Austria:						
Rock salt	1,865	763	1,261	1,349	1,409	893
Other salt	296,999	399,360	368,255	365,485	394,661	438,110
Bulgaria	[3] 56,000	(4)	(4)	(4)	(4)	(4)
Czechoslovakia	[3] 8,800	(4)	(4)	(4)	(4)	(4)
France:						
Rock salt and salt from springs	2,296,944	2,848,109	2,408,584	2,670,988	2,666,666	2,374,376
Other salt	660,732	474,809	745,164	622,677	545,643	[3] 551,000
Germany, West:						
Rock salt	1,748,882	2,824,118	2,674,205	3,522,953	3,305,217	3,361,434
Brine salt	242,454	310,306	305,654	327,607	393,423	369,023
Greece	87,593	90,868	96,480	94,080	88,185	77,162
Italy:						
Rock salt and brine salt	752,539	1,226,707	835,005	983,621	1,140,266	1,123,789
Other salt	1,080,506	438,852	715,903	562,375	588,911	544,994
Malta	1,882	4,234	1,679	4,103	3,618	1,262
Netherlands	318,709	535,039	457,250	503,664	563,835	644,851
Poland [3]	763,000	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000
Portugal:						
Rock salt	54	43	50	54	60	53
Other salt (exports)	36,679	32,379	25,301	3,325	2,513	1,383
Rumania	[3] 366,000	(4)	(4)	(4)	(4)	(4)
Spain:						
Rock salt	312,594	405,440	413,650	434,098	447,210	465,682
Other salt	700,783	967,352	702,487	1,074,363	957,580	771,727
Switzerland	111,568	139,993	120,482	112,877	128,419	135,033
U. S. S. R.[3]	5,500,000	6,100,000	6,600,000	6,800,000	7,200,000	7,200,000
United Kingdom:						
Great Britain:						
Rock salt	41,097	60,480	50,400	48,160	48,366	76,908
Other salt	4,044,992	5,173,290	4,363,529	4,495,689	4,902,151	5,155,614
Northern Ireland	14,347	14,607	12,321	[3] 11,000	12,143	13,879
Yugoslavia	124,826	105,432	163,559	136,045	152,119	149,221
Total [1] [3]	19,700,000	24,100,000	23,000,000	24,800,000	25,600,000	25,500,000

See footnotes at end of table.

TABLE 13.—World production of salt by countries [1] 1946–50 (average) and 1951–55, in short tons [2]—Continued

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
Asia:						
Aden	254,900	340,819	421,209	269,274	235,201	261,936
Afghanistan	[3] 49,000	27,268	26,125	30,016	31,360	20,944
Burma	43,189	70,862	65,385	69,909	107,456	117,297
Ceylon	52,926	40,774	54,250	65,970	57,500	40,684
China	[3] 2,400,000	[3] 5,000,000	5,450,000	[3] 5,500,000	[3] 6,100,000	[3] 6,600,000
Cyprus	5,111	12,344	----------	2,196	5,249	----------
India:						
Rock salt	62,743	6,096	6,711	6,465	4,488	} 3,335,366
Other salt	2,374,002	3,056,974	3,158,592	3,538,383	3,038,867	
Indochina (Vietnam)	68,258	103,516	146,530	117,947	116,899	70,548
Indonesia	252,870	529,761	356,046	293,214	143,300	[3] 50,700
Iran [3] [5]	50,000	220,000	240,000	240,000	275,000	275,000
Iraq	12,506	18,191	21,272	20,612	22,408	21,121
Israel	[6] 14,618	10,858	13,816	23,141	26,511	30,865
Japan	377,465	474,440	477,521	507,944	468,261	619,328
Jordan	([6])	2,989	8,132	7,778	11,472	8,493
Korea, Republic of	162,409	93,207	224,722	212,400	198,547	390,128
Lebanon [3]	5,300	7,700	7,700	9,900	17,000	17,000
Pakistan:						
Rock salt [5]	[7] 149,965	154,796	143,662	161,855	164,652	156,583
Other salt [5]	[7] 161,745	253,505	188,379	167,270	280,603	[3] 220,000
Philippines	68,031	57,629	18,486	52,690	52,990	88,180
Portuguese India	18,124	34,808	23,567	17,606	14,634	[3] 16,500
Syria	21,444	4,408	17,653	21,479	14,330	10,447
Taiwan (Formosa)	259,163	302,877	343,602	178,536	406,232	464,127
Thailand (Siam) [3]	185,000	275,000	275,000	275,000	330,000	330,000
Turkey:						
Rock salt	26,794	24,977	34,759	29,962	28,660	[3] 27,500
Other salt	276,972	275,568	321,423	354,020	458,561	529,109
Yemen	----------	----------	----------	110,231	110,231	110,231
Total [3]	7,400,000	11,400,000	12,000,000	12,300,000	12,700,000	13,800,000
Africa:						
Algeria	86,558	107,234	90,768	66,139	108,434	114,640
Anglo-Egyptian Sudan	43,650	50,943	58,765	60,473	61,330	[3] 60,600
Angola	51,945	54,265	63,394	63,723	60,810	63,860
Belgian Congo	831	643	683	893	928	505
Canary Islands	10,103	17,338	16,800	19,456	20,408	[3] 20,000
Cape Verde Islands	16,827	26,572	19,941	11,715	23,326	86,688
Egypt	410,952	757,329	549,384	418,878	496,552	442,797
Eritrea	88,837	198,416	170,858	209,439	[3] 210,000	[3] 210,000
Ethiopia: Rock salt	[3] 11,000	[3] 11,000	[3] 11,000	16,211	[3] 22,000	[3] 22,000
French Equatorial Africa	[3] 2,535	4,299	4,740	4,519	6,834	5,291
French Morocco:						
Rock salt	11,897	4,860	10,159	8,317	} 35,373	44,252
Other salt	40,124	51,859	33,654	42,113		
French Somaliland	63,537	60,848	70,989	67,202	63,389	20,082
French West Africa [3]	59,500	73,000	55,000	40,000	24,000	24,000
Italian Somaliland [3]	1,700	2,200	5,500	5,000	5,500	5,500
Kenya	18,530	21,374	18,760	23,392	21,051	28,421
Libya	6,149	15,983	13,228	13,228	16,535	16,535
Mauritius	4,048	3,748	2,425	2,646	3,417	3,858
Mozambique:						
Rock salt	79	97	114	121	109	129
Other salt	13,091	9,510	11,466	11,891	13,834	[3] 13,000
South-West Africa:						
Rock salt	3,779	5,187	7,592	5,176	5,404	7,004
Other salt	12,677	43,960	36,661	40,262	46,792	58,527
Spanish Morocco	[3] 275	[3] 275	[3] 275	[3] 275	345	[3] 300
Tanganyika	13,874	17,480	21,225	22,159	23,823	28,296
Tunisia	112,500	176,370	118,498	169,108	181,881	145,505
Uganda	6,732	8,674	4,528	8,419	8,052	10,091
Union of South Africa	[8] 158,294	165,121	154,956	140,610	172,185	154,317
Total [1] [3]	1,260,000	1,905,000	1,565,000	1,480,000	1,645,000	1,600,000

See footnotes at end of table.

TABLE 13.—World production of salt by countries[1] 1946–50 (average) and 1951–55, in short tons[2]—Continued

Country[1]	1946–50 (average)	1951	1952	1953	1954	1955
Oceania:						
Australia	253,680	336,001	310,241	347,201	425,492	[3] 413,000
New Zealand			784		1,680	[3] 1,700
Total	253,680	336,001	311,025	347,201	427,172	[3] 414,700
World total (estimate)[1]	47,300,000	61,600,000	59,800,000	63,100,000	64,500,000	68,000,000

[1] In addition to the countries listed, salt is produced in Albania, Bolivia, Gold Coast, Hungary, Madagascar, and Nigeria, but figures 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 Salt chapters. Data do not add to totals shown, owing to rounding where estimated figures are included in the detail.
[3] Estimate.
[4] Data not available; estimate by senior author of chapter included in total.
[5] Year ended March 31 of year following that stated.
[6] Jordan included in Israel.
[7] Average for 1947–50.
[8] Year ended June 30 of years stated.

Sand and Gravel

By Wallace W. Key[1] and Dorothy T. Shupp[2]

MORE SAND AND GRAVEL was produced in 1955 than in any previous year. The industry led all mineral commodities in tonnage and stimulated by the anticipated Federal highway program, cautiously prepared for greater production. When the Federal Highway Bill was not enacted in 1955, the uncertainty introduced seriously set back highway planning.

DOMESTIC PRODUCTION

The sand and gravel industry in 1955 set an alltime record in production for the sixth consecutive year; it totaled 592 million short tons, valued at $536 million—an outstanding achievement. Output per man approximated 11,730 tons in 1955, a 66-percent increase since 1945. More intensive mechanization required large volumes of capital for the installation of expensive modern equipment. Continued expansion of facilities appeared to be assured for the next decade.

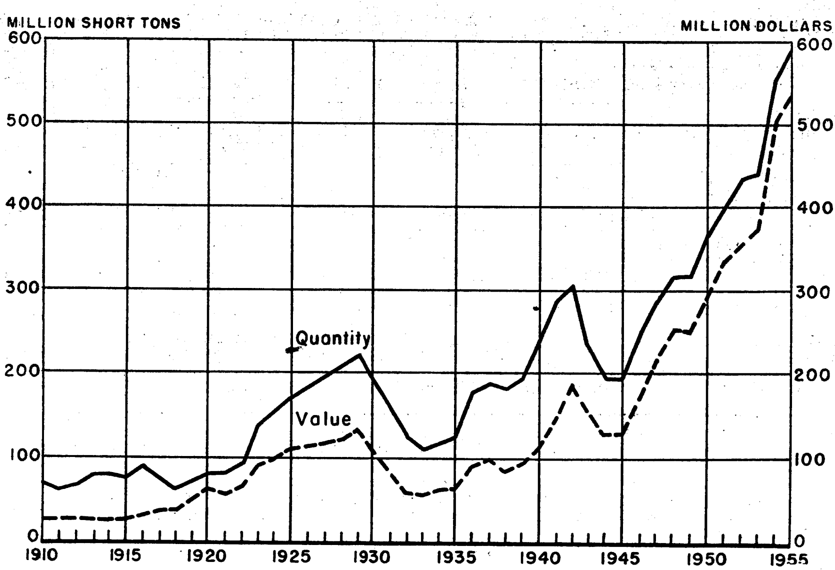

FIGURE 1.—Production of sand and gravel in the United States, 1910–55

[1] Commodity specialist.
[2] Statistical clerk.

TABLE 1.—Sand and gravel sold or used by producers in the United States,[1] 1954–55, by class of operations and uses

	1954			1955			Percent of change in—	
	Short tons	Value		Short tons	Value		Tonnage	Average value
		Total	Average		Total	Average		
COMMERCIAL OPERATIONS								
Sand:[2]								
Glass	5,809,929	$16,346,356	$2.81	6,148,796	$17,032,014	$2.77	+6	−1
Molding	6,319,510	12,779,604	2.02	8,254,732	15,761,767	1.91	+31	−5
Building	100,476,105	92,301,076	.92	107,832,777	99,037,911	.92	+7	------
Paving	51,555,983	45,527,752	.88	60,773,566	52,973,958	.87	+18	−1
Grinding and polishing[3]	1,343,642	3,835,698	2.85	1,717,271	4,611,618	2.69	+28	−6
Fire or furnace	466,857	906,281	1.94	544,561	1,104,549	2.03	+17	+5
Engine	1,374,963	1,700,574	1.24	1,470,280	1,713,692	1.17	+7	−6
Filter	581,458	1,051,653	1.81	458,829	684,564	1.49	−21	−18
Railroad ballast	970,040	507,943	.52	718,339	404,464	.56	−26	+8
Other[4]	8,416,446	14,472,743	1.72	8,544,248	15,848,694	1.85	+2	+8
Total commercial sand	177,314,933	189,429,680	1.07	196,463,399	209,173,231	1.06	+11	−1
Gravel:[5]								
Building	88,793,195	103,304,001	1.16	89,076,641	103,263,780	1.16	------	------
Paving	110,343,622	108,668,952	.98	111,927,874	108,873,370	.97	+1	−1
Railroad ballast	8,391,160	5,612,357	.67	9,397,672	5,957,003	.63	+12	−6
Other	12,090,161	9,344,019	.77	13,145,954	10,291,411	.78	+9	+1
Total commercial gravel	219,618,138	226,929,329	1.03	223,548,141	228,385,564	1.02	+2	−1
Total commercial sand and gravel	396,933,071	416,359,009	1.05	420,011,540	437,558,795	1.04	+6	−1
GOVERNMENT-AND-CONTRACTOR OPERATIONS[6]								
Sand:								
Building	1,201,636	1,299,055	1.08	1,757,760	1,975,512	1.12	+46	+4
Paving	[7]16,447,241	8,825,611	[7].54	22,833,251	11,099,094	.49	+39	−9
Total Government-and-contractor sand	[7]17,648,877	10,124,666	[7].57	24,591,011	13,074,606	.53	+39	−7
Gravel:								
Building	10,965,519	6,417,912	.59	15,045,125	7,993,634	.53	+37	−10
Paving	[7]130,989,038	71,225,162	.54	132,440,934	77,616,137	.59	+1	+9
Total Government-and-contractor gravel	[7]141,954,557	77,643,074	[7].55	147,486,059	85,609,771	.58	+4	+5
Total Government-and-contractor sand and gravel	[7]159,603,434	87,767,740	[7].55	172,077,070	98,684,377	.57	+8	+4
ALL OPERATIONS								
Sand	[7]194,963,810	199,554,346	[7]1.02	221,054,410	222,247,837	1.01	+13	−1
Gravel	[7]361,572,695	304,572,403	.84	371,034,200	313,995,335	.85	+3	+1
Grand total	[7]556,536,505	504,126,749	[7].91	592,088,610	536,243,172	.91	+6	------

[1] Includes United States Territories and possessions, and other areas administered by the United States.
[2] Includes sand produced by railroads for their own use—1954: 263,206 tons valued at $65,484; 1955: 338,867 tons, $68,234.
[3] Includes blast sand as follows—1954: 589,021 tons valued at $2,513,731; 1955: 803,962 tons, $3,253,098.
[4] Includes ground sand as follows—1954: 721,354 tons valued at $6,079,167; 1955: 1,210,063 tons, $8,389,996.
[5] Includes gravel produced by railroads for their own use—1954: 3,980,749 tons valued at $1,860,460; 1955: 5,204,389 tons, $2,376,623.
[6] Approximate figures for States, counties, municipalities, and other Government agencies directly or under lease.
[7] Revised figure.

As in previous years, California led in production which was double that of Michigan, second ranking in tonnage. Texas, Wisconsin, Ohio, Illinois, Minnesota, and New York followed in order of output. These States supplied more than 45 percent of the United States production.

The 1954 canvass was conducted in cooperation with the Bureau of the Census. A difference in commercial production reported by the two agencies was due to slight differences in coverage and classification in commercial and Government-and-contractor production.

TABLE 2.—Sand and gravel sold or used by producers in the United States,[1] 1946–50 (average) and 1951–55

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)
1946–50 (average)	115,951	101,769	194,172	135,078	310,123	236,847
1951	149,590	145,148	251,044	188,566	400,634	333,714
1952	156,203	148,855	279,419	204,672	435,622	353,527
1953	160,581	160,336	279,818	214,459	440,399	374,795
1954	[2] 194,964	199,554	[2] 361,573	304,573	[2] 556,537	504,127
1955	221,055	222,248	371,034	313,995	592,089	536,243

[1] Includes United States Territories and possessions, and other areas administered by the United States.
[2] Revised figure.

TABLE 3.—Sand and gravel sold or used by producers in the United States in 1955, by States

State	Short tons	Value	State	Short tons	Value
Alabama	3,680,173	$3,523,524	Nebraska	8,405,197	$6,192,797
Alaska	9,793,214	8,242,344	Nevada	3,580,260	3,762,384
American Samoa	1,275	552	New Hampshire	2,432,146	1,592,580
Arizona	7,755,347	6,518,905	New Jersey	11,152,552	16,424,417
Arkansas	9,003,162	7,662,942	New Mexico	4,556,447	6,004,554
California	64,878,648	66,820,360	New York	25,561,941	25,542,363
Colorado	12,911,783	8,914,429	North Carolina	7,785,741	5,911,223
Connecticut	4,345,068	4,079,661	North Dakota	11,168,849	2,637,988
Delaware	2,297,074	1,407,196	Ohio	27,906,047	31,995,215
Florida	5,065,508	4,349,148	Oklahoma	6,293,798	4,785,786
Georgia	2,987,570	2,198,905	Oregon	11,953,878	11,832,344
Hawaii	165,081	425,760	Panama Canal Zone	35,910	47,229
Idaho	8,652,138	3,933,876	Pennsylvania	13,312,971	20,511,847
Illinois	26,362,360	28,138,973	Puerto Rico	433,017	678,761
Indiana	17,081,982	14,306,348	Rhode Island	1,940,738	1,498,552
Iowa	11,770,836	8,344,832	South Carolina	3,126,952	2,677,054
Kansas	10,664,986	6,909,666	South Dakota	13,537,801	10,096,828
Kentucky	4,898,705	5,298,102	Tennessee	5,136,543	5,814,116
Louisiana	8,574,020	10,941,860	Texas	31,518,123	28,480,350
Maine	7,528,903	2,855,585	Utah	5,158,265	3,309,280
Maryland	9,694,928	12,210,658	Vermont	1,763,229	1,160,031
Massachusetts	9,580,943	8,926,329	Virginia	6,460,886	8,076,104
Michigan	37,214,459	29,490,775	Washington	21,645,161	19,350,682
Minnesota	25,896,426	17,429,334	West Virginia	5,171,399	9,779,288
Mississippi	5,624,878	4,603,032	Wisconsin	27,978,335	19,958,450
Missouri	9,919,234	9,987,850	Wyoming	3,952,119	3,977,677
Montana	13,771,609	6,615,326			
			Total	592,088,610	536,243,172

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1955, by States, uses, and class of operations

[Commercial unless otherwise indicated]

State	Sand							
	Glass		Molding		Building			
					Commercial [1]		Government-and-contractor	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama			41,958	$74,616	889,309	$697,143	100	$100
Alaska					86,059	156,729	80,304	204,011
American Samoa								
Arizona					829,443	866,097	120	50
Arkansas	(2)	(2)	(2)	(2)	1,157,483	811,942		
California	(2)	(2)	43,018	168,034	16,520,270	16,241,357	104,378	113,579
Colorado			(2)	(2)	1,535,768	1,387,966		
Connecticut			1,200	960	1,151,029	1,018,061		
Delaware					225,431	195,129		
Florida			(2)	(2)	3,324,332	2,533,253		
Georgia	(2)	(2)	(2)	(2)	1,345,444	910,549	3,200	1,400
Hawaii					97,821	223,710		
Idaho					290,962	362,029	20,000	20,000
Illinois	1,155,359	$2,670,748	853,110	1,922,344	6,590,497	5,360,272	950	328
Indiana	(2)	(2)	891,641	1,129,676	4,005,960	2,667,631		
Iowa			(2)	(2)	2,428,972	1,915,831		
Kansas	2,738	3,160	42,030	29,833	3,852,773	2,701,142	29,438	7,870
Kentucky					1,973,564	2,223,253		
Louisiana	(2)	(2)	75,543	165,748	824,375	953,705	88,755	35,502
Maine					193,093	178,663	270	27
Maryland	(2)	(2)			2,221,341	2,399,638		
Massachusetts			(2)	(2)	2,875,484	2,508,822	43,565	100,157
Michigan	348,610	919,403	1,895,382	1,795,555	5,237,547	4,102,520	5,539	1,662
Minnesota	5,795	39,822	(2)	(2)	3,387,806	2,802,358	4,050	1,215
Mississippi			36,343	91,610	593,857	447,411	84,762	95,699
Missouri	435,134	1,005,623	99,745	208,153	3,047,612	2,516,414	6	3
Montana					210,112	345,563	(2)	(2)
Nebraska					1,402,906	998,755	(2)	(2)
Nevada	(2)	(2)	84,286	249,327	288,899	332,456		
New Hampshire					282,343	227,388		
New Jersey	901,096	2,152,264	1,493,294	3,682,833	3,219,280	3,035,794		
New Mexico					404,086	433,712	174,611	331,724
New York			316,092	879,883	7,525,795	7,443,321	2,086	2,639
North Carolina					1,754,898	1,181,645	146,445	47,844
North Dakota					201,924	201,754	168,750	18,750
Ohio	(2)	(2)	453,056	1,352,772	5,968,730	6,276,596		
Oklahoma	211,700	484,850	66,150	77,250	1,374,788	1,095,208	65,000	26,000
Oregon			(2)	(2)	1,002,463	1,221,194	(2)	(2)
Panama Canal Zone					35,910	47,229		
Pennsylvania	(2)	(2)	271,015	607,501	3,823,809	5,094,580		
Puerto Rico	1,610	2,280			11,138	8,210	96	96
Rhode Island			(2)	(2)	245,473	229,849		
South Carolina	(2)	(2)	9,266	6,950	1,175,968	492,132		
South Dakota					487,503	432,592	270	600
Tennessee	(2)	(2)	224,855	572,474	1,160,689	1,465,103		
Texas	(2)	(2)	59,615	122,969	5,105,976	5,136,708		
Utah			(2)	(2)	807,303	609,762		
Vermont			50	50	49,442	38,694		
Virginia	(2)	(2)	(2)	(2)	1,448,193	1,589,376		
Washington	(2)	(2)	(2)	(2)	1,785,978	1,814,397	(2)	(2)
West Virginia	(2)	(2)	(2)	(2)	800,105	1,080,401		
Wisconsin	32,136	22,045	860,504	1,567,675	2,500,203	1,920,510		
Wyoming					72,631	103,357	27,020	30,970
Undistributed [2]	3,054,618	9,731,819	436,579	1,055,554			708,045	935,286
Total	6,148,796	17,032,014	8,254,732	15,761,767	107,832,777	99,037,911	1,757,760	1,975,512

[1] Includes 106 tons of building sand valued at $280, produced by railroads for their own use.
[2] 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 1955, by States, uses, and class of operations—Continued

State	Sand—Continued							
	Paving				Grinding and polishing [4]		Fire or furnace	
	Commercial [3]		Government-and-contractor					
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	582,903	$552,914	27,425	$8,153	(2)	(2)		
Alaska	21,683	34,205	206,436	327,645	270	$300		
American Samoa			1,275	552				
Arizona	182,475	148,630	2,494,667	1,417,182				
Arkansas	1,295,244	906,394	178,462	156,918			(2)	(2)
California	5,749,733	5,512,871	1,405,885	929,170	(2)	(2)		
Colorado	61,102	53,142	411,074	112,175	(2)	(2)		
Connecticut	911,097	778,006	144,990	20,610	(2)	(2)		
Delaware	(2)	(2)	950,586	451,894				
Florida	907,389	709,599			(2)	(2)		
Georgia	330,386	208,014	195,575	58,250	22,715	108,510		
Hawaii	(2)	(2)	1,050	1,450				
Idaho	4,700	6,095	(2)	(2)	(2)	(2)		
Illinois	1,962,809	1,477,777	159,685	100,991	364,142	1,530,026	6,005	$14,412
Indiana	2,448,005	1,876,079			16,381	7,977		
Iowa	1,087,379	829,948	598,077	217,924	5,800	6,968		
Kansas	2,711,132	1,715,333	657,562	284,167	7,970	6,136		
Kentucky	770,474	741,292	2,500	1,750				
Louisiana	1,889,255	1,852,525						
Maine	(2)	(2)	367,828	110,261				
Maryland	2,817,906	3,642,952			(2)	(2)	(2)	(2)
Massachusetts	1,358,366	1,074,808	71,735	130,461				
Michigan	4,599,304	3,670,800	406,711	129,616	295,852	127,025		
Minnesota	806,919	632,736	110,172	40,913				
Mississippi	653,508	505,145	87,400	20,480	117	70		
Missouri	808,782	770,918	221,545	381,846	213,113	473,520	18,779	38,149
Montana	51,746	59,548	6,763	1,030				
Nebraska	1,037,660	629,775	(2)	(2)				
Nevada	(2)	(2)	40,318	21,451	(2)	(2)		
New Hampshire	407,708	266,398	323,286	92,585				
New Jersey	1,722,616	1,455,233	430,475	206,950	120,610	411,446	20,605	38,417
New Mexico	21,523	35,750	945,277	1,158,470	(2)	(2)		
New York	6,058,430	5,204,455	450,630	224,897				
North Carolina	353,580	222,766	2,187,741	703,210				
North Dakota	127,212	37,512	1,848,723	300,986				
Ohio	4,743,132	4,540,227	19,413	13,175	(2)	(2)	(2)	(2)
Oklahoma	1,066,960	826,221	794,982	370,535	(2)	(2)		
Oregon	208,877	250,499			303	152		
Panama Canal Zone								
Pennsylvania	2,073,476	2,850,744			(2)	(2)	250,029	625,580
Puerto Rico	42,763	42,110	86,242	129,514				
Rhode Island	229,451	180,909	368,543	219,555			(2)	(2)
South Carolina	243,652	137,091	29,585	8,652	(2)	(2)	(2)	(2)
South Dakota	490,734	131,859	535,124	633,598				
Tennessee	645,430	590,573	55,045	15,420	(2)	(2)	(2)	(2)
Texas	4,218,564	3,318,988	1,266,866	300,187	(2)	(2)		
Utah	267,778	216,471	74,973	25,469	(2)	(2)	25,000	27,500
Vermont	116,685	74,248	110,000	39,500				
Virginia	1,038,633	697,280	52,321	21,503				
Washington	625,932	577,577	238,502	186,201	132	165		
West Virginia	1,191,328	1,305,433			(2)	(2)	(2)	(2)
Wisconsin	1,387,897	1,097,148	4,089,935	1,466,961	52,918	109,857		
Wyoming	23,703	29,853	745	1,960				
Undistributed [2]	417,545	495,107	177,122	54,877	616,948	1,829,466	224,143	360,491
Total	60,773,566	52,973,958	22,833,251	11,099,094	1,717,271	4,611,618	544,561	1,104,549

[2] Figures that may not be shown separately are combined as "Undistributed."
[3] Includes 1,806 tons of paving sand valued at $632, produced by railroads for their own use.
[4] Includes 803,962 tons of blast sand valued at $3,253,098.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1955, by States, uses, and class of operations—Continued

State	Sand—Continued							
	Engine [5]		Filter		Railroad ballast [6]		Other [7]	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	(2)	(2)						
Alaska	405	$1,800	40	$45			3,780	$6,450
American Samoa								
Arizona	(2)	(2)					(2)	(2)
Arkansas			(2)	(2)			(2)	(2)
California	74,571	152,926	52,976	95,899			986,622	1,448,525
Colorado	(2)	(2)	(2)	(2)	(2)	(2)	42,303	40,853
Connecticut			(2)	(2)			23,157	7,936
Delaware	(2)	(2)					4,725	3,500
Florida	9,294	5,025			17,244	$17,244	153,749	103,108
Georgia	115,177	5,991	5,247	26,235	1,045	491	79,026	106,452
Hawaii								
Idaho							47,242	9,530
Illinois	82,299	100,693	15,399	11,303	95,641	68,982	750,819	3,589,486
Indiana	109,801	80,454			(2)	(2)	107,803	81,807
Iowa	12,800	11,760	(2)	(2)	26,434	10,682	147,688	85,844
Kansas	46,306	43,051	32,948	71,504	56,487	20,124	340,898	149,107
Kentucky	(2)	(2)			4,800	4,080	48,681	64,676
Louisiana	2,210	1,130			(2)	(2)	(2)	(2)
Maine	(2)	(2)						
Maryland	(2)	(2)	(2)	(2)			(2)	(2)
Massachusetts	(2)	(2)	(2)	(2)			(2)	(2)
Michigan	84,895	101,191	63,315	14,110	78,256	21,185	538,088	346,274
Minnesota	18,301	16,900			(2)	(2)	139,004	370,013
Mississippi	(2)	(2)			(2)	(2)	35,026	19,256
Missouri	16,794	14,196	16,593	32,049			74,916	339,501
Montana	476	818					164,845	94,516
Nebraska	84,840	49,026			17,478	5,707	10,738	1,900
Nevada	600	250					88,472	210,150
New Hampshire	(2)	(2)	(2)	(2)				
New Jersey	(2)	(2)	(2)	(2)			541,133	1,496,894
New Mexico			(2)	(2)				
New York	(2)	(2)	(2)	(2)	(2)	(2)	1,044,363	448,165
North Carolina			(2)	(2)	(2)	(2)	26,730	25,865
North Dakota	824	830						
Ohio	(2)	(2)	49,804	72,757	(2)	(2)	534,571	2,048,742
Oklahoma	19,089	13,793	1,000	6,000			45,550	227,050
Oregon	(2)	(2)	2,683	925	(2)	(2)	42,447	33,005
Panama Canal Zone								
Pennsylvania	127,148	302,837	420	1,260			233,024	875,259
Puerto Rico							2,656	1,504
Rhode Island							(2)	(2)
South Carolina	22,528	22,713	(2)	(2)	(2)	(2)	36,515	35,225
South Dakota								
Tennessee	(2)	(2)	(2)	(2)	722	903	14,000	14,000
Texas	52,266	51,837	(2)	(2)	54,879	43,849	350,067	364,941
Utah	(2)	(2)			(2)	(2)	(2)	(2)
Vermont	1,167	1,819					(2)	(2)
Virginia	(2)	(2)	(2)	(2)	(2)	(2)	37,708	38,105
Washington	(2)	(2)	9,100	8,750			65,477	66,405
West Virginia	203,058	350,391					(2)	(2)
Wisconsin	491	736	55	260	13,525	7,345	756,790	373,302
Wyoming								
Undistributed [2]	384,940	383,525	209,249	343,467	351,828	203,872	1,025,635	2,721,348
Total	1,470,280	1,713,692	458,829	684,564	718,339	404,464	8,544,248	15,848,694

[2] Figures that may not be shown separately are combined as "Undistributed."
[5] Includes 134,124 tons of engine sand valued at $18,522, produced by railroads for their own use.
[6] Includes 120,322 tons of ballast sand valued at $19,539, produced by railroads for their own use.
[7] Includes 82,509 tons of sand valued at $29,261, used by railroads for fills and similar purposes. Also includes 1,210,063 tons of ground sand valued at $8,389,996. See table 11 for ground sand.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1955, by States, uses, and class of operations—Continued

State	Gravel							
	Building				Paving			
	Commercial [8]		Government-and-contractor		Commercial [9]		Government-and-contractor	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	954,304	$1,050,281	200	$200	636,157	$743,874	67,718	$9,710
Alaska	131,119	205,157	481,876	651,244	294,892	402,496	7,585,892	5,694,552
American Samoa								
Arizona	1,420,007	1,655,884			806,841	763,151	1,473,984	1,151,785
Arkansas	983,226	880,440	59,643	12,794	2,873,730	2,535,240	2,034,804	1,613,817
California	15,148,728	17,521,842	160,886	170,902	11,182,713	12,862,144	10,118,684	6,673,916
Colorado	1,595,083	1,876,960	31,320	14,000	1,372,718	1,404,021	7,732,802	3,871,622
Connecticut	990,058	1,255,182	350	350	540,286	584,388	326,305	117,793
Delaware	(2)	(2)			(2)	(2)	208,429	100,550
Florida	(2)	(2)			102,502	228,875		
Georgia	74,265	84,877	70,000	35,000	(2)	(2)	414,304	73,177
Hawaii							4,960	4,600
Idaho	469,015	543,379	(2)	(2)	739,318	541,037	3,871,337	1,450,596
Illinois	5,766,453	4,994,533	63,862	19,918	6,118,534	4,765,494	1,367,931	842,561
Indiana	3,300,897	3,231,593			4,716,481	4,321,254	557,346	227,547
Iowa	1,190,092	1,652,695			3,171,202	2,246,724	2,786,787	954,205
Kansas	574,285	479,748	14,000	2,800	1,269,706	988,720	963,744	272,587
Kentucky	1,450,416	1,676,416			373,372	436,213	134,193	48,486
Louisiana	1,355,365	1,569,169			3,968,640	5,788,203	147,250	147,700
Maine	215,153	200,024	20,148	1,864	489,476	340,763	5,947,111	1,839,957
Maryland	1,919,447	3,349,848			2,213,644	2,468,211	398,931	49,296
Massachusetts	2,433,690	2,870,499	152,594	124,819	1,643,426	1,168,074	238,290	162,922
Michigan	4,428,446	4,421,163	30,954	9,286	12,723,987	10,195,155	5,732,742	3,099,139
Minnesota	2,226,484	3,258,073	3,517	1,055	4,300,762	3,223,247	13,817,066	6,633,935
Mississippi	872,335	967,145			2,012,376	1,930,113	425,520	151,054
Missouri	2,159,431	2,230,948	20,250	11,250	1,126,266	994,518	1,389,356	798,340
Montana	393,072	563,394	(2)	(2)	489,674	421,730	6,439,668	2,903,891
Nebraska	1,701,460	1,296,874			3,547,557	2,919,942	389,606	190,877
Nevada	293,134	363,151	129,228	36,922	757,805	651,010	1,687,917	1,167,957
New Hampshire	201,191	294,172			442,476	563,838	746,464	133,318
New Jersey	1,597,621	2,684,510			932,978	1,056,621	47,750	22,985
New Mexico	519,572	604,092	73,547	166,185	313,167	302,669	1,914,562	2,778,193
New York	4,307,193	6,328,538	103,618	37,391	4,046,077	3,984,741	1,029,630	442,149
North Carolina	724,452	1,033,325	8,260	8,606	1,720,307	1,875,511	543,308	497,375
North Dakota	241,274	344,320	223,025	262,670	439,482	353,622	7,691,137	934,153
Ohio	5,083,077	5,663,175			8,533,463	9,218,338	158,574	101,222
Oklahoma	366,276	390,814	18,750	7,500	494,345	593,060	1,760,893	662,484
Oregon	1,881,412	2,063,447	(2)	(2)	2,992,277	3,262,128	4,925,454	4,305,096
Panama Canal Zone								
Pennsylvania	3,659,166	5,093,197			1,823,028	2,529,653	71,890	42,408
Puerto Rico	52,703	70,700			89,900	88,758	139,729	323,339
Rhode Island	246,934	309,860			347,436	320,916	468,895	172,144
South Carolina	579,141	775,335			575,765	770,336		
South Dakota	336,276	213,458	364,435	60,408	1,349,441	570,083	9,887,739	8,020,968
Tennessee	891,666	1,013,047	122,237	9,055	1,274,155	1,519,619	305,479	86,098
Texas	5,897,032	7,355,909			6,708,882	7,711,750	5,277,987	1,876,710
Utah	1,011,960	790,601	186,656	50,407	648,040	458,727	1,999,138	1,060,584
Vermont	72,154	94,655			363,249	359,122	931,192	449,555
Virginia	1,590,708	2,617,937			1,834,978	2,199,932	114,120	86,210
Washington	2,557,567	2,445,682	(2)	(2)	3,156,416	2,874,517	6,763,194	6,292,249
West Virginia	774,681	929,238			657,737	750,517		
Wisconsin	3,758,245	2,989,827	170,872	81,972	4,369,709	3,524,375	8,589,707	6,011,418
Wyoming	197,517	263,049	61,623	68,730	555,757	367,512	2,811,415	3,064,907
Undistributed [2]	482,858	695,617	12,473,274	6,148,306	786,744	692,428		
Total	89,076,641	103,263,780	15,045,125	7,993,634	111,927,874	108,873,370	132,440,934	77,616,137

[2] Figures that may not be shown separately are combined as "Undistributed."
[8] Includes 71,158 tons of building gravel valued at $34,347, produced by railroads for their own use.
[9] Includes 28,806 tons of paving gravel valued at $14,403, produced by railroads for their own use.

TABLE 4.—Sand and gravel sold or used by producers in the United States in 1955, by States, uses, and class of operations—Continued

State	Gravel—Continued				Sand and gravel			
	Railroad ballast [10]		Other [11]		Total commercial		Total Government-and-contractor	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	(2)	(2)	235,039	$254,539	3,584,730	$3,505,361	95,443	$18,163
Alaska	384,121	$285,359	516,337	272,351	1,438,706	1,364,892	8,354,508	6,877,452
American Samoa							1,275	552
Arizona	(2)	(2)	(2)	(2)	3,786,576	3,949,888	3,968,771	2,569,017
Arkansas	(2)	(2)	144,915	170,347	6,730,253	5,879,413	2,272,909	1,783,529
California	1,239,699	1,021,534	1,521,019	1,713,157	53,088,815	58,932,793	11,789,833	7,887,567
Colorado	(2)	(2)	77,664	83,153	4,736,587	4,916,632	8,175,196	3,997,797
Connecticut	5,400	4,000	242,231	284,965	3,873,423	3,940,908	471,645	138,753
Delaware			70,230	41,027	1,138,059	854,752	1,159,015	552,444
Florida			66,571	66,217	5,065,503	4,349,148		
Georgia					2,304,491	2,031,078	683,079	167,827
Hawaii					159,071	419,710	6,010	6,050
Idaho	(2)	(2)	(2)	(2)	1,748,895	1,506,327	6,903,243	2,427,549
Illinois	644,432	449,069	364,433	220,036	24,769,932	27,175,175	1,592,428	963,798
Indiana	485,416	392,777	372,607	227,712	16,524,636	14,078,801	557,346	227,547
Iowa	70,492	39,642	40,135	24,159	8,385,972	7,172,703	3,384,864	1,172,129
Kansas			62,969	134,384	9,000,242	6,342,242	1,664,744	567,424
Kentucky	81,578	42,276	(2)	(2)	4,762,012	5,247,866	136,693	50,236
Louisiana	76,641	60,976	972	360	8,338,015	10,758,658	236,005	183,202
Maine	52,485	24,575	113,586	72,975	1,193,546	903,476	6,335,357	1,952,109
Maryland	(2)	(2)	(2)	(2)	9,295,997	12,161,362	398,931	49,296
Massachusetts	15,025	5,259	491,372	359,696	9,074,759	8,407,970	506,184	518,359
Michigan	283,761	222,216	461,070	314,475	31,038,513	26,251,072	6,175,946	3,239,703
Minnesota	890,572	362,475	178,260	35,714	11,961,621	10,752,216	13,934,805	6,677,118
Mississippi	165,176	71,704	647,005	297,594	5,027,196	4,335,799	597,682	267,233
Missouri	128,177	71,470	142,735	100,952	8,288,077	8,796,411	1,631,157	1,191,439
Montana	390,608	286,463	307,003	142,608	2,007,536	1,914,640	11,764,073	4,700,686
Nebraska			45,678	56,917	7,848,317	5,958,896	556,880	233,901
Nevada			68	50	1,722,797	2,536,054	1,857,463	1,226,330
New Hampshire	(2)	(2)	16,210	4,392	1,362,396	1,366,677	1,069,750	225,903
New Jersey	(2)	(2)	56,007	67,261	10,674,327	16,194,482	478,225	229,935
New Mexico	185,603	187,584	(2)	(2)	1,448,450	1,569,982	3,107,997	4,434,572
New York	39,232	23,630	593,247	454,425	23,975,977	24,835,287	1,585,964	707,076
North Carolina	(2)	(2)	(2)	(2)	4,899,987	4,654,188	2,885,754	1,257,035
North Dakota	181,285	162,023	45,213	21,368	1,237,214	1,121,429	9,931,635	1,516,559
Ohio	395,183	316,664	1,724,411	1,747,417	27,728,060	31,880,818	177,987	114,397
Oklahoma			(2)	(2)	3,654,173	3,719,267	2,639,625	1,066,519
Oregon	176,814	160,415	520,751	422,444	6,859,431	7,431,468	5,094,447	4,400,876
Panama Canal Zone					35,910	47,229		
Pennsylvania	79,988	51,981	131,663	200,942	13,241,081	20,469,439	71,890	42,408
Puerto Rico			6,180	12,250	206,950	225,812	226,067	452,949
Rhode Island					1,103,300	1,106,853	837,438	391,699
South Carolina	(2)	(2)			3,097,367	2,668,402	29,585	8,652
South Dakota	(2)	(2)	(2)	(2)	2,750,233	1,381,254	10,787,568	8,715,574
Tennessee	(2)	(2)	260,000	260,000	4,653,782	5,703,543	482,761	110,573
Texas	569,713	316,838	1,622,828	753,306	24,973,270	26,303,453	6,544,853	2,176,897
Utah	106,018	33,020	4,267	4,054	2,897,498	2,172,820	2,260,767	1,136,460
Vermont			(2)	(2)	722,037	679,976	1,041,192	489,055
Virginia					6,294,445	7,968,391	166,441	107,713
Washington	628,039	216,404	1,095,667	535,576	9,950,839	8,625,285	11,694,322	10,725,397
West Virginia	(2)	(2)	122,139	164,540	5,171,399	9,779,288		
Wisconsin	984,750	465,116	410,598	319,903	15,127,821	12,398,099	12,850,514	7,560,351
Wyoming	201,708	47,339			1,051,316	811,110	2,900,803	3,166,567
Undistributed [2]	935,756	636,194	434,874	450,145				
Total	9,397,672	5,957,003	13,145,954	10,291,411	420,011,540	437,558,795	172,077,070	98,684,377

[2] Figures that may not be shown separately are combined as "Undistributed."
[10] Includes 3,872,985 tons of ballast gravel, valued at $1,845,863, produced by railroads for their own use.
[11] Includes 1,231,440 tons of gravel, valued at $482,010, used by railroads for fills and similar purposes.

Government-and-Contractor Production.—The changing pattern of activity was reflected by increased Government-and-contractor production; 29 percent in 1955 and 1954, 30 percent in 1953, and 31 percent in 1952. A graphical representation of the relative proportions of the total Government-and-contractor production for the past 20 years, compared with the commercial production, is depicted in figure 2. The value of Government-and-contractor production was $98.7 million at an average value of 57 cents per ton.

An outstanding development was the decreased direct production by Government construction and maintenance crews, as indicated by the 73 percent contributed by contractors in 1955, compared with 69 percent in 1954 and 65 percent in 1953.

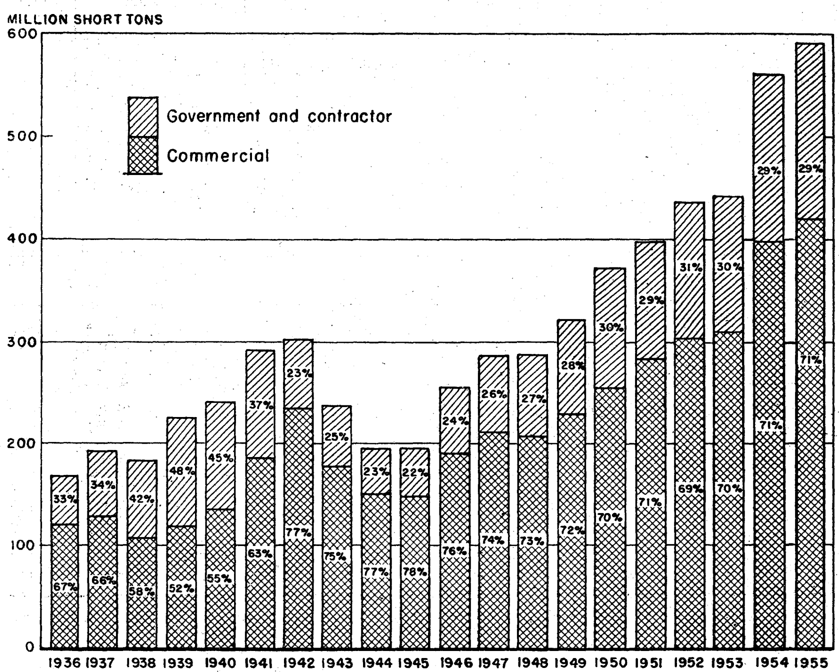

FIGURE 2.—Sand and gravel sold or used in the United States by producers, 1936–55.

TABLE 5.—Sand and gravel sold or used by Government-and-contractor producers in the United States,[1] 1946–50 (average) and 1951–55, 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)
1946–50 (average)	1,667	895	7,344	2,901	3,759	2,621	71,969	31,541	84,739	37,958
1951	1,869	2,001	12,564	4,776	7,665	6,906	92,717	39,854	114,815	53,537
1952	1,184	1,140	15,402	6,230	3,562	2,858	113,635	48,017	133,783	58,245
1953	1,078	1,197	13,925	5,926	9,044	5,937	107,456	49,575	131,503	62,635
1954	1,202	1,299	[2] 16,447	8,826	10,966	6,418	[2] 130,989	71,225	[2] 159,604	87,768
1955	1,758	1,975	22,833	11,099	15,045	7,994	132,441	77,616	172,077	98,684

[1] Includes United States Territories and possessions, and other areas administered by the United States.
[2] Revised figure.

TABLE 6.—Sand and gravel sold or used by Government-and-contractor producers in the United States,[1] 1946–50 (average) and 1951–55, by types of producer

Type of producer	1946–50 (average)		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	42,227	$0.33	41,637	$0.36	46,901	$0.35
Contractors	42,512	.56	73,178	.53	86,882	.48
Total	84,739	.44	114,815	.47	133,783	.44
States	43,829	.48	60,387	.43	68,928	.44
Counties	31,377	.32	34,249	.37	39,107	.37
Municipalities	1,819	.44	2,159	.47	2,068	.52
Federal agencies	7,714	.77	18,020	.77	23,680	.53
Total	84,739	.44	114,815	.47	133,783	.44

Type of producer	1953		1954		1955	
	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	46,250	$0.38	49,232	$0.37	46,483	$0.40
Contractors	85,253	.53	[2] 110,372	[2] .63	125,594	.64
Total	131,503	.48	[2] 159,604	[2] .55	172,077	.57
States	71,199	.49	[2] 95,420	[2] .57	101,842	.57
Counties	39,954	.38	43,378	.42	41,444	.45
Municipalities	2,720	.46	3,920	.42	2,761	.50
Federal agencies	17,630	.64	16,886	.81	26,030	.79
Total	131,503	.48	[2] 159,604	[2] .55	172,077	.57

[1] Includes United States Territories and possessions, and other areas administered by the United States.
[2] Revised figure.

States reported 59 percent of the Government-and-contractor production in 1955; counties, 24 percent; Federal agencies, 15 percent; and municipalities, 2 percent.

Degree of Preparation.—Owing to specific requirements and refinements in technology, the quantity of prepared sand and gravel continued to increase in relation to other types of sand and gravel. Washed, screened, and otherwise prepared, this product comprised 88 percent (370 million short tons) of commercial output; its average value was $1.11 per ton, compared with 57 cents for unprepared commercial bank-run material. Most prepared material was furnished by commercial producers, which was the principal reason for the higher unit value reported for them. Only 47 percent of Government-and-contractor production was prepared; its average value was 81 cents per ton. Where binding quality of unwashed

TABLE 7.—Sand and gravel sold or used by producers in the United States,[1] 1954–55, by classes of operation and degrees of preparation

	1954			1955		
	Quantity		Average value per ton	Quantity		Average value per ton
	Short tons	Percent		Short tons	Percent	
Commercial operations:						
Prepared	352,208,376	89	$1.11	370,198,251	88	$1.11
Unprepared	44,724,695	11	.58	49,813,289	12	.57
Total	396,933,071	100	1.05	420,011,540	100	1.04
Government-and-contractor operations:						
Prepared	[2] 85,615,154	[2] 54	[2] .75	81,664,919	47	.81
Unprepared	73,988,280	[2] 46	.33	90,412,151	53	.36
Total	[2] 159,603,434	100	[2] .55	172,077,070	100	.57
Grand total	[2] 556,536,505	----------	[2] .91	592,088,610	----------	.91

[1] Includes United States Territories and possessions, and other areas administered by the United States.
[2] Revised figure.

TABLE 8.—Comparison of number and production of commercial sand and gravel plants in the United States, 1954–55, by size groups [1]

Size group, in short tons annual production	1954				1955			
	Plants [2]		Production		Plants [2]		Production	
	Number	Percent of total	Thousand short tons	Percent of total	Number	Percent of total	Thousand short tons	Percent of total
Less than 25,000	1,692	40.7	16,618	4.2	1,749	41.6	17,572	4.2
25,000 to less than 50,000	737	17.7	26,445	6.7	697	16.6	25,225	6.1
50,000 to less than 100,000	709	17 1	50,829	12.9	707	16.8	50,278	12.1
100,000 to less than 200,000	511	12.3	72,062	18.4	529	12.6	75,351	18.2
200,000 to less than 300,000	210	5.1	52,097	13.3	201	4.8	49,346	11.9
300,000 to less than 400,000	111	2.7	38,104	9.7	107	2.5	36,620	8.8
400,000 to less than 500,000	62	1.5	27,991	7.1	69	1.6	31,561	7.6
500,000 to less than 600,000	34	.8	18,343	4.7	46	1.1	25,274	6.1
600,000 to less than 700,000	35	.8	22,597	5.8	33	.8	21,337	5.2
700,000 to less than 800,000	15	.4	11,186	2.8	18	.4	13,415	3.2
800,000 to less than 900,000	12	.3	10,160	2.6	10	.2	8,544	2.1
900,000 to less than 1,000,000	2	(3)	1,878	.5	7	.2	6,560	1.6
1,000,000 and over	26	.6	44,379	11.3	33	.8	53,385	12.9
Total	4,156	100.0	392,689	100.0	4,206	100.0	414,468	100.0

[1] Excludes operations by or for States, counties, municipalities, and Federal Government agencies as follows—1954: 1,503 operations with an output of 159,603,434 (revised) tons of sand and gravel; 1955: 1,440 operations, 172,077,070 tons. Excludes operations by or for railroads as follows—1954: 93 operations with an output of 4,243,955 tons of sand and gravel; 1955: 107 operations, 5,543,256 tons. Includes United States Territories and possessions, and other areas administered by the United States.
[2] Includes a few companies operating more than 1 plant but not submitting separate returns for individual plants.
[3] Less than 0.05 percent.

TABLE 9.—Sand and gravel sold or used in the United States,[1] 1953–55, by method of transportation

	1953		1954		1955	
	Thousand short tons	Percent of total	Thousand short tons	Percent of total	Thousand short tons	Percent of total
Commercial:						
Truck	189,733	43	269,888	48	284,825	48
Rail	74,612	17	77,845	14	85,001	14
Waterway	27,416	6	25,437	5	23,679	4
Unspecified	17,135	4	23,763	4	26,507	5
Total commercial	308,896	70	396,933	71	420,012	71
Government-and-contractor: Truck [2]	131,503	30	[3] 159,604	29	172,077	29
Grand total	440,399	100	[3] 556,537	100	592,089	100

[1] Includes United States Territories and possessions, and other areas administered by the United States.
[2] Entire output of Government-and-contractor operations assumed to be moved by truck.
[3] Revised figure.

material was desirable in road construction, bank-run material was of definite use; its value was reported at 36 cents per ton.

Size of Plants.—In 1955 it became increasingly necessary to improve efficiency to combat high labor and supply costs. The average annual output for commercial operations (except railroads) in 1955 totaled 99,000 tons, compared with 94,000 tons in 1954. The number of plants producing over 500,000 tons increased from 124 in 1954 to 147 in 1955. The 0.8 percent reporting over 1 million tons per year furnished 13 percent of the output. The average plant remained small.

Methods of Transportation.—Transportation costs and expanding markets forced the sand and gravel industry throughout the country to develop new facilities. Demand increased for trucks with larger capacities. Moreover, as sand and gravel became scarcer, haulage distances increased. Portable equipment at small, localized deposits was utilized, thus reducing transportation costs.

Trucks hauled 77 percent of all shipments from plants, the same as in the previous year. Rail haulage remained constant at 14 percent. Small percentages were shipped by waterway; this method dominated in some areas.

Employment and Productivity.—Emphasis on reduction of manpower increased in 1955; more and more plants installed automatic equipment.

In the sand and gravel industry in 1955, 31,000 men were employed, dropping nearly a thousand compared with 1954. The average number of days worked decreased. The average number of hours per man per day increased slightly, compared with the previous year, and the output per man per shift increased from 46 tons to 51. The leading average production per hour was reported from the Michigan-Wisconsin area; the California and Nevada area employed the most men.

TABLE 10.—Employment in the commercial sand and gravel industry and average output per man in the United States, 1946–50 (average) and 1951–55, by regions [1]

	Employment					Production (short tons)	Average output per man		Percent of commercial industry represented
	Average number of men	Time employed					Per shift	Per hour	
		Average number of days	Total man shifts	Man-hours					
				Average man per day	Total				
1946–50 (average)	21, 756	240	5, 224, 832	8. 7	45, 403, 576	195, 130, 097	37. 3	4. 3	86. 6
1951	24, 375	241	5, 883, 607	8. 7	51, 367, 929	258, 335, 982	43. 9	5. 0	90. 4
1952	25, 755	239	6, 144, 421	8. 7	53, 645, 827	280, 506, 731	45. 7	5. 2	93. 0
1953	24, 663	240	5, 907, 199	8. 6	51, 004, 252	278, 744, 705	47. 2	5. 5	90. 3
1954									
Maine, N. H., Vt., R. I., Mass., and Conn.	1, 478	210	310, 490	8. 4	2, 596, 090	14, 442, 445	46. 5	5. 6	91. 5
N. Y.	1, 715	243	416, 165	8. 7	3, 639, 787	27, 726, 821	66. 6	7. 6	99. 6
Pa., N. J., and Del.	1, 929	302	583, 422	7. 4	4, 320, 027	22, 596, 074	38. 7	5. 2	96. 9
W. Va., Va., and Md.	1, 895	260	493, 376	9. 2	4, 521, 615	18, 593, 131	37. 7	4. 1	98. 4
S. C., Ga., Ala., Fla., and Miss.	1, 754	259	453, 962	9. 6	4, 342, 183	17, 405, 231	38. 3	4. 0	98. 7
N. C., Ky., and Tenn.	1, 537	266	408, 944	8. 7	3, 575, 996	12, 812, 430	31. 3	3. 6	96. 4
Ark., La., and Texas	3, 626	282	1, 021, 136	8. 8	8, 992, 130	33, 732, 692	33. 0	3. 8	96. 7
Ohio	2, 158	242	521, 532	8. 8	4, 614, 093	25, 207, 948	48. 3	5. 5	98. 6
Ill. and Ind.	2, 706	260	704, 157	8. 5	5, 960, 128	33, 774, 479	48. 0	5. 7	93. 2
Mich. and Wis.	2, 556	233	596, 747	8. 8	5, 260, 041	33, 751, 582	56. 6	6. 4	86. 9
N. Dak., S. Dak., and Minn.	1, 061	202	214, 167	9. 3	1, 988, 518	10, 684, 680	49. 9	5. 4	74. 8
Nebr. and Iowa	1, 137	243	276, 770	9. 4	2, 600, 406	11, 895, 493	43. 0	4. 6	73. 1
Kans., Mo., and Okla.	1, 899	251	476, 346	8. 6	4, 095, 582	20, 115, 285	42. 2	4. 9	98. 6
Wyo., Colo., N. Mex., Utah, and Ariz.	1, 212	249	302, 006	8. 3	2, 500, 994	9, 214, 271	30. 5	3. 7	65. 9
Calif. and Nev.	3, 086	245	756, 958	8. 4	6, 359, 775	50, 261, 252	66. 4	7. 9	99. 0
Mont., Wash., Oreg., and Idaho	2, 039	220	447, 604	7. 9	3, 520, 141	21, 754, 334	48. 6	6. 2	89. 1
Alaska, Hawaii, and Puerto Rico	103	194	19, 961	8. 0	159, 688	679, 001	34. 0	4. 3	67. 3
Total	31, 891	251	8, 003, 743	8. 6	69, 047, 194	364, 647, 149	45. 6	5. 3	91. 9
1955									
Maine, N. H., Vt., R. I., Mass., and Conn.	1, 385	209	289, 962	8. 7	2, 531, 997	13, 606, 298	46. 9	5. 4	78. 5
N. Y.	1, 268	210	265, 827	9. 4	2, 495, 828	19, 426, 970	73. 1	7. 8	81. 0
Pa., N. J., and Del.	2, 065	251	518, 949	8. 5	4, 402, 903	22, 821, 338	44. 0	5. 2	91. 1
W. Va., Va., and Md.	1, 572	262	412, 480	9. 1	3, 749, 464	16, 303, 537	39. 5	4. 3	78. 5
S. C., Ga., Ala., Fla., and Miss.	1, 599	260	416, 218	9. 2	3, 815, 745	18, 963, 614	45. 6	5. 0	99. 4
N. C., Ky., and Tenn.	1, 423	252	358, 318	9. 3	3, 328, 190	13, 865, 781	38. 7	4. 2	96. 9
Ark., La., and Texas	3, 676	271	995, 950	9. 2	9, 130, 545	37, 300, 468	37. 5	4. 1	93. 2
Ohio	2, 049	233	477, 540	9. 2	4, 403, 708	26, 032, 807	54. 5	5. 9	93. 9
Ill. and Ind.	2, 239	252	564, 550	8. 4	4, 753, 384	32, 727, 800	58. 0	6. 9	79. 3
Mich. and Wis.	2, 255	196	441, 999	9. 2	4, 065, 688	35, 336, 296	79. 9	8. 7	76. 5
N. Dak., S. Dak., and Minn.	1, 141	153	174, 375	9. 1	1, 583, 374	10, 948, 861	62. 8	6. 9	68. 6
Nebr. and Iowa	1, 043	212	221, 175	9. 4	2, 076, 670	12, 059, 357	54. 5	5. 8	74. 3
Kans., Mo., and Okla.	1, 806	252	455, 337	8. 7	3, 950, 542	20, 530, 063	45. 1	5. 2	98. 0
Wyo., Colo., N. Mex., Utah, and Ariz.	1, 141	242	276, 205	8. 3	2, 296, 243	11, 376, 837	41. 2	5. 0	81. 7
Calif. and Nev.	4, 235	219	927, 811	8. 3	7, 691, 462	53, 644, 041	57. 8	7. 0	97. 9
Mont., Wash., Oreg., and Idaho	1, 823	177	321, 969	8. 1	2, 622, 866	16, 930, 586	52. 6	6. 5	82. 3
Alaska, Hawaii, and Puerto Rico	193	130	25, 070	8. 1	204, 011	840, 529	33. 5	4. 1	46. 6
Total	30, 913	231	7, 143, 735	8. 8	63, 102, 620	362, 715, 183	50. 8	5. 7	86. 4

[1] Incomplete totals. Includes only companies reporting employment figures and does not include plants operated by or directly for States, counties, municipalities, and Federal Government agencies.

CONSUMPTION

Construction Uses, Including Ballast.—The demand for sand and gravel continued to increase in the construction industry in 1955. Paving uses comprised 55 percent of total production and increased slightly more than the 6-percent average rise for the industry. The accomplishments of the sand and gravel industry can be correlated with the record of the construction industry as shown in figure 3.

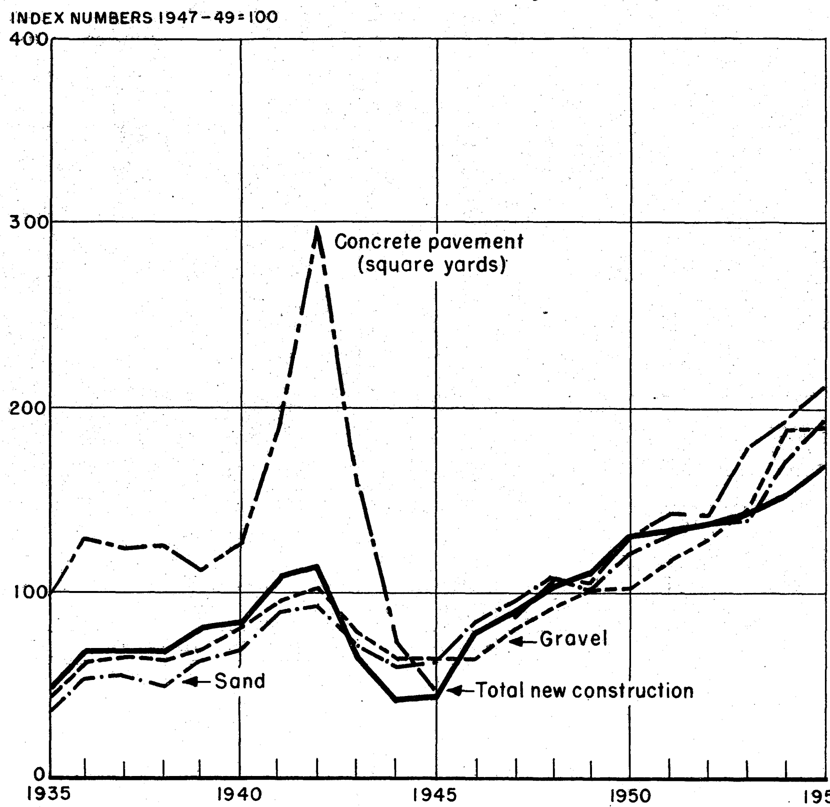

FIGURE 3.—Quantity of sand and gravel produced compared with total new construction, and total square yards of concrete pavements contracted for in the United States, 1935–55. Data on construction from Construction Review and on pavements from Survey of Current Business.

Industrial Sands.—The demand for silica as a raw material for industrial applications was considerable, rebounding from the 1954 decline. The market was strong for virtually all uses. Consumption in the glass industry continued to be high.

Silica sand of coarse grain and sphericity was useful to the petroleum industry in the Hydrafrac process of injecting grains into oil strata to increase recovery. The location of a sand deposit suitable for this application was a major factor in constructing a new plant near Ottawa, Minn.[3]

[3] Gutschick, Kenneth A., Producing Silica Sand for the Petroleum Industry: Rock Products, vol. 58, No. 12, December 1955, pp. 54–59.

New uses of silica sand were developing rapidly, offsetting some of the threat offered by plastics in many applications, such as the glass market. Perhaps the "remarkable silicones" will become more important tonnagewise, as more new products and uses are developed; the fields of application seem virtually unlimited.[4]

Industrial sands output totaled 18.6 million tons in 1955, an increase of nearly 17 percent over 1954. Molding and glass absorbed about three-fourths of the total industrial sands in 1955. Figure 4 illustrates the production of industrial sands since 1920.

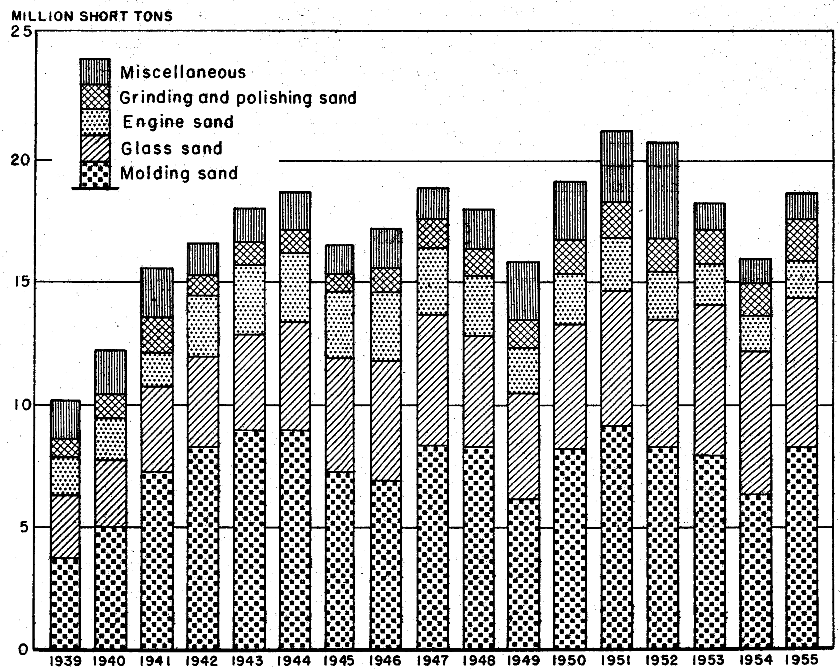

FIGURE 4.—Production of industrial sands in the United States, 1939–55.

Ground Sand.—Sales of ground sand in 1955 increased considerably over 1954, but the value per ton decreased. A breakdown of uses is shown in table 11.

Merchandising.—Competition was keen, particularly in the glass-sand industry, because the consumer could demand more rigid specifications.

Sand and gravel producers stressed examination of public relations, selling techniques, production, and labor problems as major steps to be taken to protect future business.[5]

---

[4] Rockwood, N. C., A Bright Future for Silica Silicones: Rock Products, vol. 58, No. 1, January 1955, pp. 69, 126.

[5] Rock Products, Sand and Gravel Producers Take Steps to Protect Future Business: Vol. 56, No. 3, March 1955, pp. 67–69.

TABLE 11.—Ground sand sold or used by producers in the United States, 1954–55, by uses

Use	1954			1955		
	Short tons	Value		Short tons	Value	
		Total	Average per ton		Total	Average per ton
Abrasives	182,046	$1,466,762	$8.06	209,729	$1,692,064	$8.07
Enamel	24,255	234,891	9.68	33,284	295,571	8.88
Filler	118,643	832,619	7.02	100,444	861,826	8.58
Filter purposes	(1)	(1)	(1)			
Foundry uses	123,645	1,083,819	8.77	344,316	1,873,250	5.44
Glass	(1)	(1)	(1)	221,299	1,140,542	5.15
Pottery, porcelain, and tile	147,256	1,209,410	8.21	209,299	1,975,873	9.44
Unspecified	115,890	1,189,035	10.26	91,692	550,870	6.01
Undistributed [1]	9,619	62,631	6.51			
Total	721,354	6,079,167	8.43	1,210,063	8,389,996	6.93

[1] Figures that may not be shown separately are combined as "Undistributed."

STOCKS

Stocks of sand and gravel are relatively small compared with output and substantially constant from year to year; therefore, production and sales are equivalent terms and are used interchangeably in this chapter.

PRICES

The unit value of sand and gravel remained virtually the same in 1955 as in 1954. Slight fluctuations in value were reported for the various use categories. The percentage of change for each class, with its average per ton value at the source, is shown in table 1.

FOREIGN TRADE [6]

Imports of sand and gravel in 1955, 13 percent greater than in 1954, represented less than 1 percent of domestic consumption. Approximately 99 percent of all imports represented construction materials from Canada. Virtually all material reported as glass sand was actually synthetically prepared silica from West Germany, which is not comparable with ordinary glass sand.

Sand and gravel was exported to 32 different countries and totaled 1,153,615 short tons, valued at $3,423,270.

TECHNOLOGY

Because a number of large projects were completed successfully, little doubt remained that commercial aggregate producers could satisfy the extra demand created by a nationwide superhighway construction program. Many States enlarged existing plants, erected temporary plants, or set up portable plants to retain their regular customers and supply the anticipated new requirements.

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

TABLE 12.—Sand and gravel imported for consumption in the United States, 1946–50 (average) and 1951–55, by classes

[U. S. Department of Commerce]

Year	Sand				Gravel		Total	
	Glass sand [1]		Other sand [2]					
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	10,081	$18,280	294,868	$264,890	126,317	$41,026	431,266	$324,196
1951	[3] 6,260	[3] 91,424	319,584	317,205	149,766	31,189	475,610	439,818
1952	[3] 4,016	[3] 23,998	300,182	344,674	104,332	13,771	408,530	382,443
1953	[3] 5,690	[3] 114,000	313,176	329,612	87,028	9,699	405,894	453,311
1954	[3] 10,329	[3] 93,441	271,364	[4] 298,427	2,387	[4] 1,685	284,080	[4] 393,553
1955	[3] 170	[3] 171,973	317,947	[4] 384,637	1,680	[4] 100	319,797	[4] 556,710

[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: 1946–47: "Sand, n. s. p. f."; 1948–53: "Sand, n. s. p. f., crude or manufactured."
[3] Includes 53 short tons valued at $80,847 in 1951; 11 short tons valued at $18,603 in 1952; 89 short tons valued at $106,478 in 1953; 74 short tons valued at $79,095 in 1954 and 167 short tons valued at $171,555 in 1955 imported from West Germany and consisting of synthetically prepared silica and not actually glass sand.
[4] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to years before 1954.

A Michigan gravel plant exemplified the trend toward diversity of operations by not only furnishing sand and gravel but ready-mixed concrete and bituminous aggregates as well.[7]

As the result of more complex specifications, some sand and gravel plants were forced into diversification to survive. A Kansas dredging company, through automation and more advanced technology, recovered undersize materials that had formerly been lost. Such companies learned to utilize virtually all sand and gravel by using a maze of screens, scalping tanks, gravity settlement, flumes, screw washers, and settlement ponds.[8]

An odd but efficient sand-dredging method pumped sand at a rate of 10,000 cubic yards daily from an artificial pool fed by ground water. The material was moved through a pipeline 6,000 feet long for a 3-million-cubic-yard airfield-runway-extension project.[9]

The production of concrete sand was so highly competitive in the Denver area that one producer specialized in producing masonry and plaster sand, using simple, efficient equipment.[10]

On the other hand, some company flowsheets were very complex. Owing to certain advantages and profits in furnishing both prepared and bank-run sand and gravel, a California company arranged its plant facilities to handle a variety of sizes of both washed and unwashed concrete and masonry sands and crushed and uncrushed gravels. Bank-run sands are, in some instances, preferable because a controlled quantity of clay has certain stability factors.[11]

[7] Trauffer, Walter E., Michigan Gravel Plant Supplies Both Ohio and Indiana Turnpikes: Pit and Quarry, vol. 48, No. 3, September 1955, pp. 133–134, 138, 152.
[8] Davis, Horace B., Modern Automation in Sand Production: Pit and Quarry, vol. 47, No. 9, March 1955, pp. 98–100.
[9] Roads and Streets, "Dredge in the Cornfield" Cuts Costs of Runway Extension: Vol. 98, No. 4, April 1955, pp. 72–75.
[10] Rock Products, Small Masons Sand Producer Has Simple, Efficient, Compact Plant: Vol. 58, No. 6, June 1955, p. 82.
[11] Lenhart, Walter B., Dual Function Sand-Gravel Plant: Rock Products, vol. 58, No. 5, May 1955, pp. 50–51, 57.

An Arizona plant demonstrated the growing complexity of the sand and gravel industry by using a hydraulic sand sizer, a liquid cyclone, and four spirals to recover fines; a rod mill was used in manufacturing more fine sand for concrete, masonry, and engine sands. In addition, a so-called dry plant produced 100-percent crushed products. This plant joined the recent trend toward centrally controlled operations.[12]

The well-designed and efficient sand-recovery system of a Texas company employed modern production techniques and automatic equipment, offering a complete line of aggregates to meet specifications for every concrete, masonry, and plaster requirement.[13]

In California, extremely impure material was processed by a complicated method, which included the use of an 8-cell Wemco attrition machine, originally developed to scour silica sand for glass manufacture—believed to be the first such machine in a commercial sand and gravel plant.[14]

Many sand and gravel plants, especially along the eastern coastal areas, have much difficulty removing clay. One producer in South Carolina used handpicking, scrubbing, blade mills, screw classifiers, and liquid cyclones to produce a material that would meet rigid specifications. The main problem in most clay-removing procedures was the loss of much fine sand carried off with the clay. The larger volume of water complicated the retention of the minus 50- and 100-mesh sand while discarding minus 200-mesh material, which is mostly clay. For each 100 tons of raw material, 1,000 gallons per minute of water was usually required.[15]

Flexibility became a necessity for an aggregate plant in the Pacific Northwest in producing aggregate to meet the requirements of a Corps of Engineers gigantic dam project. A Wemco hydroseparator was required to recover fines; rod mills made up the deficiency in certain finer sizes.[16]

Deleterious materials were removed successfully by heavy-medium separation in a number of plants to produce salable concrete or bituminous aggregates. A Michigan contractor successfully produced an aggregate at a 100-tons-per-hour installation.[17]

Patents were issued for a nonblinding screen,[18] a vibrating screen,[19] a modified apparatus commonly called a sand cone,[20] and a gravity-separation apparatus.[21]

A paper was presented before the National Sand and Gravel Association on the application of jigs for removing deleterious materials.[22]

Three 8-inch suction pumps dredged material to supply two unusually large liquid cyclones (34- and 72-inch), which produced clean,

---

[12] Lenhart, Walter B., Unique Sand Processing in Modern, Centrally Controlled Plant: Rock Products, vol. 58, No. 6, June 1955, pp. 70–74.

[13] Rock Products, Efficient Sand-Recovery System: Vol. 58, No. 10, October 1955, pp. 71, 102.

[14] Utley, Harry F., Black Point Aggregates, Inc. A Profitable Venture: Pit and Quarry, vol. 47, No. 10, April 1955, pp. 116–117.

[15] Trauffer, Walter E., South Carolina Gravel Plant Designed to Remove Clay and Save Fine Sand: Pit and Quarry, vol. 48, No. 3, September 1955, pp. 110–114.

[16] Rock Products, Flexible Plant Set-Up to Meet Specifications for Dalles Dam: Vol. 58, No. 7, July 1955, pp. 46–49, 52.

[17] Pit and Quarry, Gravel Producer Adds Heavy Media Separation: Vol. 48, No. 3, September 1955, pp. 125–126, 128.

[18] Bixby, Kenneth R., Non-blinding Screen: U. S. Patent 2,722,314, Nov. 1, 1955.

[19] Gisler, Henry J., and Jelks, James W., Vibrating Screen: U. S. Patent 2,723,032, Nov. 8, 1955.

[20] Drigenko, Constantine, and Phipps, John B., Classifying Apparatus for Sand Commonly Called Sand Cones: U. S. Patent 2,723,030, Nov. 8, 1955.

[21] Roller, Wilfred L., Gravity-Separation Apparatus: U. S. Patent 2,720,971, Oct. 18, 1955.

[22] Rock Products, Removing Deleterious Particles: Vol. 58, No. 3, March 1955, pp. 87–88.

graded, and blended products at a plant near Gaillard, Ga., 100 miles south of Atlanta.[23]

At a Pennsylvania glass sand plant, fine silica, discarded with tailings, was recovered by cleaning waste water for storage in a water-supply pond. Removal prevented accumulation of solids in the pond and was accomplished by a wet-cyclone process.[24]

Treatment of silica sand occasionally rivals that of more costly products in the complexity of the flowsheet used. One California company began flotation and other highly refined methods usually reserved for preparing higher priced minerals.[25]

Actually, research on purifying sand by flotation has been in progress for about twenty years, but only recently have sands, especially iron-stained ones, been separated successfully. Means of preparation and the use of proper reagents have been described.[26]

A California company found that recoveries of silica sand by flotation had been poor because the sand surfaces were dirty or iron-stained. Attrition by a modified scrubbing machine before flotation increased recovery from 60 to 90 percent.[27]

Success in the sand and gravel industry sometimes requires inventiveness, courage, and tenacity. After experimentation with various flowsheets, a Denver company tailored its plant to fit existing needs in spite of what would have appeared to be insurmountable obstacles. The difficulties were solved in the following stages: the use of rotary sand screens prevented the plugging or blinding formerly encountered on the vibrating screens because of the angularity of the particles; utilization of a ball mill to produce fines for use in concrete resulted in marketing a concrete product of superior quality; the 54-inch Gyradisc crusher, after much testing and investigation, also produced fines of salable quality from the 25 to 30-percent of material previously wasted; an installation of a loose-weave construction screen eliminated the use of rotary sand screens at this stage, allowed considerable flexing, and virtually stopped screen-blinding. A floating plant in process of construction was expected to include the above processing methods.[28]

A noteworthy trend was the transition of producers of other construction materials into the sand and gravel industry. An example was a California company that formerly dealt in lumber, millwork, and building supplies, now produced and distributed aggregates, ready-mixed concrete, and asphaltic mixtures.[29]

A new Illinois plant began production from a deposit of limestone gravel of glacial origin. Ball mills and classifiers provided accurately controlled gradations.[30] Another producer who had a shortage of fines solved the problem by crushing the coarse gravels.[31]

[23] Lenhart, Walter B., Liquid Cyclones Recover Fine Sand: Rock Products, vol. 58, No. 4, April 1955, pp. 70–72, 132.

[24] Rock Products, Recover Fine Sand From Waste Water: Vol. 58, No. 3, March 1955, p. 101.

[25] Pit and Quarry, Wet Cyclones, Circular Screens Process California Silica Sand: Vol. 47, No. 10, April 1955, pp. 128–130.

Rock Products, Make Glass Sand by Removing Clay With Screens, Scrubber & Cyclones: Vol. 58, No. 10, September 1955, pp. 48–50.

[26] Messner, William E., Scrubbing Solves Sand Flotation Problem: Min. Eng., vol. 7, No. 2, February 1955, pp. 138–139.

[27] Mining Magazine, Ore-Dressing Notes: Vol. 93, No. 5, November 1955, pp. 278–279.

[28] Trauffer, Walter E., Cooley's New South Denver Plant Tailored to Fit Existing Needs: Pit and Quarry, vol. 47, No. 10, April 1955, pp. 78–83, 134.

[29] Utley, Harry F., Transition at Southern Pacific Milling Co.: Pit and Quarry, vol. 47, No. 7, January 1955, pp. 152–154.

[30] Herod, Buren C., New Material Service Plant Opened at Algonquin, Illinois: Pit and Quarry, vol. 48, No. 5, November 1955, pp. 71–72, 74–75.

[31] Utley, Harry F., Producer Manufactures Sand to Overcome Fines Deficiency: Pit and Quarry, vol. 48, No. 5, September 1955, pp. 79–80.

Although many dredges have worked gravel deposits for the gold content in the West, few have produced gravel for commercial purposes. A fully engineered suction dredge operating in California and a "Doodle-bug" dredge in Colorado that utilized a shore-operated dragline were exceptions.[32]

In new construction and in remodeling, the trend was toward plants of solid steel construction and fully automatic handling of the sand and gravel.[33]

Automation at an Ohio gravel plant increased plant efficiency while drastically reducing maintenance and manpower requirements.[34]

The trend in some areas was toward small, compact, efficient sand and gravel plants that could be worked by two men. A pilot plant of this type was built in California to demonstrate a new type of roll crusher that was an important part of the equipment.[35]

Notable progress in the efficiency and versatility of portable sand and gravel plants has made possible favorable competition with stationary plants; one Montana portable plant proved more economical. Portable plants were used in support of permanent plants, lengthening the life of the permanent plant. Some of the advantages of portable plants were: The transportation savings attendant upon production at the deposit site (sometimes amounting to more than the value of the material itself); improved efficiency and greater versatility in methods and equipment; and greater adaptability for use in diverse areas for small scattered deposits.[36]

An article discusses the various uses of silica and outlined the range of future applications.[37]

Sand definitions from the foundryman's point of view are given in an article.[38] The applications of silica sand, as well as other forms of silica in foundries, were described.

The important field of silicones, which are finding wide application, was covered by a book on the subject.[39]

Various colleges, Federal, and State agencies became more acutely aware of the growing importance of silica sands. In some States, research on industrial application of localized silica sand deposits was prompted chiefly by the heavy transportation costs from distant sources.[40]

---

[32] Rock Products, Hydraulic Dredging in California for Sand and Gravel: Vol. 58, No. 9, September 1955, p. 45.

[33] Pit and Quarry, Fort Worth Sand and Gravel Company Builds Fully Automatic Plant: Vol. 48, No. 4, October 1955, pp. 108-109, 114.

[34] Pit and Quarry, Pushbutton Operation Reduces Manpower and Maintenance for Ohio aggregate producer: Vol. 48, No. 4, October 1955, pp. 106-107.

[35] Lenhart, Walter B., Sand-Gravel Plant Serves as Laboratory for Crusher Tests: Rock Products, vol. 58, No. 9, September 1955, pp. 96, 98.

[36] Pit and Quarry, Contractor Becomes Gravel Producer with Unique Portable-Stationary Plant: Vol. 47, No. 10, April 1955, pp. 142-143; Portable Gravel Plant Economically Produces 60,000-Ton Maintenance Stockpile in Montana: Vol. 47, No. 7, January 1955, pp. 155-156.

[37] Edwards, F. J., Future of Quartz and Silica: Jour. Soc. Glass Technol., vol 39, No. 186, February 1955, pp. 58-60.

[38] Sanders, C. A. and Myers, O. J., What Is Silica Sand: American Foundryman, vol. 26, No. 6, December 1954, pp. 56-59.

[39] McGregor, Rob Roy, Silicones and Their Uses: McGraw-Hill Book Co., 330 W. 42nd St., New York 36, N. Y. 352 pp.

[40] Lowery, W. D., Silica Sand Resources of West Virginia: Virginia Polytechnic Institute, Engineering Experiment Station Series No. 96, October 1954, 63 pp.
McMaster, R. C., Petrography and Genesis of New Jersey Beach Soils: New Jersey Dept. of Conservation and Economic Development, Geological Series No. 63, 1954, 239 pp.
Murphy, T. D., Silica Resources of Clark County, Nevada: Nevada Bureau of Mines Bull. No. 55, 1954, 28 pp.

Secondary Metals—Nonferrous

By Archie J. McDermid [1] [2]

	Page		Page
Secondary aluminum	2	Secondary magnesium	18
Secondary antimony	6	Secondary nickel	19
Secondary copper and brass	7	Secondary tin	21
Secondary lead	14	Secondary zinc	23

RECOVERIES of all metals from nonferrous scrap were greater in 1955 than in 1954, chiefly because of the general upward trend in industrial activities that began in 1954 and continued throughout 1955. The tendency was definitely upward in all four of the major secondary metals—aluminum, copper, lead and zinc—but was less pronounced for zinc than for the other three metals. As usual, more copper than any other metal was recovered from nonferrous scrap in 1955, and the copper, tin, lead, zinc, and other metals recovered from copper scrap comprised over half of the total secondary nonferrous metal produced.

TABLE 1.—Salient statistics of nonferrous secondary metals recovered from scrap processed in continental United States, 1954–55, in short tons

Metal	From new scrap		From old scrap		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1954						
Aluminum	232,052	$94,213,112	59,989	$24,355,534	292,041	$118,568,646
Antimony	3,497	2,131,072	18,861	11,493,893	22,358	13,624,965
Copper	432,841	255,376,190	407,066	240,168,940	839,907	495,545,130
Lead	55,938	15,327,012	424,987	116,446,438	480,925	131,773,450
Magnesium	4,997	2,698,380	3,253	1,756,620	8,250	4,455,000
Nickel	3,995	5,024,112	4,610	5,797,536	8,605	10,821,648
Tin	10,281	18,877,972	19,053	34,985,119	29,334	53,863,091
Zinc	199,117	43,009,272	72,657	15,693,912	271,774	58,703,184
Total	----------	436,657,122	----------	450,697,992	----------	887,355,114
1955						
Aluminum	259,622	113,402,890	76,372	33,359,289	335,994	146,762,179
Antimony	3,256	2,093,608	20,446	13,146,778	23,702	15,240,386
Copper	474,419	353,916,574	514,585	383,880,410	989,004	737,796,984
Lead	52,865	15,753,770	449,186	133,857,428	502,051	149,611,198
Magnesium	5,693	3,404,414	4,553	2,722,694	10,246	6,127,108
Nickel	4,020	5,380,368	7,520	10,064,768	11,540	15,445,136
Tin	9,946	18,843,692	21,797	41,296,596	31,743	60,140,288
Zinc	221,226	54,421,596	83,549	20,553,054	304,775	74,974,650
Total	----------	567,216,912	----------	638,881,017	----------	1,206,097,929

[1] Commodity specialist.
[2] Figures on imports and exports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.

TABLE 2.—Secondary metals recovered as unalloyed metal, in alloys, and in chemical compounds in the United States, 1946–50 (average) and 1951–55, in short tons

	1946–50 (average)	1951	1952	1953	1954	1955
Aluminum	266,823	292,608	304,522	368,566	292,041	335,994
Antimony	20,723	23,943	23,089	22,360	22,358	23,702
Copper	885,691	932,282	908,197	958,464	839,907	989,004
Lead	459,857	518,110	471,294	486,737	480,925	502,051
Magnesium	7,522	11,526	11,477	11,930	8,250	10,246
Nickel	8,223	8,602	7,479	8,352	8,605	11,540
Tin	29,646	34,434	32,261	30,914	29,334	31,743
Zinc	299,991	314,377	310,423	294,678	271,774	304,775

TABLE 3.—Number and classification of plants in the United States reporting consumption of nonferrous scrap metals, refined copper, and copper-alloy ingots in 1955

Kind of plant	Type of materials used				
	Aluminum	Copper	Lead and tin	Zinc	All nonferrous types
Primary plants	(1)	[2] 12	5		
Secondary smelters	[3] 134	[4] 103	273	85	
Distillers				[5] 21	
Chemical plants	10	51		[6] 17	
Brass mills		61			
Wire mills		[7] 13			
Foundries and miscellaneous manufacturers	[8] 174	[9] 1,955	28	[10] 61	[11] 126
Total	318	2,195	306	184	126

[1] Data omitted, as primary producers report on a consolidated basis, making it difficult to determine the number of plants.
[2] Primary refineries that consumed copper-base scrap.
[3] Includes 129 aluminum-alloy ingotmakers and 5 military aluminum smelters.
[4] Includes 71 secondary copper smelters and 32 secondary smelters using copper materials in other than copper alloys.
[5] Includes 14 secondary plants and 7 primary producers that used scrap in addition to ore; includes producers of zinc dust and redistilled slab zinc.
[6] Includes 2 primary producers and 15 secondary chemical plants, some of which were producers of zinc oxide by roasting processes.
[7] Refers to companies operating wire mills; some companies operate more than 1 plant.
[8] Foundries using aluminum scrap in nonferrous castings.
[9] Includes 1,492 brass foundries and 463 miscellaneous manufacturers.
[10] Includes foundries, galvanizers, die casters, and zinc rolling mills.
[11] Foundries and miscellaneous manufacturers reporting use of nonferrous scrap other than copper or aluminum; excludes small plants canvassed only at 5-year intervals and plants included in other columns.

Monthly recovery of secondary copper in 1955 fluctuated more than that of other secondary metals owing to variations in prices paid for refined copper and copper scrap, but over a longer period fluctuation in secondary aluminum was greatest. In the 10-year period 1946–55 the recovery of secondary aluminum had a greater average annual percentage change (23) than any of the other 3 major nonferrous metals; copper was next with 15 percent, then zinc (12), then lead (10).

Consumption of scrap of all nonferrous metals except tin increased in 1955. The domestic supply of aluminum and copper scrap was inadequate in 1955, as in 1954, but was increased to some extent by establishment of export quotas on February 10, 1955, by the United States Department of Commerce. Exports of copper and brass scrap totaled 76,000 tons in 1955 compared with 170,000 in 1954. Corresponding figures for aluminum scrap were 18,000 and 39,000 tons.

Lead scrap and zinc scrap were in better supply than aluminum scrap and copper scrap; prices of all four rose during 1955. A factor that tended to increase the availability of new scrap was the increased consumption of the major nonferrous refined metals, which indicated increased generation of process scrap. The higher industrial activity in 1955 also affected old-scrap generation through increased wear of equipment. The consumption of old scrap of most metals increased more than consumption of new scrap.

Classification of secondary-metal operations and definition of terms used in this chapter are explained in Minerals Yearbook, 1954, volume I, Secondary Metals—Nonferrous chapter.

SECONDARY ALUMINUM[3]

Domestic recovery of secondary aluminum from all types of scrap in 1955 totaled 336,000 short tons valued at $147 million, a 15-percent increase in quantity from the 292,000 tons valued at $119 million recovered in 1954.

Secondary recovery was greater in 1955 than in 1954, because aluminum scrap was more plentiful and because business activity was at a higher level. Establishment of export quotas for scrap in 1955 increased its availability for domestic consumers. Exports totaled 18,000 tons in 1955 compared with 39,000 tons in 1954, whereas imports of aluminum scrap were 41,000 tons in 1955 and 15,000 in 1954. According to data published by the Bureau of the Census, shipments of aluminum castings and mill products increased in 1955, following a decline in 1954, indicating greater activity in the aluminum industry in general in 1955.

TABLE 4.—Aluminum recovered from scrap processed in the United States, by kind of scrap and form of recovery, 1954–55, in short tons

Kind of scrap	1954	1955	Form of recovery	1954	1955
New scrap:					
Aluminum-base [1]	231,418	258,872	As metal	5,752	9,023
Copper-base	104	93	Aluminum alloys	280,932	323,468
Zinc-base	285	367	In brass and bronze	264	231
Magnesium-base	245	290	In zinc-base alloys	1,450	762
			In magnesium alloys	48	484
Total	232,052	259,622	In chemical compounds	3,595	2,026
Old scrap:			Grand total	292,041	335,994
Aluminum-base [2]	59,316	75,474			
Copper-base	92	117			
Zinc-base	340	428			
Magnesium-base	241	353			
Total	59,989	76,372			
Grand total	292,041	335,994			

[1] Aluminum alloys recovered from new aluminum-base scrap, including all constituents, totaled 277,787 tons in 1955 and 246,609 tons in 1954.

[2] Aluminum alloys recovered from old aluminum-base scrap, including all constituents, totaled 83,764 tons in 1955 and 66,438 tons in 1954.

[3] Assistance of Clarke I. Wampler is acknowledged.

Of the 334,000 tons of secondary aluminum recovered from aluminum scrap only in 1955, 259,000 tons was salvaged from new scrap and 75,000 tons (22 percent) from old scrap. In comparison, 52 percent of the secondary copper recovered from copper scrap was reclaimed from old scrap.

Of the 362,000 tons of metal recovered from aluminum scrap in 1955, 92 percent was aluminum, the other 8 percent being chiefly copper, magnesium, nickel, zinc, and silicon. Comparable metal content figures for copper, lead, and zinc scrap are 83, 93, and 99 percent, respectively. No aluminum was reported separated from its alloys as refined metal.

TABLE 5.—Production of secondary aluminum and aluminum-alloy products in the United States, 1952–55, gross weight in short tons

Product	1952	1953	1954	1955
Secondary aluminum ingot: [1]				
Pure (98.5 percent) Al	4,893	5,203	5,752	9,023
Aluminum-silicon (Cu, 0.6 percent)	15,372	21,647	16,714	22,826
Aluminum-silicon (Cu, 0.6 to 2.0 percent)	7,092	8,012	5,129	6,552
No. 12 and variations	20,665	17,963	16,454	19,582
Aluminum-copper alloys (Si max., 1.5 percent)	[2] 6,240	[2] 4,448	[2] 7,598	2,166
No. 319 and variations	37,055	34,369	27,427	33,517
AXS 679 and variations	61,839	74,646	67,330	106,465
Aluminum-silicon-copper-nickel alloys	15,474	17,316	20,466	29,574
Deoxidizing and other dissipative uses	43,398	43,682	27,487	36,596
Aluminum-base hardeners	6,485	8,387	7,374	10,045
Aluminum-magnesium alloys	1,019	675	849	1,295
Aluminum-zinc alloys	3,181	2,678	3,377	6,033
Miscellaneous	10,307	12,719	13,402	[2] 15,937
Total	233,020	251,745	219,359	299,611
Secondary aluminum recovered by primary producers and independent fabricators	73,392	111,106	83,973	79,119
Aluminum-alloy castings	7,811	12,907	12,094	17,481
Aluminum in chemicals	3,293	4,676	3,595	2,026

[1] Gross weight, including copper, silicon, and other alloying elements, at independent secondary smelters; total secondary aluminum and aluminum-alloy ingot contained 20,959 tons of primary aluminum in 1952, 19,528 tons in 1953, 12,139 tons in 1954, and 20,002 tons in 1955.

[2] Of the total, 1,031 tons was produced in 1952, 883 tons in 1953, 5,434 tons in 1954, and 4,192 tons in 1955 at Naval air stations and United States Air Force bases.

Production of secondary aluminum ingot by independent secondary smelters increased 37 percent to 300,000 tons in 1955. The alloy made in greatest quantity was AXS 679, output of which increased 58 percent to 106,000 tons. In making the 300,000 tons of secondary ingot 56,000 tons of primary aluminum and other alloying ingredients was used, in addition to aluminum scrap. The ingot produced by secondary smelters was chiefly casting ingot, used by foundries, and deoxidizing ingot and shot. Secondary aluminum reclaimed from scrap by primary-aluminum producers decreased 6 percent to 79,000 tons in 1955. Part of this was recovered in secondary-aluminum ingot at secondary smelters operated by primary producers, and part of it as the secondary-metal content of primary-aluminum ingot at primary plants. Both wrought alloys and casting alloys were produced at the latter plants.

Consumption of aluminum scrap totaled 427,000 tons in 1955, compared with 351,000 in 1954. In 1955, 25 percent was old scrap and in 1954, 23 percent.

All primary producers reported their aluminum operations in 1954 and 1955; quantitative coverage of aluminum-scrap operations by

TABLE 6.—Stocks and consumption of new and old aluminum scrap in the United States in 1955, 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 clips	609	22,558	19,060	3,321	22,381	786
Castings and forgings	850	30,474	5,260	24,977	30,237	1,087
Alloy sheet	3,198	81,192	66,259	14,491	80,750	3,640
Borings and turnings	2,603	83,529	83,869		83,869	2,263
Grindings and sawings	151	1,359	1,347		1,347	163
Dross and skimmings	989	26,154	25,544		25,544	1,599
Foil and wire	647	5,413	2,265	3,357	5,622	438
Utensils	497	9,408		9,246	9,246	659
Aircraft	153	14,593		14,442	14,442	304
Pistons	59	2,808		2,787	2,787	80
Irony aluminum	508	10,759		10,476	10,476	791
Miscellaneous	1,880	26,619	9,598	17,580	27,178	1,321
Total	12,144	314,866	213,202	100,677	313,879	13,131
Primary producers and fabricators:						
2S and 3S sheet and clips	552	15,513	15,394		15,394	671
Castings and forgings	48	325	119	233	352	21
Alloy sheet	1,652	45,080	45,549		45,549	1,183
Borings and turnings	224	3,344	3,145		3,145	423
Dross and skimmings		11				11
Foil and wire	425	4,237	3,051	1,079	4,130	532
Aircraft	66			66	66	
Miscellaneous	1,092	17,871	16,850	1,253	18,103	860
Total	4,059	86,381	84,108	2,631	86,739	3,701
Foundries and miscellaneous manufacturers:						
2S and 3S sheet and clips	288	6,124	5,299	16	5,315	1,097
Castings and forgings	265	5,479	4,385	1,128	5,513	231
Alloy sheet	46	4,626	4,536	56	4,592	80
Borings and turnings	332	3,039	3,046		3,046	325
Dross and skimmings	19	1,548	1,498		1,498	69
Foil and wire		1		1	1	
Utensils	64	165		224	224	5
Aircraft		10		9	9	1
Pistons	3	362		268	268	97
Miscellaneous	79	674	257	430	687	66
Total	1,096	22,028	19,021	2,132	21,153	1,971
Chemical plants:						
Castings and forgings	17	151		155	155	13
Dross and skimmings	1,108	4,936	4,984		4,984	1,060
Foil		94	35	14	49	45
Miscellaneous	38	100	86		86	52
Total	1,163	5,281	5,105	169	5,274	1,170
Grand total:						
2S and 3S sheet and clips	1,449	44,195	39,753	3,337	43,090	2,554
Castings and forgings	1,180	36,429	9,764	26,493	36,257	1,352
Alloy sheet	4,896	130,898	116,344	14,547	130,891	4,903
Borings and turnings	3,159	89,912	90,060		90,060	3,011
Grindings and sawings	151	1,359	1,347		1,347	163
Dross and skimmings	2,116	32,649	32,026		32,026	2,739
Foil and wire	1,072	9,745	5,351	4,451	9,802	1,015
Utensils	561	9,573		9,470	9,470	664
Aircraft	219	14,603		14,517	14,517	305
Pistons	62	3,170		3,055	3,055	177
Irony aluminum	508	10,759		10,476	10,476	791
Miscellaneous	3,089	45,264	26,791	19,263	46,054	2,299
Total	18,462	428,556	321,436	105,609	427,045	19,973

[1] Excludes secondary smelters owned by primary-aluminum companies.

foundries and independent secondary smelters is estimated at 80 percent for each of the 2 years.

The average price of virgin pig aluminum sold by producers in 1955 was 21.84 cents per pound compared with 20.30 cents in 1954.

TABLE 7.—Dealers' average monthly aluminum-scrap buying prices and consumers' alloy-ingot prices at New York in 1955, in cents per pound

[Metal Statistics, 1956]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
New aluminum clippings	14.79	16.33	18.25	18.25	16.82	16.43	16.75	18.72	19.51	19.50	19.50	20.36	17.93
Cast aluminum scrap	11.29	13.70	15.75	15.75	13.85	13.80	14.75	15.81	17.39	17.75	17.24	17.00	15.34
No. 12 aluminum-alloy ingot	22.89	26.74	29.75	29.21	26.79	26.25	26.97	29.97	30.71	30.91	30.39	31.34	28.49

SECONDARY ANTIMONY [4]

Recovery of secondary antimony in 1955 totaled 23,700 short tons, valued at $15,200,000, a 6-percent increase in quantity from the 22,400 tons valued at $13,600,000 recovered in 1954.

All this metal was recovered from lead- and tin-base scrap used in making lead- or tin-alloy products. Secondary smelters recovered 88 percent of the total in 1955, primary producers 6 percent, and foundries and manufacturers 6 percent. The last group included bearing foundries, can manufacturers, rolling mills, and detinners. The bearing foundries sweated babbitt from old railroad-car boxes and melted the bronze backs to make new bearings. The bronze contained a little antimony, rendering it unsuitable for anything but bearings. Up to 1 percent antimony can be tolerated in bronze used for this purpose.

The largest source of secondary antimony was battery-plate scrap. Smelters treated 398,600 tons of plate scrap in 1955, which yielded 59 percent of all antimony recovered. The next largest sources were type-metal scrap (16 percent) and common babbitt (12 percent).

TABLE 8.—Antimony recovered from scrap processed in the United States, by kind of scrap and form of recovery, 1954–55, in short tons

Kind of scrap	1954	1955	Form of recovery	1954	1955
New scrap:			In antimonial lead [1]	15,726	15,946
Lead-base	3,497	3,256	In other lead alloys	6,486	7,631
Tin-base			In tin-base alloys	146	125
Total	3,497	3,256	Grand total	22,358	23,702
Old scrap:					
Lead-base	18,741	20,362			
Tin-base	120	84			
Total	18,861	20,446			
Grand total	22,358	23,702			

[1] Includes 1,565 tons of antimony recovered in antimonial lead from secondary sources at primary plants in 1954 and 1,523 tons in 1955.

Although the antimony content of scrap used in lead and tin alloys increased 6 percent in 1955, primary antimony so used decreased 13 percent.

The average New York selling price for primary antimony in 1955 was 32.15 cents per pound compared with 30.47 cents in 1954.

[4] Assistance of Edith E. den Hartog is acknowledged.

Data on consumption of scrap, from which antimony was recovered, may be found in the tables on lead and tin scrap in the sections of this chapter devoted to those metals. Products in which antimony was recovered are included in the Secondary Lead section of the chapter.

SECONDARY COPPER AND BRASS [5]

Domestic recovery of copper in unalloyed and alloyed form from all classes of nonferrous scrap metal in 1955 totaled 989,000 short tons valued at $738 million, an 18-percent increase in quantity from the 1954 recovery of 840,000 tons valued at $496 million. The increased recovery was due partly to greater availability of scrap, brought about by establishment of export quotas on February 10, 1955, by the United States Department of Commerce. Exports of unalloyed copper and copper-alloy scrap totaled 76,000 tons in 1955 compared with 170,000 tons in 1954. The high prices for scrap, which varied with the refined-copper price, also aided materially in increasing the supply of scrap available for treatment. The distribution of scrap allowed all major groups to increase their recoveries, but the prices were such that total consumption of unalloyed copper scrap, especially old scrap, increased notably and use of low-grade scrap and residues decreased sharply.

Labor strikes hampered operations at a number of scrap-consuming plants of primary copper producers in the summer of 1955, and floods in August did much damage to a considerable number of brass mills in Connecticut.

TABLE 9.—Copper recovered from scrap processed in the United States, by kind of scrap and form of recovery, 1954–55, in short tons

Kind of scrap	1954	1955
New scrap:		
Copper-base	427,407	467,730
Aluminum-base	5,202	6,190
Nickel-base	197	453
Lead-base		
Zinc-base	35	46
Total	432,841	474,419
Old scrap:		
Copper-base	404,160	510,775
Aluminum-base	2,181	2,500
Nickel-base	655	1,236
Lead-base		6
Tin-base	69	48
Zinc-base	1	20
Total	407,066	514,585
Grand total	839,907	989,004

Form of recovery	1954	1955
As unalloyed copper:		
At primary plants	179,943	206,555
At other plants	32,298	40,373
Total	212,241	246,928
In brass and bronze	586,298	696,543
In alloy iron and steel	1,487	2,301
In aluminum alloys	21,386	26,934
In other alloys	440	400
In chemical compounds	18,055	15,898
Total	627,666	742,076
Grand total	839,907	989,004

Of the 989,000 tons of secondary copper recovered during the year, 979,000 tons came from copper scrap; the rest was a constituent of aluminum, nickel, and other nonferrous scrap. Recovery of all metals from copper scrap totaled 1,177,000 tons compared with 1,008,000 tons in 1954. Of the 1955 total, the brass mills recovered 469,000 tons in brass-mill products, secondary smelters 360,000 tons in brass ingot and refined copper, primary producers 214,000 tons (chiefly in refined copper), and foundries and other manufacturers the remaining

[5] Assistance of Gertrude N. Greenspoon and Ivy C. Roberts is acknowledged.

TABLE 10.—Copper recovered as refined copper, in alloys and in other forms, from copper-base scrap processed in the United States, 1954–55, in short tons

	From new scrap		From old scrap		Total	
	1954	1955	1954	1955	1954	1955
By secondary smelters	64,460	65,626	204,093	233,323	268,553	298,949
By primary copper producers	103,714	73,836	82,131	139,789	185,845	213,625
By brass mills	243,756	307,284	48,837	49,162	292,593	356,446
By foundries and manufacturers	13,644	19,171	61,477	82,760	75,121	101,931
By chemical plants	1,833	1,813	7,622	5,741	9,455	7,554
Total	427,407	467,730	404,160	510,775	831,567	978,505

TABLE 11.—Production of secondary copper and copper-alloy products in the United States, 1953–55, gross weight in short tons

Item produced from scrap	Gross weight produced		
	1953	1954	1955
Unalloyed copper products:			
Refined copper by primary producers	189,585	179,943	206,555
Refined copper by secondary smelters	21,355	26,482	29,762
Copper powder [1]	7,201	4,779	9,138
Copper castings	1,729	1,037	1,473
Total	[2] 219,870	212,241	246,928

Item produced from scrap	Nominal composition (percent)							
	Cu	Sn	Pb	Zn	Ni			
Brass and bronze ingots:								
Tin bronze	88	10		2		18,183	14,734	14,911
Leaded tin bronze	88	6	1.5	4.5		21,152	18,216	20,129
Leaded red brass	85	5	5	5		98,686	98,283	115,888
Leaded semired brass	81	3	7	9		60,322	62,584	69,844
High-leaded tin bronze	80	10	10			16,822	14,099	21,446
Do	84	6	8	2		17,207	16,946	16,928
Do	75	5	20			5,963	5,481	6,889
Leaded yellow brass	66	1	3	30		21,917	23,071	25,062
Nickel silver	58	2	7	18	14	3,728	2,996	3,230
Do	65	4	3	5	22			
Low brass	80			20		3,084	2,345	4,012
Conductor bronze	94	2	2	2		548	612	1,031
Manganese bronze	60Cu 40Zn, ±Mn, Al, etc.					18,157	14,079	13,840
Aluminum bronze	90Cu 10Al, ±Mn, Zn, Fe, etc.					5,115	4,298	5,137
Silicon bronze	92Cu +Si, ±Zn, Fe, Al, Mn					4,835	4,807	4,677
Copper-base hardeners and special alloys						9,708	9,248	12,884
Total [3]						305,427	291,799	335,908
Brass-mill products						[2] 495,227	393,301	470,780
Brass and bronze castings						111,824	84,222	105,670
Brass powder						1,160	1,125	1,715
Copper in chemical products						21,550	18,055	15,898
Grand total						1,155,058	1,000,743	1,176,899

[1] Includes black-copper shipments.
[2] Revised figures.
[3] Includes alloying ingredients.

134,000 tons (chiefly in brass and bronze castings). The recoverable copper content of old copper-base scrap consumed in 1955 increased 107,000 tons to 511,000 tons and was greater than copper recoverable from new scrap for the first time since 1949.

Primary producers were responsible for 58,000 of the 107,000-ton increase in copper recovered from old scrap in 1955. Their recovery from new scrap decreased, but their total recovery rose 28,000 tons to a total of 214,000 tons. In spite of August floods in Connecticut, total monthly output of all brass mills continued high throughout 1955. Their production of secondary metal in the latter half of 1955, although 11 percent less than in the first half, was 16 percent greater than in the latter half of 1954.

TABLE 12.—Composition of secondary copper-alloy production, 1953–55, gross weight in short tons

Year	Copper	Tin	Lead	Zinc	Nickel	Aluminum	Total
BRASS AND BRONZE-INGOT PRODUCTION [1]							
1953	241,150	10,076	13,905	39,780	441	75	305,427
1954	224,664	10,387	14,448	41,864	366	70	291,799
1955	259,384	16,670	21,481	37,896	411	66	335,908
SECONDARY-METAL CONTENT OF BRASS-MILL PRODUCTS							
1953	368,684	116	5,254	119,782	1,311	80	495,227
1954	294,493	125	3,105	93,947	1,576	55	393,301
1955	356,489	119	4,059	108,095	1,948	70	470,780
SECONDARY-METAL CONTENT OF BRASS AND BRONZE CASTINGS							
1953	83,039	5,221	17,505	5,919	60	80	111,824
1954	62,879	3,748	12,371	5,093	63	68	84,222
1955	81,168	4,857	13,005	6,413	62	165	105,670

[1] About 95 percent secondary metal and 5 percent primary metal.

The increasing trend in monthly consumption of copper scrap by major consumers, which began in the middle of 1954, continued in early 1955 and reached a peak in March at 109,000 tons. Consumption remained about that through June. After the usual July drop the upward trend was resumed until October, when the highest consumption of the year—115,000 tons—occurred. Scrap consumption declined in November and December but was still over 100,000 tons, as it had been in 6 other months of 1955. Highest reported monthly consumption in 1954 was 100,000 tons in December.

Total consumption of copper-base scrap increased 126,000 tons to 1,355,000 tons in 1955, whereas recovery of metal from copper-base scrap increased 176,000 tons to 1,177,000. The disproportionate increase in recovery was due chiefly to a 101,000-ton increase in treatment of high-grade unalloyed scrap, mostly in old scrap, and an 80,000-ton decline in consumption of low-grade scrap and residues, mostly in new scrap.

457676—58——63

Foundries reporting consumption of ingot in 1955 totaled 1,402, with an average of 205 tons each. Average consumption in 1954 and 1953 was 177 and 197 tons, respectively. Secondary-copper smelters' shipments of brass ingot in 1955 were 338,000 tons, virtually all of which (except the 9,000 tons accounted for by the mills, chemical plants, and exports) was shipped to the foundries. On this basis

TABLE 13.—Stocks and consumption of new and old copper scrap in the United States in 1955, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year	Receipts		Consumption				Stocks, end of year
		Purchased scrap	Machine shop scrap	Purchased scrap			Machine shop scrap	
				New	Old	Total		
Secondary smelters:								
No. 1 wire and heavy copper	3,072	42,364		3,403	39,019	42,422		3,014
No. 2 wire, mixed heavy, and light copper	3,990	41,416		2,476	38,979	41,455		3,951
Composition or red brass	4,555	112,166		41,059	71,529	112,588		4,133
Railroad-car boxes	628	1,021			1,484	1,484		165
Yellow brass	6,384	81,592		13,909	67,796	81,705		6,271
Cartridge cases	184	644		8	737	745		83
Auto radiators (unsweated)	2,373	51,627			50,826	50,826		3,174
Bronze	2,327	37,090		12,581	24,872	37,453		1,964
Nickel silver	560	2,987		315	2,576	2,891		656
Low brass	334	3,620		3,036	626	3,662		292
Aluminum bronze	189	265		45	321	366		88
Low-grade scrap and residues	4,781	39,714		22,459	14,888	37,347		7,148
Total	29,377	414,506		99,291	313,653	412,944		30,939
Primary producers:								
No. 1 wire and heavy copper	440	37,529		11,881	25,516	37,397		572
No. 2 wire, mixed heavy, and light copper	3,601	121,048		40,986	80,232	121,218		3,431
Refinery brass	1,033	40,529		8,780	20,874	29,654		11,908
Low-grade scrap and residues	14,231	156,032		53,649	76,351	130,000		40,263
Total	19,305	355,138		115,296	202,973	318,269		56,174
Brass mills: [1]								
No. 1 wire and heavy copper	4,078	97,223		80,677	16,546	97,223		6,080
No. 2 wire, mixed heavy, and light copper	1,341	30,838		28,636	2,202	30,838		3,002
Yellow brass	18,204	224,601		222,824	1,777	224,601		24,243
Cartridge cases	4,946	71,528		29,598	41,930	71,528		5,375
Bronze	1,212	1,656		1,584	72	1,656		700
Nickel silver	1,682	8,891		8,825	66	8,891		1,821
Low brass	2,829	25,724		25,356	368	25,724		3,514
Aluminum bronze	1,735	673		673		673		194
Mixed-alloy scrap	4,588	16,046		16,046		16,046		2,945
Total [1]	40,615	477,180		414,219	62,961	477,180		47,874
Foundries, chemical plants, and other manufacturers:								
No. 1 wire and heavy copper	1,609	18,830	232	8,192	10,519	18,711	202	1,758
No. 2 wire, mixed heavy, and light copper	1,420	14,236	597	6,534	7,448	13,982	555	1,716
Composition or red brass	4,071	10,364	12,416	2,388	8,981	11,369	11,600	3,882
Railroad-car boxes	5,033	65,226	2,785		66,921	66,921	2,815	3,308
Yellow brass	2,401	14,427	4,484	5,562	9,608	15,170	4,422	1,720
Auto radiators (unsweated)	16	3,368			3,278	3,278		106
Bronze	1,404	6,870	3,784	813	6,137	6,950	3,946	1,162
Nickel silver	11	39	16		35	35	17	14
Low brass	271	1,611	929	210	1,456	1,666	815	330
Aluminum bronze	77	712	350	80	507	587	272	280
Low-grade scrap and residues	1,981	8,196	645	500	7,460	7,960	604	2,258
Total	18,294	143,879	26,238	[2] 24,279	[2] 122,350	[2] 146,629	25,248	16,534

See footnotes at end of table.

TABLE 13.—Stocks and consumption of new and old copper scrap in the United States in 1955, gross weight in short tons—Continued

Class of consumer and type of scrap	Stocks, beginning of year	Receipts: Purchased scrap	Receipts: Machine shop scrap	Consumption: Purchased scrap: New	Consumption: Purchased scrap: Old	Consumption: Purchased scrap: Total	Consumption: Machine shop scrap	Stocks, end of year
Grand total:[3]								
No. 1 wire and heavy copper	9,199	195,946	232	104,153	91,600	195,753	202	11,424
No. 2 wire, mixed heavy, and light copper	10,352	207,538	597	78,632	128,861	207,493	555	12,100
Composition or red brass	8,626	122,530	12,416	43,447	80,510	123,957	11,600	8,015
Railroad-car boxes	5,661	66,247	2,785		68,405	68,405	2,815	3,473
Yellow brass	26,989	320,620	4,484	242,295	79,181	321,476	4,422	32,234
Cartridge cases	5,130	72,172		29,606	42,667	72,273		5,458
Auto radiators (unsweated)	2,389	54,995			54,104	54,104		3,280
Bronze	4,943	45,616	3,784	14,978	31,081	46,059	3,946	3,826
Nickel silver	2,253	11,917	16	9,140	2,677	11,817	17	2,491
Low brass	3,434	30,955	929	28,602	2,450	31,052	815	4,136
Aluminum bronze	2,001	1,650	350	798	828	1,626	272	562
Low-grade scrap and residues[4]	22,026	244,471	645	85,388	119,573	204,961	604	61,577
Mixed-alloy scrap	4,588	16,046		16,046		16,046		2,945
Total[3]	107,591	1,390,703	26,238	653,085	701,937	1,355,022	25,248	151,521

[1] Brass-mill stocks include home scrap; purchased scrap consumption assumed equal to receipts, so lines in brass-mill and grand-total sections do not balance.
[2] Of the totals shown, chemical plants reported the following: Unalloyed copper scrap, 1,409 tons of new and 4,419 of old; copper-base alloy scrap, 488 tons of new and 7,258 of old.
[3] Includes machine-shop scrap receipts and consumption for foundries, chemical plants, and other manufacturers.
[4] Includes refinery brass.

TABLE 14.—Consumption of copper and brass materials in the United States, 1954–55, by principal consuming groups, in short tons

Item consumed	Primary producers	Brass mills	Wire mills	Foundries and other manufacturers[1]	Secondary smelters
1954					
Copper scrap	326,575	399,759		103,462	373,471
Primary material	[2] 1,211,919				
Refined copper[3]		545,645	668,601	30,720	7,434
Brass ingot		5,091	571	[4] 285,712	
Slab zinc		97,310		4,060	6,898
Miscellaneous		555		313	18,696
1955					
Copper scrap	318,269	477,180		133,055	412,944
Primary material	[2] 1,342,459				
Refined copper[3]		647,044	812,663	33,726	6,827
Brass ingot		6,864	876	[4] 329,184	
Slab zinc		134,016		6,064	6,163
Miscellaneous		1,119		418	17,627

[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] Shipments to foundries by smelters.

coverage of the foundry consumption survey was 87 percent in quantity in 1955, 85 percent in 1954, and 89 percent in 1953; however, in 1955 foundries' stocks of ingot increased 3,000 tons, so that their consumption was 326,000 tons instead of the previously indicated 329,000. This would make the coverage 88 percent. The comparable percentages for previous years are not available.

TABLE 15.—Foundry consumption of brass ingot by types, refined copper and copper scrap, in the United States in 1955, by geographic divisions 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 brass ingot	Refined copper consumed	Copper scrap consumed
New England:												
Connecticut	237	1,786	6,597	240	2,866	138	17	13	585	12,479	410	2,231
Maine	26	25	138	21	6	57	27		38	338	} 465	4,040
Massachusetts	810	2,268	5,822	397	199	383	25	84	361	10,349		
New Hampshire	14	16	979	27	479	91	152	122	59	1,939	} 152	128
Rhode Island and Vermont	29	70	1,015	39	29	20	5		449	1,656		
Total	1,116	4,165	14,551	724	3,579	689	226	219	1,492	26,761	1,027	6,399
Middle Atlantic:												
New Jersey	1,180	626	6,880	378	783	427	22	176	37	10,509	212	7,146
New York	1,809	3,626	11,916	518	366	1,363	72	258	546	20,474	1,900	8,461
Pennsylvania	2,182	3,936	18,625	4,368	1,553	2,535	1,057	149	1,810	36,215	5,486	20,697
Total	5,171	8,188	37,421	5,264	2,702	4,325	1,151	583	2,393	67,198	7,598	36,304
East North Central:												
Illinois	1,075	2,142	21,536	1,643	231	705	67	441	1,003	28,843	161	6,356
Indiana	224	367	11,596	1,411	110	180	80	40	54	14,062	115	3,075
Michigan	624	1,873	12,759	930	1,148	1,456	93	17	247	19,147	1,341	3,739
Ohio	2,091	5,380	25,827	9,990	249	1,100	233	160	960	45,990	2,937	12,170
Wisconsin	1,010	1,271	7,375	2,518	1,616	299	54	1,602	220	15,965	2,173	2,907
Total	5,024	11,033	79,093	16,492	3,354	3,740	527	2,260	2,484	124,007	6,727	28,247
West North Central:												
Iowa	10	99	2,194	67	18	121	7	26	1	2,543	} 266	{ 86
Kansas	30		142	6	131	6		1	78	394		{ 3,168
Minnesota	383	331	2,195	477	59	73	6	9	161	3,694	8	3,320
Missouri	334	302	2,747	506	715	139	36	151	595	5.525	175	11,256
Nebraska and South Dakota	84	31	81		63	59				318	413	28
Total	841	763	7,359	1,056	986	398	49	187	835	12,474	862	17,858

South Atlantic:												
Delaware	8	10	781	8	15	16			2	840		
Florida	16	22	46		6	192			58	340	1	295
Georgia	4	474	147	12		6		2	4	649		1,128
Maryland and District of Columbia	105	95	135	138		62	7	112	51	705	244	920
North and South Carolina	6	18	493	849	159	14	1	1	3	1,544	3	58
Virginia	391	172	103	250	132	45	10	14	8	1,125	408	11,108
West Virginia	8	88	7,178	64	584	56				7,978		
Total	538	879	8,883	1,321	896	391	18	129	126	13,181	656	13,509
East South Central:												
Alabama	69	586	5,501	153	1,312	446	60	20	384	8,531	279	354
Kentucky		134	267	64	7,639	8			8	8,120		155
Mississippi		6	6			7				19	3	6,231
Tennessee	84	71	1,277	1,223	104	37	5		7	2,808		
Total	153	797	7,051	1,440	9,055	498	65	20	399	19,478	282	6,740
West South Central:												
Arkansas and Louisiana	41	17	107	18	1	45	1		4	234		257
Oklahoma	192	574	148	110			6		67	1,097		40
Texas	123	52	3,261	123	26	410	8	22	92	4,117	39	4,043
Total	356	643	3,516	251	27	455	15	22	163	5,448	39	4,340
Mountain:												
Arizona, Colorado, New Mexico, and Wyoming	126	31	167	28		48			23	423	12	2,016
Idaho, Montana, Nevada, and Utah	2	5	60	2	3	18				90	123	502
Total	128	36	227	30	3	66			23	513	135	2,518
Pacific:												
California	438	782	14,270	948	455	541	63	46	233	17,776	117	13,055
Oregon	15	15	24	304	14	17	15			404	35	1,797
Washington	82	30	77	3		197	19		9	417		2,288
Total	535	827	14,371	1,255	469	755	97	46	242	18,597	152	17,140
Grand total	13,862	27,331	172,472	27,833	21,071	11,317	2,148	3,466	8,157	287,657	17,478	133,055

TABLE 16.—Foundry consumption of brass ingot in the United States, percent by type of ingot, 1950–55

[Percent of total]

Year	Tin bronze	Leaded tin bronze	Leaded red brass	High-leaded tin bronze	Leaded yellow brass	Manganese bronze	Hardeners	Nickel silver	Low brass	Total consumption, tons
1950	4.4	15.0	61.8	4.6	6.9	3.7	1.3	0.6	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
1953	6.5	10.4	54.5	9.4	7.8	6.3	1.0	1.2	2.9	255,770
1954	5.3	10.0	59.1	8.0	7.4	5.4	.6	1.2	3.0	242,497
1955	4.8	9.5	60.0	9.7	7.3	3.9	.8	1.2	2.8	287,657

TABLE 17.—Brass and copper scrap imported into and exported from the United States, 1946–50 (average) and 1951–55, in short tons

[U. S. Department of Commerce]

	1946–50 (average)	1951	1952	1953	1954	1955
Imports for consumption:						
Brass scrap (gross weight)	51,489	6,523	10,321	9,679	5,272	11,748
Copper scrap (copper content)	11,466	6,792	5,125	7,827	4,752	12,597
Exports:						
Brass scrap	6,788	4,857	[1] 6,261	[1] 33,680	[1] 93,972	[1] 45,260
Copper scrap	4,375	7,701	8,941	34,568	[2] 75,749	31,137

[1] Copper-base alloy scrap (new and old); not strictly comparable with earlier years.
[2] Revised figures.

TABLE 18.—Dealers' average monthly buying prices for copper scrap and consumers' alloy-ingot prices at New York in 1955, in cents per pound

[Metal Statistics, 1956]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
No. 1 heavy copper scrap	27.45	29.24	30.51	31.07	30.39	32.48	34.10	36.01	39.43	35.70	36.49	40.58	33.62
No. 1 composition scrap	21.49	23.47	24.76	25.85	24.86	25.25	27.35	28.82	30.77	28.58	29.12	31.61	26.83
No. 1 composition ingot	30.61	32.93	34.39	36.70	35.45	34.50	36.60	40.03	42.50	41.75	41.00	41.90	37.36

Copper-scrap prices trended upward in 1955 and were approximately 25 percent higher at the end of the year than at the beginning. The average monthly price of No. 1 composition scrap, the most used item, rose from 21.49 cents per pound in January to 31.61 cents in December. The average weighted price of all grades of refined copper sold by producers in 1955 was 37.3 cents per pound compared with 29.5 cents in 1954.

SECONDARY LEAD[6]

Recovery of secondary lead in 1955 totaled 502,000 short tons valued at $150 million—a 4-percent increase over the 481,000 tons valued at $132 million reclaimed in 1954. The quantity of lead

[6] Assistance of Edith E. den Hartog is acknowledged.

reclaimed exceeded mine production (338,000 tons) by 49 percent and imports of lead (462,000 tons) by 9 percent and was greater than mine production for the tenth successive year. Secondary lead accounted for approximately 39 percent of total United States supply in 1955.

Primary-lead refiners (several of which use some scrap) recovered 50,000 tons of secondary lead or 10 percent of the total. Of the refiners' total, 4,100 tons was refined lead and 45,900 was in antimonial lead, which also contained 1,500 tons of secondary antimony. Total output of antimonial lead by these plants was 64,000 tons, of which 60,000 tons was lead and 4,000 tons antimony.

TABLE 19.—Lead recovered from scrap processed in the United States, by kind of scrap and form of recovery, 1954–55, in short tons

Kind of scrap	1954	1955	Form of recovery	1954	1955
New scrap:			As soft lead:		
Lead-base	49,657	45,828	At primary plants	5,066	4,079
Copper-base	6,281	7,037	At other plants	114,941	124,241
Total	55,938	52,865	Total	120,007	128,320
Old scrap:					
Battery-lead plates	258,438	264,126	In antimonial lead [1]	238,839	247,703
All other lead-base	143,825	160,379	In other lead alloys	98,584	107,016
Copper-base	22,708	24,670	In copper-base alloys	23,341	18,627
Tin-base	16	11	In tin-base alloys	154	385
Total	424,987	449,186	Total	360,918	373,731
Grand total	480,925	502,051	Grand total	480,925	502,051

[1] Includes 43,555 tons of lead recovered in antimonial lead from secondary sources at primary plants in 1954 and 45,903 tons in 1955.

Shipments of secondary lead, as metal, increased from 120,000 tons in 1954 to 128,000 in 1955. Shipments of all lead alloys increased over the preceding year, with a higher recovered-lead content in each instance. In antimonial lead the lead recovered increased 4 percent, in common babbitt 10 percent, in solder 8 percent, in type metals 11 percent, and in cable lead 6 percent. Shipments of all lead products by the industry totaled 631,000 tons, including 106,000 tons of primary metals used with scrap and secondary metal. Primary metals used by the secondary industry consisted of 83,000 tons of refined lead, 6,000 tons of antimonial lead, 13,000 tons of refined and detinners' brand tin, 3,000 tons of antimony, and 1,000 tons of miscellaneous metals, such as arsenic and bismuth. The data on shipments do not include secondary lead in other than lead and tin products.

Of the 631,000 tons of secondary lead and tin products shipped in 1955, 52,000 tons was refined and antimonial lead shipped by primary plants; 425,000 tons was secondary pig metal shipped to consumers by secondary smelters; 68,000 tons was pig, bar, and ingot metal containing over 50 percent primary metal, shipped by secondary smelters; and 92,000 was fabricated products shipped by secondary smelters and manufacturers, chiefly bearing foundries and can manufacturers. The fabricated products included solder in ribbon, wire, or core form, soft lead in sheets, pipe, weights, etc., and antimonial-lead battery parts, die castings, and other products. The 631,000-ton

TABLE 20.—Secondary-metal content of shipments [1] of secondary lead and tin products in the United States in 1955, gross weight in short tons

Products	Lead	Tin	Antimony	Copper	Total
Refined pig lead	117,670				117,670
Remelt lead	10,365				10,365
Lead foil	285				285
Total	128,320				128,320
Refined pig tin		3,134			3,134
Remelt tin		188			188
Tinfoil		5			5
Total		3,327			3,327
Lead and tin alloys:					
Antimonial lead	247,703	319	15,946	34	264,002
Common babbitt	18,354	1,605	2,854	40	22,853
Genuine babbitt	64	417	35	31	547
Other tin babbitts	321	439	90	32	882
Solder	49,768	8,707	894	12	59,381
Type metals	21,134	1,878	3,718	13	26,743
Cable lead [2]	16,981	15	116	7	17,119
Miscellaneous lead-tin alloys	322	20	20		362
Total	354,647	13,400	23,673	169	391,889
Composition foil	457	78	29		564
Tin content of chemical products		768			768
Grand total	483,424	17,573	23,702	169	524,868

[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 secured from reports on that basis.
[2] Included in "remelt lead" to 1954.

TABLE 21.—Shipments of secondary lead and tin products in the United States in 1955, by type of plant, gross weight in short tons

Plant	Lead	Tin	Antimony	Copper	Total
Secondary smelters	419,139	13,054	20,777	144	453,114
Primary producers	49,982		1,523		51,505
Manufacturers and foundries	14,303	4,519	1,402	25	20,249
Total	483,424	17,573	23,702	169	524,868

total equals the secondary-metal content of shipments plus consumption of primary metal. The sum of the itemized shipments of lead products is greater than 631,000 tons, because some products were shipped from one consumer to another, who processed them further and reshipped them, causing some duplication.

Remelt and percentage metals reshipped within the secondary-lead industry in 1955 totaled about 29,000 tons and consisted of 12,000 tons of antimonial lead, 7,000 tons of soft lead, 6,000 tons of solder, 1,600 tons of bearing metal, 1,600 tons of type metals, and minor quantities of cable lead, tin, and pewter.

Consumption of lead-base scrap by primary and secondary smelters, foundries, and other manufacturers totaled 654,000 tons compared with 631,000 tons in 1954. Consumption of battery-lead plates, which accounted for 61 percent of all scrap used, increased 3 percent. Both refined and antimonial lead was produced from battery-plate scrap in 1955. Consumption of all other lead scrap also increased, with the exception of drosses and residues. Consumption of lead

TABLE 22.—Stocks and consumption of new and old lead scrap in the United States in 1955, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year[1]	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Smelters and refiners:						
Soft lead	4,606	70,266		70,714	70,714	4,158
Hard lead	2,923	19,634		19,967	19,967	2,590
Cable lead	831	25,579		25,669	25,669	741
Battery-lead plates	30,793	383,504		398,587	398,587	15,710
Mixed common babbitt	452	7,298		7,215	7,215	535
Solder and tinny lead	449	17,794		17,790	17,790	453
Type metals	1,168	21,674		21,917	21,917	925
Dross and residues	20,017	78,385	76,366		76,366	22,036
Total	61,239	624,134	76,366	561,859	638,225	47,148
Foundries and other manufacturers:						
Soft lead	213	851	26	919	945	119
Hard lead	186	531	15	646	661	56
Cable lead	13	66		67	67	12
Battery-lead plates	89	34		20	20	103
Mixed common babbitt	441	12,482	188	12,269	12,457	466
Solder and tinny lead	520	1,201	1,138	99	1,237	484
Type metals	3	74		73	73	4
Dross and residues	73	89	23		23	139
Total	1,538	15,328	1,390	14,093	15,483	1,383
Grand total:						
Soft lead	4,819	71,117	26	71,633	71,659	4,277
Hard lead	3,109	20,165	15	20,613	20,628	2,646
Cable lead	844	25,645		25,736	25,736	753
Battery-lead plates	30,882	383,538		398,607	398,607	15,813
Mixed common babbitt	893	19,780	188	19,484	19,672	1,001
Solder and tinny lead	969	18,995	1,138	17,889	19,027	937
Type metals	1,171	21,748		21,990	21,990	929
Dross and residues	20,090	78,474	76,389		76,389	22,175
Total	62,777	639,462	77,756	575,952	653,708	48,531

[1] Revised figures.

scrap was lower in July (40,000 tons) than in the lowest month in 1954 or 1953, but increased sharply in succeeding months to 57,000 tons in October—the highest monthly consumption of the year. A rising trend in lead-scrap consumption that began in the middle of 1954 continued through 1955. Stocks of scrap at all plants dropped 23 percent during the year—from 63,000 tons to 48,000.

Imports of lead scrap for consumption totaled 20,580 short tons in 1955 and 5,655 tons in 1954; exports of lead scrap totaled 2,983 tons in 1955 and 3,894 tons in 1954.

The average weighted price of refined lead sold by producers in 1955 was 14.9 cents per pound, compared with 13.7 cents in 1954. Dealers' monthly average buying prices for lead scrap and refined lead and battery-plate smelting charges appear in table 23.

Refining secondary lead is simpler than refining primary lead bullion because fewer elements must be removed. Soft lead, babbitt, and solder scrap usually are treated in reverberatory furnaces or refining kettles. Because of the presence of lead oxide and lead sulfate, battery plates are smelted in blast furnaces to make antimonial lead or in reverberatory furnaces to make refined lead. Although antimonial lead may be made in the same furnaces from either scrap or primary material or a combination of both, most of that produced in 1955 at both primary and secondary plants was made from scrap

TABLE 23.—Dealers' monthly average buying prices for lead scrap and prices of refined lead at New York and average battery-plate smelting charges in 1955

[American Metal Market]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
CENTS PER POUND													
No. 1 Heavy scrap lead	11.52	11.51	11.62	11.62	11.62	11.62	11.62	11.62	11.83	12.25	12.25	12.30	11.78
Refined lead	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.00	15.12	15.50	15.50	15.54	15.14
DOLLARS PER TON													
Battery-plate smelting charge	65	60	56	55	53	52	50	49	51	59	58	54	55

storage-battery plates, smelted alone except for auxiliary additions of alloying ingredients.

SECONDARY MAGNESIUM[7]

Secondary magnesium recovered from scrap in 1955, including that treated on toll, totaled 10,200 short tons valued at $6,127,000, a 24-percent increase in quantity from the 8,300 tons valued at $4,455,000 recovered in 1954.

Of the 10,200 tons, the largest item (3,600 tons) consisted of anodes for cathodic protection of ships, pipelines, water heaters, etc. This quantity was more than twice that recovered as anodes in 1954. In cathodic and other dissipative uses secondary-magnesium ingot contributed 3,500 tons of the 16,900 total used. Secondary magnesium recovered in aluminum alloys increased 400 tons (14 percent) but that recovered in magnesium-alloy ingot decreased 200 tons (7 percent).

Consumption of magnesium scrap totaled 9,500 tons in 1955 compared with 7,500 in 1954, whereas consumption of primary magnesium and primary-magnesium alloy was 46,000 tons in 1955 and 39,000

TABLE 24.—Magnesium recovered from scrap processed in the United States, by kind of scrap and form of recovery, 1954–55, in short tons

Kind of scrap	1954	1955
New scrap:		
Magnesium-base	3,305	3,712
Aluminum-base	1,692	1,981
Total	4,997	5,693
Old scrap:		
Magnesium-base	2,682	3,926
Aluminum-base	571	627
Total	3,253	4,553
Grand total	8,250	10,246

Form of recovery	1954	1955
In magnesium-alloy ingot [1]	3,581	3,342
In magnesium-alloy castings	289	256
In magnesium-alloy shapes	3	5
In aluminum alloys	2,602	2,976
In zinc and other alloys	8	47
In chemical and other dissipative uses	2	1
In cathodic protection	1,765	3,619
Grand total	8,250	10,246

[1] Figures include secondary magnesium incorporated in primary-magnesium ingot.

[7] Assistance of Hazel B. Comstock is acknowledged.

TABLE 25.—Stocks and consumption of new and old magnesium scrap in the United States in 1955, gross weight in short tons

Scrap item	Stocks, beginning of year	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Cast scrap	523	6,967	2,161	4,795	6,956	534
Solid wrought scrap	41	894	867		867	68
Borings, turnings, drosses, etc	51	1,706	1,646		1,646	111
Total	615	9,567	4,674	4,795	[1] 9,469	713

[1] Includes 313 tons consumed in making magnesium castings, 6 tons in wrought products, 448 tons in aluminum alloys, 56 tons in other alloys, 4,163 tons in magnesium-alloy ingot, and 4,483 tons in cathodic protection. Detailed information on consumption of primary magnesium will be found in the Magnesium chapter.

in 1954. Magnesium scrap and secondary-magnesium ingot were used chiefly in castings, casting alloys, and cathodic protection in 1955, but primary magnesium was used in considerable quantities in wrought and cast products and alloys and in many dissipative uses.

The average price paid for primary magnesium ingot (98.5 percent), f. o. b. Freeport, Tex., in 1955 was 29.9 cents per pound compared with 27.0 cents in 1954.

SECONDARY NICKEL

The domestic recovery of secondary nickel from nonferrous scrap totaled 11,500 short tons valued at $15,400,000 in 1955, an increase of 34 percent in quantity over the 8,600 tons valued at $10,800,000, recovered in 1954. In comparison, domestic mine production was about 4,400 tons in 1955. Three-quarters of the secondary recovery in each year was from nickel scrap. In 1955, 39 percent of the total recovered was in nickel and nickel-base alloys, compared with 27 percent in copper-base alloys. In 1954 the corresponding percentages were 27 and 32. Secondary nickel recovered in iron and steel from nonferrous scrap only was 2,400 tons in 1955; much more was recovered from ferrous scrap, but the quantity was not reported.

TABLE 26.—Nickel recovered from nonferrous scrap processed in the United States, by kind of scrap and form of recovery, 1954–55, in short tons

Kind of scrap	1954	1955	Form of recovery	1954	1955
New scrap:			As metal	1,324	2,301
Nickel-base	2,114	1,787	In nickel-base alloys	1,030	2,210
Copper-base	1,592	1,844	In copper-base alloys	2,785	3,137
Aluminum-base	289	389	In aluminum-base alloys	395	509
Total	3,995	4,020	In lead-base alloys	12	
Old scrap:			In cast iron and steel [1]	2,030	2,422
Nickel-base	4,194	7,005	In chemical compounds	1,029	961
Copper-base	313	382	Grand total	8,605	11,540
Aluminum-base	103	133			
Total	4,610	7,520			
Grand total	8,605	11,540			

[1] Includes only nonferrous-nickel scrap added to cast iron and steel.

The nonferrous scrap from which virtually all the reported secondary nickel was recovered consisted of about 12,000 tons each of nickel-base and copper-base scrap. The nickel-base scrap yielded 8,800 tons and the copper-base 2,200 tons of nickel, chiefly in nonferrous metal and alloys.

Primary producers recovered an appreciable production of nickel in chemical form from refinery residues, and some of this nickel was tabulated as recovered from copper scrap. Some of this scrap may have been copper-nickel alloy. If so, it would have been so mixed with low-grade copper scrap that it would have been reported in that classification.

TABLE 27.—Stocks and consumption of new and old nickel scrap in the United States in 1955, 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	306	2,502	158	2,511	2,669	139
Monel metal	455	2,394	489	2,141	2,630	219
Nickel silver	[1] 560	[1] 2,987	[1] 315	[1] 2,576	[1] 2,891	[1] 656
Miscellaneous nickel alloys	6	39	30	13	43	2
Nickel residues	66	1,165		1,089	1,089	142
Total	833	6,100	677	5,754	6,431	502
Foundries and plants of other manufacturers:						
Unalloyed nickel	200	1,328	231	937	1,168	360
Monel metal	330	2,196	766	1,464	2,230	296
Nickel silver	[1] 1,693	[1] 9,068	[1] 8,825	[1] 101	[1] 8,926	[1] 1,835
Miscellaneous nickel alloys	24	601	29	541	570	55
Nickel residues	240	1,521	933	637	1,570	191
Total	794	5,646	1,959	3,579	5,538	902
Grand total:						
Unalloyed nickel	506	3,830	389	3,448	3,837	499
Monel metal	785	4,590	1,255	3,605	4,860	515
Nickel silver	[1] 2,253	[1] 12,055	[1] 9,140	[1] 2,677	[1] 11,817	[1] 2,491
Miscellaneous nickel alloys	30	640	59	554	613	57
Nickel residues	306	2,686	933	1,726	2,659	333
Total	1,627	11,746	2,636	9,333	11,969	1,404

[1] Excluded from totals because it is copper-base scrap, although containing considerable nickel. Stocks of other manufacturers include home scrap, so lines in which their stocks are included will not balance.

The average spot-delivery price of Grade F nickel ingot and shot in 10,000-pound lots at New York was 66.92 cents in 1955 compared with 62.88 cents in 1954. Dealers' buying price for nickel clippings at New York, as published in American Metal Market, remained at 57 cents per pound from the beginning of 1955 until May 23, when it increased to 75 cents, then to 80 cents on June 22, to 92 cents on August 30, to $1.25 on October 4, and to $1.50 on December 30. The prices of monel clippings ranged from 28 cents per pound to 60 and paralleled those of nickel clippings.

Imports of nickel scrap in 1953, 1954, and 1955 were 900, 400, and 400 tons, respectively.

SECONDARY TIN [8]

Secondary tin recovered in 1955 totaled 31,700 short tons valued at $60,100,000, an 8-percent increase in quantity over the 29,300 tons valued at $53,900,000 in 1954. The increase in recoverable tin content was due to higher tin content of copper- and lead-base scrap consumed, whereas the increase in tin reported as recovered from scrap was due chiefly to increased recovery in lead- and tin-base alloys. Tin recoverable from copper-base scrap in 1955 totaled 14,900 tons, and most of it was recovered in brass and bronze ingot, castings, or brass-mill products.

Consumption of tin-base scrap decreased 25 percent to 3,700 tons in 1955, but the scrap consumed in 1955 was of higher grade. From tin-base scrap consumed in 1955, 3,200 tons of tin, lead, antimony, and copper was recovered, representing 87 percent of the scrap consumed, compared with 3,900 tons of tin, lead, antimony, and copper recovered from tin-base scrap in 1954, representing 80 percent of the scrap consumed. Consumption of tin residues, including tin scruff and dross, decreased 700 tons and of high-tin babbitt 600 tons. These items comprised 78 percent of the total tin scrap consumed in 1955. 31,900 tons of secondary tin was reported consumed in 1955 compared with 28,500 tons in 1954. Most of this was tin content of alloy scrap consumed, but some was secondary refined tin.

The average price of scrap block-tin pipe in New York in 1955 was 77.20 cents per pound. The average for the first 4 months of the year was approximately 72.50 cents, but 6 successive rises brought it to an average of 81.40 cents in December. The average selling price of Straits tin in New York was 94.73 cents per pound in 1955 compared with 91.81 cents in 1954.

Secondary tin recovered by detinning plants, as metal and in chemical compounds, increased 5 percent to 3,870 short tons in 1955. Tinplate clippings and old cans were the source of 3,580 tons in 1955, 2,880 of which was reclaimed as metal and 700 tons in the form of tin compounds. In 1954 such materials provided 3,570 tons of tin, 2,970

TABLE 28.—Tin recovered from scrap processed in the United States, by kind of scrap and form of recovery, 1954–55, in short tons

Kind of scrap	1954	1955	Form of recovery	1954	1955
New scrap:			As metal:		
Tinplate	3,521	3,536	At detinning plants	3,030	3,102
Tin-base	1,341	977	At other plants	254	225
Lead-base	2,301	2,319			
Copper-base	3,118	3,114			
Total	10,281	9,946	Total	3,284	3,327
Old scrap:					
Tin cans	49	47	In solder	7,924	8,707
Tin-base	2,360	2,050	In tin babbitt	810	856
Lead-base	7,110	7,890	In chemical compounds	662	768
Copper-base	9,534	11,810	In lead-base alloys	2,689	3,915
			In brass and bronze	13,965	14,170
Total	19,053	21,797	Total	26,050	28,416
Grand total	29,334	31,743	Grand total	29,334	31,743

[8] Assistance of John B. Umhau and Edith E. den Hartog is acknowledged.

TABLE 29.—Stocks and consumption of new and old tin scrap in the United States in 1955, gross weight in short tons

Class of consumer and type of scrap	Stocks, beginning of year [1]	Receipts	Consumption			Stocks, end of year
			New scrap	Old scrap	Total	
Smelters and refiners:						
Block-tin pipe, scrap, and foil	34	717		713	713	38
Tin scruff and dross	237	1,663	1,427		1,427	473
No. 1 pewter	21	81		81	81	21
High-tin babbitt	119	1,123		1,162	1,162	80
Residues	188	447	250		250	385
Total	599	4,031	1,677	1,956	3,633	997
Foundries and other manufacturers:						
Block-tin pipe, scrap, and foil	5	11	8	6	14	2
High-tin babbitt	9	5		12	12	2
Residues						
Total	14	16	8	18	26	4
Grand total:						
Block-tin pipe, scrap, and foil	39	728	8	719	727	40
Tin scruff and dross	237	1,663	1,427		1,427	473
No. 1 pewter	21	81		81	81	21
High-tin babbitt	128	1,128		1,174	1,174	82
Residues	188	447	250		250	385
Total	613	4,047	1,685	1,974	3,659	1,001

[1] Revised figures.

tons as metal and 600 tons in compounds. The treatment of other tin-bearing materials accounted for the remaining production.

The tonnage of tinplate clippings treated in 1955—572,420 long tons—was the largest on record and 6,040 tons more than the previous peak of 566,380 tons in 1954. The average cost of such clippings, delivered to plants, increased from $18.04 a long ton in 1954 to $29.09 in 1955.

TABLE 30.—Tin recovered from scrap processed at detinning plants in the United States, 1954–55

	1954	1955
Scrap treated:		
Clean tinplate clippings .... long tons	566,377	572,419
Old tin-coated containers .... do	6,348	5,905
Total .... o	572,725	578,324
Tin recovered:		
From new tinplate clippings .... short tons	3,521	3,536
From old tin-coated containers .... do	49	47
Total .... do	3,570	3,583
Form of recovery:		
As metal .... do	2,974	2,887
In compounds .... do	596	696
Total .... do	[1] 3,570	[1] 3,583
Weight of tin compounds produced .... do	1,014	1,274
Average quantity of tin recovered per long ton of clean tinplate scrap used .... pounds	12.43	12.35
Average quantity of tin recovered per long ton of old tin-coated containers used .... do	15.55	16.01
Average delivered cost of clean tinplate scrap .... per long ton	$18.04	$29.09
Average delivered cost of old tin-coated containers .... do	$21.05	$33.65

[1] Recovery from tinplate clippings and old containers only. In addition, detinners recovered 122 tons of tin as metal and in compounds from tin-base scrap and residues in 1954 and 287 tons from these sources in 1955.

The average quantity of tin recovered per long ton of tinplate scrap treated was 12.35 pounds in 1955, compared with 12.43 pounds in 1954. The lower recovery continued to reflect treatment of a larger proportion of electrolytic tinplate carrying a thinner coating of tin. The average quantity of tin recovered per long ton of old cans, which is higher by reckoning than tinplate clippings, increased from 15.55 pounds in 1954 to 16.01 pounds in 1955.

Imports of tinplate scrap were 28,700 long tons in 1955 compared with 29,200 in 1954. Exports of tinplate scrap in 1955 were 960 long tons (944 in 1954), mostly to Middle East destinations.

TABLE 31.—Tinplate scrap imported for consumption in the United States, by countries, 1954–55, in long tons

[U. S. Department of Commerce]

Country	1954	1955	Country	1954	1955
North America:			Africa:		
Canada	[1] 25,187	27,370	Algeria	614	175
Cuba	1,133	237	British East Africa	40	
Total	[1] 26,320	27,607	French Morocco	809	
			Madagascar	25	
Europe:			Tunisia	135	103
Germany, West		36	Union of South Africa	1,249	711
Iceland	22	43	Total	2,872	989
Italy		46			
Total	22	125	Grand total	[1] 29,214	28,721

[1] Revised figure.

SECONDARY ZINC [9]

Secondary zinc recovered from purchased scrap and residues in 1955 totaled 305,000 short tons valued at $75 million compared with 272,000 tons valued at $59 million in 1954.

The 33,000-ton increase consisted of 5,000 tons in metallic zinc and zinc alloys, 21,000 tons in brass and bronze, 4,000 tons in aluminum and magnesium alloys, and 3,000 tons in zinc-chemical products. In terms of recoverable metal by type of scrap used, the total increase included 11,000 tons from zinc scrap, 18,000 tons from copper scrap, and 4,000 tons from aluminum and magnesium scrap. Total zinc recovered from copper-base scrap (150,000 tons) was greater than zinc recovered from zinc-base scrap in 1955, whereas in 1954 more zinc was recovered from zinc-base than from copper-base scrap.

Production of redistilled slab, including that produced by secondary plants and the secondary-zinc content of slab distilled by primary producers, decreased 2,000 tons to 66,000 tons in 1955, although output of primary slab increased 20 percent. Output of zinc dust, made chiefly from galvanizers' dross at secondary smelters, rose 13 percent to 30,000 tons. An offgrade zinc dust, known as tube-mill dust, is generated as a byproduct of hot-dip galvanizing pipe and tubing. The production results, when excess molten zinc from the interior of newly galvanized pipe is blown out with superheated steam, in the form of oxide-coated spherical dust particles. Most of such dust is classified as new scrap and is sold to primary zinc plants for redistillation. A little higher grade tube-mill dust is used in refining cadmium and is said to be superior to regular zinc dust for that purpose. In the

[9] Assistance of Esther B. Miller is acknowledged.

TABLE 32.—Zinc recovered from scrap processed in the United States, by kind of scrap and form of recovery, 1954–55, in short tons

Kind of scrap	1954	1955
New scrap:		
Zinc-base	109,236	114,215
Copper-base	88,291	101,988
Aluminum-base	1,526	4,948
Magnesium-base	64	75
Total	199,117	221,226
Old scrap:		
Zinc-base	27,558	33,974
Copper-base	43,760	47,642
Aluminum-base	1,279	1,845
Magnesium-base	60	88
Total	72,657	83,549
Grand total	271,774	304,775

Form of recovery	1954	1955
As metal:		
By distillation:		
Slab zinc [1]	[2] 67,381	65,477
Zinc dust	23,893	25,112
By remelting	7,247	8,165
Total	[2] 98,521	98,754
In zinc-base alloys	12,506	17,772
In brass and bronze	131,602	152,252
In aluminum-base alloys	2,854	6,888
In magnesium-base alloys	213	192
In chemical products:		
Zinc oxide (lead-free)	[2] 8,528	9,055
Zinc sulfate	[2] 3,957	4,944
Zinc chloride	11,117	11,515
Lithopone	1,998	2,773
Miscellaneous	478	630
Total	173,253	206,021
Grand total	271,774	304,775

[1] Includes zinc content of redistilled slab made from remelt die-cast slab.
[2] Revised figure.

retorts used at primary plants, reduction of zinc oxide to zinc is accomplished by reduction with coke; but, in the retorts at secondary plants, although air is excluded, no reduction of oxides is attempted. Production of chemicals from zinc scrap increased 11 percent to 29,000 tons. Of the increase, 1,000 tons each was in zinc sulfate and lithopone. Most of the lead-free zinc oxide produced in 1955 was made from concentrates, other primary materials, or refined zinc; but, whether the source was primary or secondary, the product was made largely by roasting processes at smelters. However, appreciable quantities were made at chemical plants by treating residues generated as a byproduct in manufacturing sodium hydrosulfite. The other zinc-chemical products reported were manufactured chiefly at chemical plants.

Consumption of 211,000 tons of zinc scrap and residues in 1955 yielded 148,000 tons of zinc and 1,000 tons of alloying metals, chiefly aluminum and copper from die-cast scrap. In 1954 treatment of

TABLE 33.—Production of secondary zinc and zinc-alloy products in the United States, 1946–50 (average) and 1951–55, gross weight in short tons

Products	1946–50 (average)	1951	1952	1953	1954	1955
Redistilled slab zinc	57,678	48,657	55,111	52,875	[1] 68,013	[1] 66,042
Zinc dust	26,604	29,754	25,113	25,297	26,714	30,118
Remelt spelter [2]	7,348	4,454	3,197	2,938	4,456	5,019
Remelt die-cast slab	9,576	5,596	7,098	5,695	9,418	12,729
Zinc-die and die-casting alloys	3,637	4,919	3,400	3,411	4,037	6,377
Galvanizing stocks	598	198	203	107	186	325
Rolled zinc	2,842	3,474	2,948	3,132	2,701	2,915
Secondary zinc in chemical products	46,133	40,760	31,205	34,680	[3] 26,078	28,917

[1] Includes redistilled slab made from remelt die-cast slab.
[2] Contains small tonnages of bars, anodes, etc.
[3] Revised figure.

198,000 tons of zinc scrap produced 137,000 tons of zinc and 1,000 tons of other metals. Average recovery was 71 percent in 1955 and 69 percent in 1954. Of the total zinc-scrap consumption, old scrap constituted 20 percent in 1955, 17 percent in 1954, and 13 percent in 1953, a 3-year upward trend. The chief item of old scrap was die castings, which comprised over three-fourths of all old zinc scrap consumed in each year.

Consumption of sal skimmings increased 21 percent to 25,000 tons in 1955. About 97 percent was used by chemical plants and 3 percent by secondary-zinc smelters. The latter roasted some, to vaporize the chlorine, for shipment to chemical plants as zinc oxide and converted some to redistilled slab zinc. Consumption of galvanizers' dross totaled 56,000 tons in 1955, virtually the same as in 1954. As more aluminum was added to the zinc bath in the continuous galvanizing process than in regular hot-dip galvanizing, the dross generated in the former process had a higher aluminum content. Secondary distillers preferred the dross from hot-dip lines, because the presence of alumi-

TABLE 34.—Stocks and consumption of new and old zinc scrap in the United States in 1955, 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:						
New clippings	301	2,832	2,880		2,880	253
Old zinc	633	5,504		5,287	5,287	850
Engravers' plates	418	3,045		2,433	2,433	1,030
Skimmings and ashes	5,305	38,302	38,313		38,313	5,294
Sal skimmings	405	892	762		762	535
Die-cast skimmings	1,609	11,661	11,917		11,917	1,353
Galvanizers' dross	4,764	57,864	55,789		55,789	6,839
Die castings	2,891	32,575		32,745	32,745	2,721
Rod and die scrap	283	983		956	956	310
Flue dust	3,146	2,504	5,509		5,509	141
Chemical residues	2,416	10,123	10,708		10,708	1,831
Total	22,171	166,285	125,878	41,421	167,299	21,157
Chemical plants, foundries and other manufacturers:						
New clippings	136	4,216	4,266		4,266	86
Old zinc	10	182		188	188	4
Engravers' plates	1	248		249	249	
Skimmings and ashes	441	2,290	1,857		1,857	874
Sal skimmings	10,282	24,233	24,114		24,114	10,401
Galvanizers' dross	19	21				40
Die castings	160	1,565	1,580	83	1,663	62
Rod and die scrap	9	47		50	50	6
Flue dust	335	2,384	2,588		2,588	131
Chemical residues	1,053	9,316	8,971		8,971	1,398
Total	12,446	44,502	43,376	570	43,946	13,002
Grand total:						
New clippings	437	7,048	7,146		7,146	339
Old zinc	643	5,686		5,475	5,475	854
Engravers' plates	419	3,293		2,682	2,682	1,030
Skimmings and ashes	5,746	40,592	40,170		40,170	6,168
Sal skimmings	10,687	25,125	24,876		24,876	10,936
Die-cast skimmings	1,609	11,661	11,917		11,917	1,353
Galvanizers' dross	4,783	57,885	55,789		55,789	6,879
Die castings	3,051	34,140	1,580	32,828	34,408	2,783
Rod and die scrap	292	1,030		1,006	1,006	316
Flue dust	3,481	4,888	8,097		8,097	272
Chemical residues	3,469	19,439	19,679		19,679	3,229
Total	34,617	210,787	169,254	41,991	211,245	34,159

num in the dross made it hard to melt, aluminum having a higher melting point than zinc. When zinc dust is distilled from dross, 1 percent of aluminum in the dross is said to cause 0.01 percent of aluminum in the dust through entrainment. Aluminum holds zinc in the residues in secondary retorts and tends to cause foaming. Continuous dross is more acceptable to primary than to secondary plants, because it can be diluted with enough primary material to avoid the effect of the aluminum. More galvanizers' dross is generated per ton of slab zinc consumed in intermittent hot-dip galvanizing than in continuous galvanizing. Although the latter type of operation is increasing, large enough quantities of both types of dross were available to consumers in 1955. Over half of the dross consumed in both 1954 and 1955 emerged as zinc dust. Consumption of chemical residues totaled 20,000 tons in 1955, compared with 17,000 in 1954. Although this consumption was less than that of four other zinc scrap items in 1955, chemical residues was one of the most sought-after types of raw material because of its relatively pure combinations of zinc salts that are readily convertible into zinc oxide or other zinc chemicals.

Reclassification of certain flue dusts as primary residues resulted in an apparent decrease in the consumption of flue dust as scrap in 1955.

Exports of zinc scrap and residues totaled 21,612 short tons in 1955 and 16,689 tons in 1954.

The average weighted purchase price for all grades of refined zinc in 1955 was 12.3 cents per pound compared with 10.8 cents in 1954. Dealers' monthly average buying prices for zinc scrap at New York and prices of Prime Western zinc at East St. Louis are listed in table 35.

TABLE 35.—Dealers' monthly average buying prices for zinc scrap at New York and prices of Prime Western zinc at East St. Louis in 1955, in cents per pound

[Metal Statistics, 1956]

	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Average
New zinc clips	7.00	7.00	7.00	7.42	7.50	7.50	7.50	7.72	8.15	8.25	8.25	8.25	7.61
Old zinc	5.50	5.50	5.50	5.50	4.79	4.98	5.37	5.37	5.68	5.75	5.75	5.75	5.45
Prime Western zinc	11.50	11.50	11.50	11.93	12.00	12.25	12.50	12.50	12.96	13.02	13.00	13.00	12.30

Silver

By J. P. Ryan [1] and Kathleen M. McBreen [2]

AFTER declining for 4 consecutive years, United States silver production rose slightly in 1955 to over 37 million fine ounces. It was 62 percent above the wartime low in 1946 but was smaller than in any prewar year since 1934. The slight gain in output reflected increased mining of base-metal ores containing byproduct silver.

Idaho continued to be the leading silver-producing State, followed by Utah, Montana, and Arizona, an order unchanged since 1943. These 4 States furnished 83 percent of the domestic silver output in 1955. About two-thirds of the Idaho production was recovered from dry ores mined principally for silver, but most of the rest from the four leading States was a byproduct of ores treated principally for base metals. Nearly 98 percent of the domestic silver output was recovered in smelting ore and concentrate.

World production of silver was 4 percent higher in 1955 than in 1954; gains in output from Mexico, Bolivia, and Australia, more than offset losses in Canada and Central America.

The dominant factors that affected the international silver market were the policy and silver reserves of the Bank of Mexico and the free stocks of silver in the United States Treasury. The Treasury continued to purchase domestically mined silver at $0.90505+ per fine troy ounce. The New York market, which had remained stable for more than 2 years, ranged higher in 1955, following withdrawal of the Bank of Mexico from the market. Without the stabilizing influence of the Bank of Mexico, prices rose from a low of $0.825 to a high of $0.920 per ounce of silver 0.999 fine, at New York, the highest price for silver since 1921. Similarly, the London price, following the New York price, ranged from a low of 73.750d. to a high of 80.250d.

Silver consumed in 1955 for world coinage was about 38.3 million ounces, a 42-percent drop from the preceding year. A sharp decline in United States coinage absorption more than offset gains for Saudi Arabia and Mexico. The net inflow of silver into the United States in 1955 was valued at $66.4 million, 13 percent less than in 1954.

World silver consumption, including coinage, continued to exceed world production. The demand for silver in the arts and industries of the United States increased 18 percent from 1954 to 101.4 million ounces.

Silver legislation similar to that introduced in the previous Congress, on which no action was taken, again was introduced in 1955. A bill (S. 1427) to repeal existing silver laws was referred to the Senate Subcommittee on the Federal Reserve; hearings were held in July, but

[1] Commodity specialist.
[2] Statistical assistant.

TABLE 1.—Salient statistics of silver in the United States,[1] 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Mine production fine ounces	34,793,633	39,764,932	39,452,330	37,570,838	[2] 36,941,383	37,197,742
Ore (dry and siliceous) produced:						
Gold ore short tons	3,228,182	2,606,202	2,339,160	2,198,688	2,248,604	2,233,953
Gold-silver ore do	434,347	368,184	237,211	81,658	46,345	120,303
Silver ore do	405,846	492,143	502,208	555,050	680,442	570,303
Percentage derived from—						
Dry and siliceous ores	27	32	31	29	40	30
Base-metal ores	73	68	69	71	60	70
Placers	(3)	(3)	(3)	(3)	(3)	(3)
Net consumption in industry and the arts fine ounces	97,757,800	105,000,000	96,500,000	106,000,000	86,000,000	101,400,000
Imports	$76,034,709	$103,468,510	$67,296,379	$95,103,962	$79,699,120	$72,932,031
Exports	$21,797,282	$8,590,185	$4,921,285	$8,426,910	$3,636,256	$6,560,789
Monetary stocks (end of year) fine ounces [4]		1,965,000,000	1,938,000,000	1,926,000,000	1,935,000,000	1,930,000,000
Price, average, per fine ounce [5]	$0.885+	$0.905+	$0.905+	$0.905+	$0.905+	$0.905+
World production fine ounces (estimated)	173,500,000	[2] 199,700,000	[2] 215,300,000	[2] 221,200,000	[2] 213,000,000	221,500,000

[1] Includes Alaska.
[2] Revised figure.
[3] Less than 0.5 percent.
[4] Owned by Treasury Department; privately held coinage not included.
[5] Treasury buying price for newly mined silver.

no decision was reached. Further hearings were scheduled for January 1956.

Silver returnable by foreign governments under terms of the lend-lease agreements of World War II declined about 12 million ounces; the total quantity still owing at December 31, 1955, was approximately 387.3 million ounces.

LEND-LEASE SILVER

During World War II the United States supplied to various countries about 411 million ounces of silver under lend-lease arrangements that provide for its return within 5 years of official termination of the war. The Netherlands, the only country to return lend-lease silver, remitted about 11 million ounces against its lend-lease account in 1954 and 12.2 million ounces in 1955, leaving a balance of 33.5 million to be returned. The silver returned was accounted for by the Treasury as an addition to free stocks (that is, stocks eligible for sale to industry). An extension of 2 years from the date due for repayment (April 1957) was granted to Ethiopia and Saudi Arabia, and to India for part of its obligation.

TABLE 2.—Silver produced in the United States,[1] 1946–50 (average) and 1951–55, according to mine and mint returns, in fine ounces of recoverable metal

	1946–50 (average)	1951	1952	1953	1954	1955
Mine	34,793,633	39,764,932	39,452,330	37,570,838	[2] 36,941,383	37,197,742
Mint	35,234,420	39,907,257	39,840,300	37,735,500	35,584,800	36,469,610

[1] Includes Alaska. [2] Revised figure.

TABLE 3.—Silver refined in the United States, 1955, by States

[U. S. Bureau of the Mint]

State or Territory	Fine ounces	State or Territory	Fine ounces
Alaska	34,700	Oregon	6,600
Arizona	4,600,000	Pennsylvania	10,500
California	600,000	South Dakota	153,000
Colorado	2,510,000	Tennessee	61,000
Idaho	14,000,000	Texas	27
Illinois	3,100	Utah	6,270,000
Michigan	503,000	Vermont	50,450
Missouri	350,000	Virginia	1,650
Montana	5,829,400	Washington	420,000
Nevada	834,000	Wyoming	23
New Mexico	183,000		
New York	48,900	Total	36,469,610
North Carolina	260		

MINE PRODUCTION

Domestic mine production of recoverable silver which had declined for 4 successive years, 1951 through 1954, reversed the trend in 1955. The increase was due to greater output of base-metal ores containing

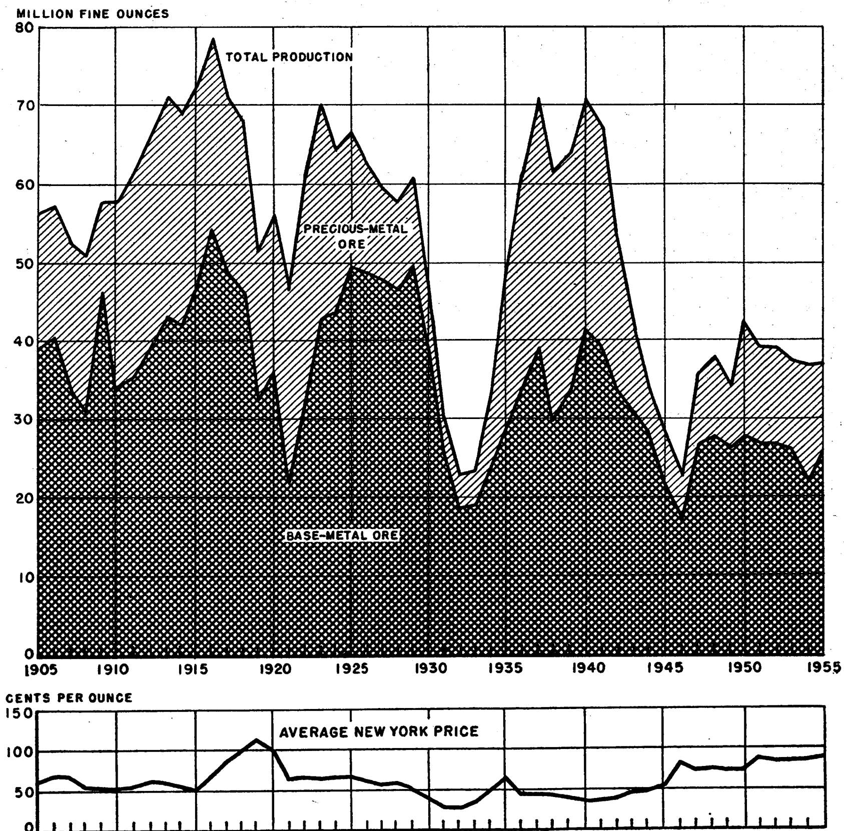

FIGURE 1.—Silver production in the United States, and average price per ounce, 1905–55.

byproduct silver. Analysis of silver production from 1951 to 1955, by ores, shows that approximately two-thirds was recovered from base-metal ores; and most of the remainder was recovered as a byproduct or coproduct of gold mining. The rate of domestic silver production in 1955 was much lower than the prewar average.

Units of measurement, methods of calculating production, ore classification, and methods of recovery are described in detail in the Gold chapter of the 1954 Minerals Yearbook.

TABLE 4.—Mine production of silver in the United States,[1] in 1955, by months

	Fine ounces		Fine ounces
January	3,071,833	August	2,805,910
February	3,030,510	September	2,995,903
March	3,655,987	October	3,235,047
April	3,317,663	November	3,107,985
May	3,456,387	December	3,003,886
June	3,110,009		
July	2,406,622	Total	37,197,742

[1] Includes Alaska.

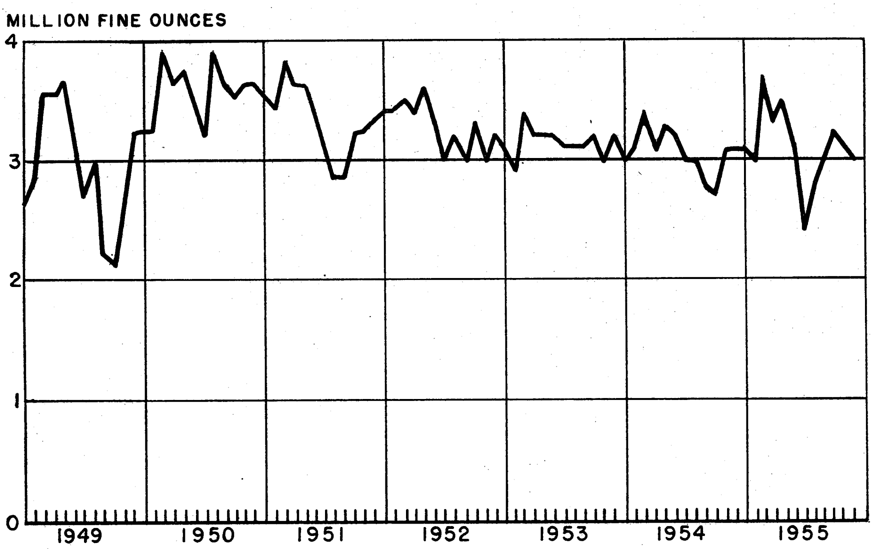

FIGURE 2.—Mine production of silver in the United States, 1949–55, by months, in terms of recoverable silver.

The leading silver-producing areas in the United States, in order, from 1945–55 were the Coeur d'Alene region in Idaho, the Summit Valley (Butte) district in Montana, and the West Mountain (Bingham) district in Utah; 62 percent of the domestic silver output in 1955 was from these 3 areas.

Only 3 of the 25 leading silver-producing mines depended principally on the silver value of the ore; ores valuable chiefly for copper, lead, zinc, and gold supplied most of the silver production. The 9 leading mines (each producing over 1 million ounces of silver in 1955) contributed 62 percent of the United States output; the entire 25 leading mines contributed 82 percent.

TABLE 5.—Mine production of recoverable silver in the United States, 1946–50 (average) and 1951–55, by districts and regions that produced 200,000 fine ounces or more during any year (1951–55), in fine ounces

District or region	State	1946–50 (average)	1951	1952	1953	1954	1955
Coeur d'Alene Region	Idaho	9, 938, 239	13, 639, 808	13, 752, 081	13, 636, 680	14, 898, 699	12, 984, 323
Summit Valley	Montana	5, 104, 934	5, 950, 647	5, 514, 330	6, 289, 415	4, 663, 429	5, 577, 999
West Mountain (Bingham)	Utah	4, 164, 286	4, 923. 249	5, 338, 291	5, 027, 419	4, 109, 083	4, 409, 373
Redcliff (Battle Mountain)	Colorado	318, 555	412, 788	348, 090	581, 100	2, 111, 786	1, 613, 090
Warren (Bisbee)	Arizona	1, 184, 277	1, 292, 719	1, 242, 935	1, 266, 153	1, 379, 192	1, 208, 553
Park City Region	Utah	1, 216, 114	1, 131, 360	861, 563	802, 036	826, 270	988, 768
Big Bug	Arizona	486, 583	636, 812	581, 699	591, 388	579, 281	695, 947
Coso	California	662, 297	570, 595	(1)	(1)	(1)	(1)
Copper Mountain	Arizona	554, 248	612, 336	402, 593	369, 470	403, 017	634, 330
Tintic	Utah	931, 756	944, 818	666, 345	562, 649	932, 683	612, 241
Ajo	Arizona	428, 751	437, 675	450, 303	435, 940	390, 104	488, 436
Pioneer	do	359, 326	581, 952	606, 563	627, 890	634, 044	485, 557
Upper Peninsula	Michigan	-----	-----	-----	-----	-----	478, 000
Upper San Miguel	Colorado	517, 049	621, 257	764, 478	717, 939	576, 525	453, 578
Warm Springs	Idaho	416, 668	506, 363	630, 886	561, 554	554, 213	426, 733
Flint Creek	Montana	50, 679	82, 033	233, 799	[2] 225, 005	331, 544	387, 060
Republic (Eureka)	Washington	144, 177	(1)	[3] 241, 935	[3] 251, 205	[3] 273, 384	[3] 362, 772
Silver Peak	Nevada	2, 921	6, 459	(1)	(1)	(1)	353, 435
Mineral Creek	Arizona	49, 492	172, 765	214, 030	265, 857	207, 785	351, 480
Southeastern	Missouri	127, 375	184, 424	517, 432	359, 781	352, 971	268, 620
Creede	Colorado	315, 972	236, 652	174, 219	173, 966	238, 685	135, 640
Central	New Mexico	(1)	236, 484	306, 236	78, 842	30, 426	128, 719
Rush Valley	Utah	(1)	189, 110	179, 401	204, 793	181, 653	128, 324
California (Leadville)	Colorado	(1)	272, 352	322, 000	196, 239	137, 557	98, 153
Pioche	Nevada	566, 167	415, 622	425, 475	317, 628	79, 313	48, 427
Grand Island	Colorado	27, 220	109, 206	274, 104	(1)	-----	40, 344
Animas	do	444, 717	415, 876	321, 308	99, 619	11, 912	32, 206
Verde (Jerome)	Arizona	432, 221	408, 891	233, 946	30, 553	6, 791	17, 768
Resting Springs	California	(1)	(1)	(1)	(1)	(1)	(1)

[1] Figure withheld to avoid disclosing individual company confidential data.
[2] Combined with First Chance and Henderson districts in 1953 to avoid disclosing individual company output.
[3] Chelan and Ferry Counties combined in 1952–55 to avoid disclosing individual company output.

TABLE 6.—Twenty-five leading silver producing mines in the United States in 1955, in order of output

Rank	Mine	District	State	Operator	Source of silver
1	Sunshine	Evolution	Idaho	Sunshine Mining Co	Silver ore.
2	Utah Copper	West Mountain (Bingham)	Utah	Kennecott Copper Corp	Copper ore.
3	Butte Hill Lead-Zinc Mines	Summit Valley	Montana	The Anaconda Co	Lead-zinc ore.
4	Bunker Hill	Yreka	Idaho	The Bunker Hill Co	Lead, lead-zinc ores.
5	Butte Hill Copper Mines	Summit Valley	Montana	The Anaconda Co	Copper ore.
6	Galena	Placer Center	Idaho	American Smelting & Refining Co	Silver ore.
7	Eagle	Red Cliff (Battle Mountain)	Colorado	The New Jersey Zinc Co	Copper, zinc ores.
8	United States and Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co	Lead, lead-zinc, silver ores.
9	Lavender Pit-Copper Queen	Warren	Arizona	Phelps Dodge Corp	Copper ore.
10	Kelley	Summit Valley	Montana	The Anaconda Co	Do.
11	Iron King	Big Bug	Arizona	Shattuck Denn Mining Co	Lead-zinc ore.
12	Darwin Group	Coso	California	The Anaconda Co	Lead-zinc, lead ores.
13	Morenci Branch	Copper Mountain	Arizona	Phelps Dodge Corp	Gold-silver, copper ores.
14	New Cornelia	Ajo	do	do	Gold, copper ores, copper tailings.
15	Magma	Pioneer	do	Magma Copper Co	Copper ore.
16	White Pine	Upper Peninsula	Michigan	White Pine Copper Co	Do.
17	Lucky Friday	Hunter	Idaho	Lucky Friday Silver-Lead Mine Co	Lead-zinc ore.
18	Treasury Tunnel-Black Bear	Upper San Miguel	Colorado	Idarado Mining Co	Copper-lead-zinc ore.
19	Triumph	Warm Springs	Idaho	Triumph Mining Co	Lead-zinc ore.
20	Chief No. 1	Tintic	Utah	Chief Consolidated Mining Co	Silver, lead, lead-zinc ores.
21	Mohawk	Silver Peak	Nevada	Bruhi Mining Co	Silver ore.
22	Ray Mines and Open Pit	Mineral Creek	Arizona	Kennecott Copper Corp	Copper ore.
23	Mayflower, Galena, and Star Units.	Blue Ledge	Utah	New Park Mining Co	Lead-zinc ore.
24	Ontario-Park Utah	do	do	United Park City Mines Co	Do.
25	Algonquin	Flint Creek	Montana	American Machine & Metals Co	Do.

TABLE 7.—Mine production of recoverable silver in the United States, 1945–55, with production of maximum year, and cumulative production from earliest record to end of 1955, by States, in fine ounces

State	Maximum production [1]		Production by years											Total production from earliest record to end of 1955
	Year	Quantity	1945	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	
Western States and Alaska:														
Alaska	1916	1,379,171	9,983	41,793	66,150	67,341	36,056	52,638	31,023	32,986	35,387	33,697	33,693	20,181,116
Arizona	1937	9,422,552	3,558,216	3,268,765	4,569,084	4,837,740	4,970,736	5,325,441	5,120,985	4,701,330	4,351,429	4,298,811	4,634,179	335,497,149
California	1921	3,629,223	986,798	1,342,651	1,597,442	724,771	783,880	1,071,917	1,145,219	1,099,658	1,036,372	309,575	954,181	116,923,103
Colorado	1893	25,838,600	2,226,780	2,240,151	2,557,653	3,011,011	2,894,886	3,492,278	2,787,882	2,813,643	2,200,317	3,417,072	2,772,073	756,373,493
Idaho	1937	19,587,766	8,142,667	6,491,104	10,345,779	11,448,875	10,049,257	16,095,019	14,753,023	14,923,165	14,639,740	15,867,414	13,831,458	642,439,142
Montana	1892	19,038,800	5,942,070	3,273,140	6,326,190	6,930,716	6,327,025	6,590,747	6,393,768	6,138,185	6,689,556	5,177,942	6,080,390	805,804,342
Nevada	1913	16,090,083	1,043,380	1,250,651	1,377,579	1,790,020	1,800,209	1,537,217	981,669	941,195	697,086	560,182	845,397	600,134,266
New Mexico	1885	2,343,800	465,127	338,000	515,833	537,674	380,855	338,581	443,267	479,318	205,309	109,132	251,072	71,015,772
Oregon	1941	276,158	10,461	6,927	30,379	13,596	12,195	13,565	6,218	4,037	12,259	14,335	8,815	5,340,711
South Dakota	1900	536,200	26,564	86,901	111,684	94,693	109,383	142,065	139,590	132,102	138,642	151,407	154,092	10,861,667
Texas	1938	1,433,008	23,265	42,922	20,547	3,065	2,691	2,454	1,381	4,672		100	126	33,303,399
Utah	1925	21,276,689	6,106,545	4,118,453	7,780,032	8,045,329	6,724,880	7,083,808	7,310,665	7,194,109	6,725,807	6,179,243	6,250,565	782,466,957
Washington	1902	721,450	281,444	264,453	293,736	375,831	357,853	363,656	334,948	315,645	321,202	313,735	436,348	15,942,827
Wyoming	1901	21,400	31	26	95	11	21		2		11	74	20	74,926
Total			28,823,331	22,765,937	35,592,183	37,880,673	34,449,927	42,109,386	39,449,640	38,780,045	37,053,117	36,432,719	36,252,409	4,196,358,870
West Central States: Missouri	1952	517,432	94,822	69,401	93,600	114,187	123,413	236,273	184,424	517,432	359,781	352,971	268,620	6,412,698
States east of the Mississippi:														
Alabama	1936	869	1											5,239
Georgia	1904	1,500			13	3								10,963
Illinois	1924	8,891	2,198	2,302	1,790	4,047	3,128	2,001	3,465	3,781	2,338	1,160	3,075	162,127
Maryland	1917	1,092												2,595
Michigan	1916	716,640	21,863		3,089								478,000	10,734,112
New York	1955	66,162	14,271	15,786	22,409	18,788	18,378	32,628	47,568	38,895	35,398	34,576	66,162	703,924
North Carolina	1906	30,769										[2] 438	181	357,842
Pennsylvania	1942	15,501	10,434	7,887	9,863	13,731	10,827	10,563	13,575	9,247	6,972	8,415	10,379	275,126
South Carolina	1940	8,047												35,325
Tennessee	1920	110,719	35,391	18,016	79,147	39,692	41,833	39,958	24,960	57,569	68,935	60,759	66,619	3,517,822
Vermont	1955	50,447	20,586	35,275	21,469	24,910	27,446	28,205	41,300	45,361	43,128	48,572	50,447	[3] 434,890
Virginia	1944	18,993	1,300								1,169	1,773	1,850	84,181
Total			106,044	79,266	137,780	101,171	101,612	113,355	130,868	154,853	157,940	[2] 155,693	676,713	16,324,146
Grand total			29,024,197	22,914,604	35,823,563	38,096,031	34,674,952	42,459,014	39,764,932	39,452,330	37,570,838	[2] 36,941,383	37,197,742	4,219,095,714

[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] Revised figure.
[3] Includes a small quantity for New Hampshire.

TABLE 8.—Ore, old tailings, etc., yielding silver, produced in the United States and average recoverable content, in fine ounces, of silver per ton in 1955 [1]

State	Gold ore		Gold-silver ore		Silver ore	
	Short tons	Average ounces of silver per ton	Short tons	Average ounces of silver per ton	Short tons	Average ounces of silver per ton
Western States and Alaska:						
Alaska	3,883	0.104				
Arizona	3,317	.246	67,516	0.227	25,511	0.674
California	154,494	.552	1,155	8.425	2,559	6.686
Colorado	106,084	.095	180	20.783	8,000	8.810
Idaho	6,740	1.400	298	19.721	372,414	25.140
Montana	1,308	3.517	8,032	4.363	1,153	32.691
Nevada	166,655	.052	7,128	6.289	23,010	17.667
New Mexico	135	.822	2,673	10.734	2,407	.666
Oregon	3,791	2.313				
South Dakota	1,665,341	.093				
Texas						
Utah	639	1.052	33,321	3.130	135,249	4.214
Washington	121,185	2.445				
Wyoming	206	.097				
Total	2,233,778	.259	120,303	2.057	570,303	18.381
States east of the Mississippi	175	1.034				
Total	2,233,953	.259	120,303	2.057	570,303	18.381

State	Copper ore		Lead ore		Lead-copper ore	
	Short tons	Average ounces of silver per ton	Short tons	Average ounces of silver per ton	Short tons	Average ounces of silver per ton
Western States and Alaska:						
Alaska			1	122.000		
Arizona	52,253,289	0.070	4,706	5.212		
California	9,365	7.231	5,731	26.981		
Colorado	67,513	19.586	21,579	4.135	77	22.091
Idaho	180,960	.038	50,475	3.429	202	98.817
Montana	5,760,564	.474	8,280	5.817		
Nevada	10,520,428	.012	9,912	15.644		
New Mexico	7,297,379	.012	26,086	.087		
Oregon	44	.636				
South Dakota						
Texas	35	2.686	6	5.333		
Utah	27,751,432	.105	14,877	4.880		
Washington	10,800	2.384	10	12.500		
Wyoming						
Total	103,851,809	.105	141,663	5.081	279	77.642
States east of the Mississippi	7,102,949	.074	287			
Total	110,954,758	.103	141,950	5.071	279	77.642

TABLE 8.—Ore, old tailings, etc., yielding silver, produced in the United States and average recoverable content, in fine ounces, of silver per ton in 1955[1]—Con.

State	Zinc ore		Zinc-lead, zinc-copper, and zinc-lead-copper ores		Total ore	
	Short tons	Average ounces of silver per ton	Short tons	Average ounces of silver per ton	Short tons	Average ounces of silver per ton
Western States and Alaska:						
Alaska					3,884	0.135
Arizona	807	0.597	388,069	2.424	52,743,215	.088
California	38	8.132	131,177	4.662	304,519	3.108
Colorado	228,576	1.279	476,407	2.061	908,416	3.051
Idaho	[2] 106,950	.440	1,242,777	3.384	1,960,816	7.053
Montana	47,381	1.655	1,433,199	2.193	7,259,917	.837
Nevada	4,589	2.286	28,615	3.249	10,760,337	.078
New Mexico	54,788	.149	78,525	1.538	7,461,993	.034
Oregon					3,835	2.293
South Dakota					1,665,341	.093
Texas					41	3.073
Utah	[2] 66,524	.125	604,950	4.249	28,606,992	.218
Washington	570	.070	1,579,548	.072	1,712,113	.255
Wyoming					206	.097
Total	510,223	.873	5,963,267	2.143	113,391,625	.319
States east of the Mississippi	2,297,616		3,010,580	.046	[3] 12,411,607	[3] .054
Total	2,807,839	.159	8,973,847	1.440	125,803,232	.293

[1] Missouri excluded.
[2] Zinc slag.
[3] Excludes magnetite-pyrite ore and gold and silver therefrom. Includes material classified as fluorspar ore mined in Illinois.

TABLE 9.—Mine production of silver in the United States,[1] 1946–50 (average) and 1951–55, 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	
1946–50 (average)	0.2	27.0	21.3	6.7	1.6	43.2	34,793,633
1951	.2	31.9	20.8	4.2	1.8	41.1	39,764,932
1952	.1	31.3	20.6	4.4	2.0	41.6	39,452,330
1953	.1	29.2	24.5	5.2	.9	40.1	37,570,838
1954	.1	39.5	22.0	3.4	1.1	33.9	[2] 36,941,383
1955	.1	30.4	30.8	2.7	1.2	34.8	37,197,742

[1] Includes Alaska.
[2] Revised figure.

TABLE 10.—Mine production of silver in the United States in 1955, by States and sources, in fine ounces of recoverable metals

State	Placers	Dry ore	Copper ore	Lead ore	Lead-copper ore	Zinc ore	Zinc-lead, zinc-copper, and zinc-lead-copper ores	Total
Alaska	33,167	404		122				33,693
Arizona	5	33,306	3,635,071	24,527		482	940,788	4,634,179
California	7,725	112,196	67,718	154,626		309	611,607	954,181
Colorado	274	84,343	1,322,305	89,238	1,701	292,295	981,917	2,772,073
Idaho	929	9,377,698	6,905	173,089	19,961	47,059	4,205,817	13,831,458
Illinois							3,075	3,075
Michigan			478,000					478,000
Missouri				[1] 268,620	(1)			268,620
Montana	261	77,336	2,732,585	48,161		78,406	3,143,641	6,080,390
Nevada	883	459,983	126,014	155,066		10,491	92,960	845,397
New Mexico	10	30,406	89,434	2,268		8,153	120,801	251,072
New York							66,162	66,162
North Carolina		181						181
Oregon	20	8,767	28					8,815
Pennsylvania			[2] 10,379					10,379
South Dakota		154,092						154,092
Tennessee							66,619	66,619
Texas			94	32				126
Utah		674,961	2,924,471	72,603		8,312	2,570,218	6,250,565
Vermont			50,447					50,447
Virginia							1,850	1,850
Washington		296,326	25,745	125		40	114,112	436,348
Wyoming		20						20
Total	43,274	11,310,019	11,469,196	988,477	21,662	445,547	12,919,567	37,197,742

[1] A little silver recovered from lead-copper ore from 1 mine included with that from lead ore.
[2] From magnetite-pyrite ore.

TABLE 11.—Silver produced in the United States from ore and old tailings, in 1955, 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 (fine ounces)	Concentrates smelted and recoverable metal			
				Concentrates (short tons)	Fine ounces	Short tons	Fine ounces
Western States and Alaska:							
Alaska	3,884	3,871	339	14	23	13	164
Arizona	[2] 49,251,362	[2] 48,537,958	31,733	1,619,458	3,474,383	713,404	1,128,058
California	304,519	293,309	83,150	30,010	663,466	11,210	199,840
Colorado	908,416	830,137	10,563	112,774	1,368,191	78,279	1,393,045
Idaho	1,960,816	1,841,194	779	193,895	13,671,948	119,622	157,802
Montana	7,259,917	7,128,084	7	631,050	5,712,940	131,833	367,182
Nevada	10,760,337	10,627,412	365,829	271,237	175,305	132,925	303,380
New Mexico	7,461,993	7,354,983	11	232,625	201,451	107,010	49,600
Oregon	3,835	3,812	81	162	8,652	23	62
South Dakota	1,665,341	1,665,341	154,092				
Texas	41					41	126
Utah	28,606,992	28,346,943		927,349	5,488,251	260,049	762,314
Washington	1,712,113	1,651,302	88,038	85,022	322,987	60,811	25,323
Wyoming	206	200	4			6	16
Total	109,899,772	108,284,546	734,626	4,103,596	31,087,597	1,615,226	4,386,912
States east of the Mississippi	[3] 12,411,607	12,321,616	4	523,103	676,709	89,991	
Grand total	122,311,379	120,606,162	734,630	4,626,699	31,764,306	1,705,217	4,386,912

[1] Missouri excluded.
[2] Excludes 3,491,853 tons of ore leached from which no gold or silver was recovered.
[3] Excludes magnetite-pyrite ore from Pennsylvania. Includes material classified as fluorspar ore mined in Illinois.

TABLE 12.—Silver produced at amalgamation and cyanidation mills in the United States and percentage of silver recoverable from all sources, 1946–50 (average) and 1951–55 [1]

Year	Bullion and precipitates recoverable (fine ounces)		Silver from all sources (percent)			
	Amalgamation	Cyanidation	Amalgamation	Cyanidation	Smelting [2]	Placers
1946-50 (average)	102, 572	396, 907	0. 3	1. 2	98. 3	0. 2
1951	93, 958	274, 974	. 2	. 7	98. 9	. 2
1952	87, 589	140, 943	. 2	. 4	99. 3	. 1
1953	98, 399	129, 538	. 3	. 3	99. 3	. 1
1954	95, 941	208, 581	. 3	. 6	99. 0	. 1
1955	90, 647	643, 983	. 3	1. 7	97. 9	. 1

[1] Includes Alaska. Illinois and Missouri excluded in 1946; Missouri excluded in 1947–55.
[2] Both crude ores and concentrates.

TABLE 13.—Silver produced at amalgamation and cyanidation mills in the United States in 1955, by States

State	Amalgamation	Cyanidation	Silver from all sources in State (percent)	
	Bullion recoverable (fine ounces)	Bullion and precipitates recoverable (fine ounces)	Amalgamation	Cyanidation
Western States and Alaska:				
Alaska	339		1. 01	
Arizona	3	31, 730		0. 68
California	9, 391	73, 759	. 98	7. 73
Colorado	3, 169	7, 394	. 11	. 27
Idaho	779		. 01	
Montana	7			
Nevada	527	365, 302	. 06	43. 21
New Mexico	11			
Oregon	81		. 92	
South Dakota	76, 312	77, 780	49. 52	50. 48
Washington	20	88, 018		20. 17
Wyoming	4		20. 00	
Total	90, 643	643, 983	. 25	1. 78
States east of the Mississippi	4			
Grand total	90, 647	643, 983	. 24	1. 73

CONSUMPTION AND USES IN INDUSTRY AND THE ARTS

Consumption of silver in the United States in the arts and industry was 18 percent greater in 1955 than in 1954 and exceeded average prewar consumption in 1930–40 by a wide margin. Silver consumption in the United States since 1941 has exceeded any annual output ever achieved by domestic mines.

The principal industrial consumer of silver in 1955 continued to be the silverware industry, mostly in the fabrication of sterling-silver tableware. The photographic industry ranked second in consumption, followed by the electroplating industry and the manufacture of silver-clad equipment for the chemical industry.

Increased use of silver in the electrical and electronics fields and in brazing alloys for metal joining in 1955 more than offset a decline in

TABLE 14.—Net industrial[1] consumption of silver in the United States, 1946-50 (average) and 1951-55, in fine ounces

[U. S. Bureau of the Mint]

Year	Issued for industrial use	Returned from industrial use	Net industrial consumption
1946-50 (average)	129,023,438	31,265,638	97,757,800
1951	151,650,905	46,650,905	105,000,000
1952	121,538,076	25,038,076	96,500,000
1953	125,389,200	19,389,200	106,000,000
1954	104,628,698	18,628,698	86,000,000
1955	123,535,180	22,135,180	101,400,000

[1] Including the arts.

consumption for sterling and plated ware. Silver brazing alloys and solders are made by alloying silver with varying proportions of base metals, such as copper, zinc, and cadmium. Silver-bearing alloys were widely used in joining pipes, making electrical connections, and forming mechanical assemblies, especially in products that must withstand relatively high temperatures and vibrational stresses.

Silver was used in manufacturing various chemical products for the laboratory and for caustic, astringent, and antiseptic purposes in medicine. Dental fillings and surgical wires and plates also consumed important quantities of silver.

MONETARY STOCKS

Stocks of silver in the United States Treasury, including silver bullion and silver dollars securing silver certificates, subsidiary coin, and free silver bullion, decreased nearly 5 million ounces in 1955 to 1,930 million ounces. This figure does not include some 387 million ounces of World War II lend-lease silver held by foreign governments.

Silver requirements of governments for coinage dropped about 28 million in 1955 to 38.3 million ounces. United States coinage requirements decreased 44.9 million to 8.2 million ounces; Saudi Arabia used 17.2 million, Mexico 2.3 million, Canada 0.5 million, Western Germany 0.1 million, and other countries about 12 million ounces.

PRICES

The Treasury buying price for domestically mined silver was fixed on July 31, 1946, by act of Congress (Public Law 579, 79th Congress), at $0.9050505+ per fine troy ounce; this price held through 1955.

The New York price of silver per troy ounce, 0.999 fine, after remaining stable for 26 months at $0.8525 rose to $0.8975 in March following withdrawal of the Bank of Mexico from the market. Subsequent brisk industrial demand and reduced new supply due to labor strikes at the refineries of the principal producers brought about further increases in price, which reached $0.9075 in July, virtually equivalent to the Treasury selling price. Continued strong demand by the domestic trade and depletion of accumulated stocks resulted in large purchases from the Treasury and a further rise in the New York price to $0.920 per ounce in October, the highest recorded price in 35 years. Price fluctuations near the Treasury buying price were frequent in the last quarter, and at the end of the year the New York price was $0.905 per ounce. The London price of silver per troy ounce, 0.999 fine, in general followed that of New York; quotations ranged from a low of 73¾d. in February to a high of 80¼d. per ounce in October, equivalent to $0.8558 and $0.9335, respectively, in United States currency.

TECHNOLOGY

A noteworthy achievement in applying the geological and engineering sciences to mining exploration was exemplified in 1955 by the successful deep-level development of the Galena unit of the American Smelting & Refining Co. in the Silver Belt area of the Coeur d'Alene mining district in Idaho.[3] The cooperation and resources of several mining companies contributed to the success in surmounting considerable physical difficulties, thus justifying the faith and perseverance required during the 8 years needed to bring the Deep Galena mine into production.

During 1955 the Bureau of Mines published the following reports of investigations relating to silver:

5138. HAMILTON, W. H. and MCLELLAN, R. R., Investigation of Kokomo Zinc Deposits, Summit County, Colo. 28 pp.

5139. SOULE, J. H., Investigation of the Copper King Copper-Gold-Silver Deposits, Silver Crown Mining District, Laramie County, Wyo. 37 pp.

FOREIGN TRADE [4]

Imports of silver continued to exceed exports by a wide margin in 1955.

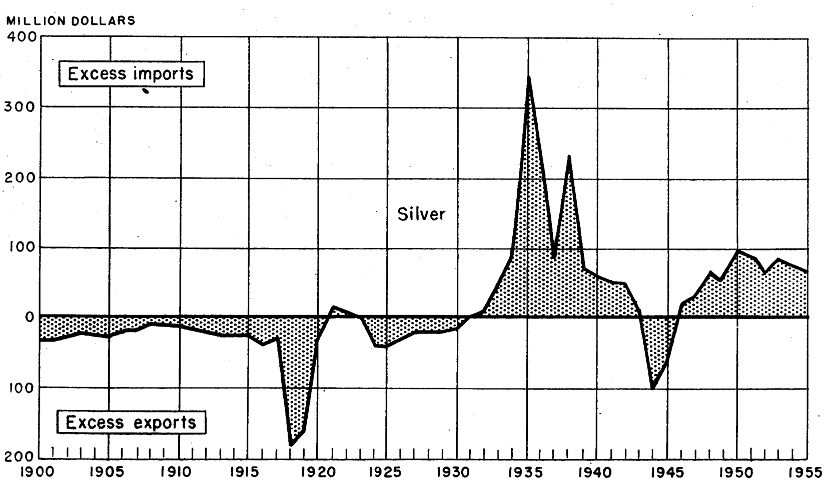

FIGURE 3.—Net imports or exports of silver, 1900–55.

[3] Berg, J. E., How a Geologic Gamble Paid Off at Silver Belt's Vulcan Mine: Mining World, vol. 17, No. 2, February 1955, pp. 52–55.

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

TABLE 15.—Value of silver imported into and exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Imports	Exports	Excess of imports over exports
1946–50 (average)	$76,034,709	$21,797,282	$54,237,427
1951	103,468,510	8,590,185	94,878,325
1952	67,296,379	4,921,285	62,375,094
1953	95,103,962	8,426,910	86,677,052
1954	79,699,120	3,636,256	76,062,864
1955	72,932,031	6,560,789	66,371,242

TABLE 16.—Silver imported into the United States in 1955, 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		
North America:						
Bahamas					$16,752	
Canada	8,930,083	$7,830,226	12,261,308	$10,859,018	967,055	
Cuba	366,673	334,537			549,350	
El Salvador	207,133	174,180			200,000	
Guatemala	213,806	176,193				
Honduras	1,968,235	1,715,054				
Mexico	7,655,879	6,684,739	13,878,868	12,183,082		
Nicaragua	225,905	193,854				
Panama	315	271			15,000	
Total	19,568,029	17,109,054	26,140,176	23,042,100	1,748,157	
South America:						
Bolivia	2,972,997	2,543,800				
Brazil	4,838	4,175				
Chile	1,210,558	1,055,392				
Colombia	60,577	51,993				
Ecuador	42,491	36,167				
Peru	8,202,799	7,142,864	2,641,464	2,304,872		$9,500
Venezuela	97,394	83,028				
Total	12,591,654	10,917,419	2,641,464	2,304,872		9,500
Europe:						
Malta, Gozo, and Cyprus	15,711	13,825				
Netherlands	16,848,063	11,980,803				
Portugal	45,845	39,413				
Switzerland						5,963
Turkey	11,020	10,469				
United Kingdom	34,092	29,659	27,241	23,666	456	13
Total	16,954,731	12,074,169	27,241	23,666	456	5,976
Asia:						
Iran	181,224	151,122				
Japan			52,134	42,512		
Lebanon	1,432,655	1,229,837				
Philippines	278,512	242,862				
Saudi Arabia	1,821,215	1,574,446				
Total	3,713,606	3,198,267	52,134	42,512		
Africa:						
Federation of Rhodesia and Nyasaland	234,362	210,357				
Union of South Africa	960,350	831,724				
Total	1,194,712	1,042,081				
Oceania: Australia	1,635,443	1,413,802				
Grand total	55,658,175	45,754,792	28,861,015	25,413,150	1,748,613	15,476

TABLE 17.—Silver exported from the United States in 1955, by countries of destination

[U. S. Department of Commerce]

Country of destination	Ore and base bullion		Bullion, refined		United States coin (value)	Foreign coin (value)
	Troy ounces	Value	Troy ounces	Value		
North America:						
Bahamas					$30,000	
Canada			88,624	$77,376	150	$1,985,281
Cuba			31,544	28,593		3,128
French West Indies					440	
Honduras						630
Mexico			1,438,958	1,288,955		79,200
Panama						1,696
Total			1,559,126	1,394,924	30,590	2,069,935
South America:						
Brazil			14,796	12,613		
Colombia			683,391	623,617		
Venezuela			23,142	20,328		
Total			721,329	656,558		
Europe:						
Germany, West			1,913,023	1,782,000		
Ireland					5,000	
Netherlands					3,000	
Switzerland			10,192	9,218		
United Kingdom	71,074	$63,125	604,589	523,371		
Total	71,074	63,125	2,527,804	2,314,589	8,000	
Asia: Thailand			13,376	12,268		
Africa: Liberia					10,800	
Grand total	71,074	63,125	4,821,635	4,378,339	49,390	2,069,935

WORLD REVIEW

World silver output in 1955 was 221.5 million ounces, a 4-percent gain over the preceding year. Increased production in United States, Mexico, Peru, Bolivia, and Australia more than offset lower output from Canada and Central America.

World consumption of silver, including the arts, industry, and United States coinage, has exceeded production for several years. In 1955 total world consumption was 217.4 million ounces, slightly less than in the preceding year. A large drop in coinage requirements more than offset increased use in the arts and industries.

457676—58——65

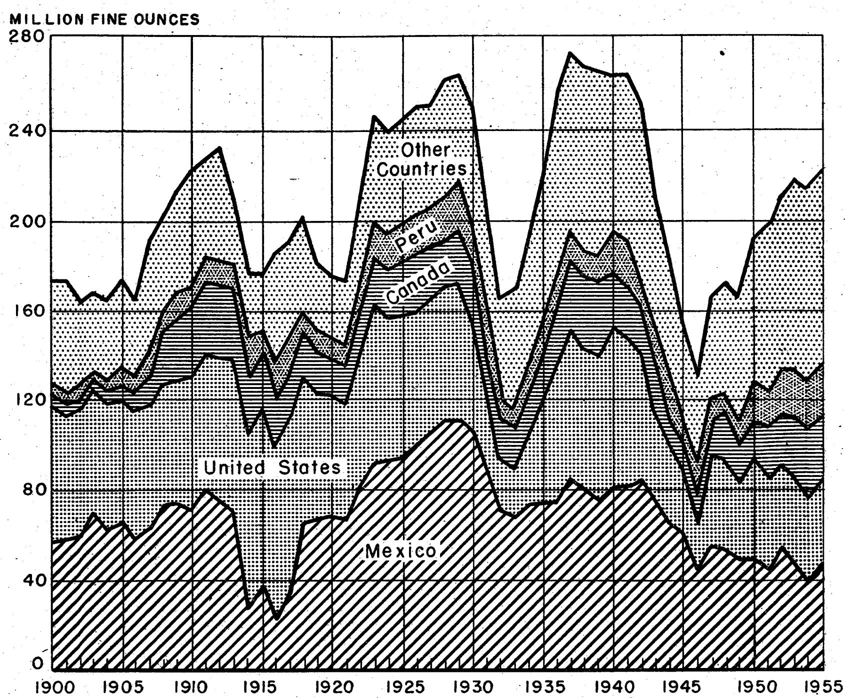

FIGURE 4.—World production of silver, 1900–55.

TABLE 18.—World production of silver, 1946–50 (average) and 1951–55, by countries,[1] in fine ounces [2]

[Compiled by Berenice B. Mitchell and Augusta W. Jann]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
United States	35,234,420	39,907,257	39,840,300	37,735,500	35,584,800	36,469,610
Canada	16,816,981	23,125,825	25,222,227	28,299,335	31,117,949	27,901,427
Central America and West Indies:						
Costa Rica [3]	1,208	582				
Cuba	167,712	[3] 172,318	[3] 163,211	[3] 167,895	[3] 179,479	[3] 366,673
Guatemala	84,172	309,857	371,679	[4] 328,636	283,811	343,111
Honduras	3,042,670	3,182,254	3,703,975	5,640,251	3,432,023	1,745,327
Nicaragua	[5] 203,044	206,882	238,389	252,697	218,148	268,316
Panama	468	5,788				
Salvador	[5] 307,582	352,102	368,448	353,169	256,778	230,054
Mexico	51,644,605	43,797,734	50,353,560	47,873,677	39,896,467	47,957,654
Total	107,502,800	111,060,600	120,261,800	120,651,200	110,969,500	115,282,200
South America:						
Argentina	1,845,228	1,253,879	962,948	895,474	1,639,698	1,414,633
Bolivia (exports)	6,621,780	7,137,465	7,073,163	6,113,013	5,047,666	5,851,107
Brazil	21,505	20,319	17,301	21,194	21,207	17,738
Chile	782,446	1,191,089	1,415,533	1,497,839	1,489,029	1,714,535
Colombia	118,762	129,773	123,165	117,385	112,534	112,036
Ecuador	226,360	33,600	82,297	86,600	35,126	47,732
Peru	11,276,659	14,959,129	18,386,141	19,650,694	20,405,883	22,982,476
Total	20,892,700	24,725,300	28,060,500	28,382,200	28,751,100	32,140,300

See footnotes at end of table.

TABLE 18.—World production of silver, 1946–50 (average) and 1951–55, by countries,[1] in fine ounces [2]—Continued

Country	1946–50 (average)	1951	1952	1953	1954	1955
Europe:						
Austria	4,322	5,466	3,215	5,144	5,787	3,537
Czechoslovakia [4]	1,367,200	1,608,000	1,608,000	1,608,000	1,608,000	1,608,000
Finland	158,090	157,275	150,083	235,794	239,459	224,573
France	560,882	705,902	712,165	675,514	376,164	353,658
Germany:						
East [4]	2,500,800	3,536,600	3,536,600	4,501,100	4,500,000	4,500,000
West	1,072,780	1,819,957	1,877,700	2,314,435	2,400,246	2,226,117
Greece	1,280	64,300	72,403	61,665	85,360	77,869
Hungary [4]	28,450	48,200	64,300	64,300	64,300	64,300
Italy	578,347	809,234	838,041	832,383	872,025	802,804
Norway	196,763	163,969	147,893	112,528	112,528	71,375
Poland [4]	70,780	96,500	96,500	96,500	96,500	96,500
Portugal	28,601	65,459	77,740	59,447	55,299	64,300
Rumania [4]	468,450	643,000	643,000	643,000	643,000	643,000
Spain	596,942	735,908	553,128	1,144,939	1,312,522	1,473,404
Sweden	1,187,590	1,145,917	2,196,281	1,571,464	2,215,604	2,445,964
U. S. S. R.[4]	14,624,200	24,000,000	24,000,000	25,000,000	25,000,000	25,000,000
United Kingdom	18,980	26,777	30,734	28,914	32,000	32,000
Yugoslavia	1,448,751	3,032,008	2,577,043	3,048,019	2,829,394	2,983,589
Total [4]	25,000,000	39,000,000	39,000,000	42,000,000	42,500,000	42,700,000
Asia:						
Burma	98,419	280,270	154,783	672,403	1,278,289	1,268,231
China [4]	96,700	320,000	400,000	320,000	320,000	320,000
India	12,398	14,612	17,675	14,624	17,199	15,425
Japan	2,414,808	4,609,998	5,177,909	6,028,489	6,051,413	5,943,772
Korea:						
North [4]	93,440	(6)	(6)	(6)	(6)	(6)
Republic of	21,554	5,401	11,381	52,213	50,252	79,637
Philippines	126,188	274,602	693,751	572,046	527,160	502,069
Saudi Arabia	70,903	109,912	111,945	150,626	63,681	----------
Taiwan (Formosa)	10,770	32,762	6,880	40,639	39,160	63,948
Total [4]	2,945,000	5,700,000	6,600,000	7,900,000	8,400,000	8,300,000
Africa:						
Algeria	31,681	8,681	8,648	----------	----------	----------
Bechuanaland	618	70	281	463	292	189
Belgian Congo	4,383,991	3,795,266	4,727,252	4,961,631	4,550,166	4,076,457
French Morocco	541,117	1,865,000	2,283,000	2,054,158	1,169,589	979,537
Gold Coast (exports)	44,939	52,853	44,116	44,949	48,214	39,284
Kenya	3,480	2,150	17,315	21,758	1,245	1,770
Mozambique	490	83	102	209	44	----------
Nigeria	1,575	200	270	172	182	----------
Rhodesia and Nyasaland, Federation of:						
Northern Rhodesia [7]	232,352	100,702	348,954	492,813	403,661	402,466
Southern Rhodesia	87,703	79,731	81,356	84,566	81,657	76,836
South-West Africa	440,000	1,030,066	1,064,335	795,702	779,879	1,279,213
Swaziland	103	18	----------	----------	----------	----------
Tanganyika (exports)	25,109	35,697	35,900	41,580	42,672	43,292
Tunisia	54,187	61,119	69,413	39,095	106,097	96,450
Uganda (exports)	85	14	14	55	----------	----------
Union of South Africa	1,160,906	1,162,588	1,176,433	1,193,152	1,235,418	1,461,336
Total	7,008,300	8,194,000	9,857,000	9,730,000	8,420,000	8,457,000
Oceania:						
Australia:						
Commonwealth	9,831,322	10,792,032	11,425,872	12,402,963	13,827,038	14,555,412
New Guinea	[8] 26,862	45,011	62,965	58,693	48,977	44,459
Fiji	31,253	24,869	25,838	19,328	17,794	20,421
New Zealand	222,238	133,291	51,016	75,888	33,049	27,930
Total	10,111,700	10,995,000	11,566,000	12,557,000	13,927,000	14,648,000
World total (estimate)	173,500,000	199,700,000	215,300,000	221,200,000	213,000,000	221,500,000

[1] Silver is also produced in Bulgaria, Cyprus, Hong Kong, Malaya, Indonesia, Sarawak, and Sierra Leone, but production data are not available; estimates are included in total.
[2] This table incorporates a number of revisions of data published in previous Silver chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] Imports into the United States. Scrap is included in this figure in many instances, most notably in the case of Cuba.
[4] Estimate. [5] Exports. [6] Data not available; estimate included in total.
[7] Recovered from refinery slimes. [8] Years ended May 31, 1946, to 1950.

Australia.—Production of silver in Australia in 1955 was 5 percent higher than in the preceding year, continuing a rising trend for the sixth successive year. The increasing silver production reflected principally an expanding output of base metals containing silver. Australia was the chief supplier of silver to the London market during 1955.

Canada.—Silver production in Canada, the third ranking producer, was 27.9 million ounces in 1955, a 10-percent decline from the preceding year. Of the total output, 83 percent was recovered as a byproduct from base-metal ores, 14 percent from silver-cobalt and silver ores, and 3 percent from gold ores. Most of the output was exported to the United States. Consumption dropped about 14 percent in 1955, owing chiefly to a large reduction in the quantity used for coinage.

Honduras.—Output of silver from Honduras—the leading producer in Central America—dropped in 1955 to almost half the quantity produced in the preceding year. This sharp decline in production resulted from closing of the San Juancito mine in 1954.

Mexico.—Silver production in Mexico rose 20 percent in 1955 to 48 million ounces, and this country maintained its position as the world's leading silver-producing country by a wide margin. Most of Mexico's output continues to be shipped to the United States, but large quantities were also shipped during 1955 to London and the continent.

Mexico authorized a new issue of silver coins in September 1955—a 5-peso and a 10-peso. The Mexican Mint consumed 2.3 million ounces in 1955 in minting these coins.

Peru.—Peru continues to be the leading silver-producing country of South America—a position held for many years. Output in 1955 increased 13 percent to 23 million ounces, continuing a rising production trend since 1949. Most of Peru's silver output was obtained as a byproduct or coproduct of complex ores mined principally for base metals.

Slag—Iron Blast-Furnace

By Wallace W. Key [1]

OUTPUT of processed iron blast-furnace slag in 1955 was the largest in the history of the industry. The industry regained ground lost during the steel strike of 1954, and the market for slag products continued to grow.

Production of processed iron blast-furnace slag increased more than 3 million tons over the 1954 figure. With the exception of the unscreened, air-cooled variety, output of all types of processed slag advanced at a uniformly high rate. The value per ton for all types (excluding granulated slag used for hydraulic cement, for which no value was given) averaged higher in 1955 than in any previous year. This reflected increased costs and general economic conditions. Screened, air-cooled slag was the major product, followed in order by granulated, expanded, and unscreened, air-cooled slag. Highway and airport construction combined was in first place as a market for iron blast-furnace slag. The tonnage consumed in agricultural uses was nearly 50 percent higher than in the previous year, and a trend continued toward replacing air-cooled slag by granulated slag for soil liming and conditioning.

TABLE 1.—Iron blast-furnace slag processed in the United States, 1946–50 (average) and 1951–55, by types

[National Slag Association]

Year	Air-cooled						Granulated		Expanded		
	Screened			Unscreened						Value	
	Short tons	Value		Short tons	Value		Short tons	Value [1]	Short tons		
		Total	Average per ton		Total	Average per ton				Total	Average per ton
1946–50 (average)	17,303,689	$19,017,058	$1.10	676,399	$370,197	$0.55	1,573,208	$286,093	1,232,080	$2,489,630	$2.02
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
1953	24,021,624	32,677,948	1.36	845,311	581,083	.69	3,358,910	1,250,450	2,285,758	5,557,813	2.43
1954	22,372,477	31,228,295	1.40	808,548	537,207	.66	3,455,005	1,512,084	2,599,112	6,198,822	2.38
1955	24,900,883	36,131,615	1.45	809,461	596,540	.74	3,835,829	1,618,277	2,891,844	7,961,466	2.75

[1] Excludes value of slag used for hydraulic cement manufacture.

[1] Commodity specialist.

DOMESTIC PRODUCTION

The output of slag from iron blast-furnaces, as reported to the Bureau of Mines by pig-iron producers was 43 million short tons in 1955, compared with 34 million in 1954. The quantity of slag processed for commercial use in 1955, as reported by the processing companies, was 32 million short tons, 74 percent of the total production. The tonnage of processed slag was 11 percent higher than in 1954. As production of slag was reduced in 1954 by a steel strike, the increase in 1955 was due primarily to the availability of a continuous supply of slag to serve the construction industry. The increased quantity was produced by the same number of plants as in the previous year; 45 companies operated 68 air-cooled plants, 15 granulating plants, and 20 expanded-slag plants in the United States.

Of the processed-slag output, screened, air-cooled slag comprised 77 percent, unscreened 2 percent, granulated 12 percent, and expanded 9 percent of the total in 1955; none of these varied more than 1 percent from 1954.

Although iron blast-furnace slag was produced in 15 States, 3 (Ohio, Pennsylvania, and Alabama) produced nearly two-thirds of the total. As in preceding years, Ohio led the other States, with 24 percent of the total output—about the same as 1954. Slightly more than one-third of the total was produced in the following States: California, Colorado, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, New York, Tennessee, Texas, and West Virginia.

TABLE 2.—Iron blast-furnace slag processed in the United States, 1954–55, by States

[National Slag Association]

	Screened air-cooled			All types		
	Quantity		Value	Quantity		Value
	Short tons	Percent of total		Short tons	Percent of total	
1954						
Alabama	4,532,577	20	$5,509,453	5,252,000	18	$6,783,444
Ohio	5,775,025	26	8,735,490	7,389,266	25	11,620,281
Pennsylvania	4,780,834	21	7,260,777	6,619,761	23	8,512,776
Other States [1]	7,284,041	33	9,722,575	9,974,115	34	12,559,907
Total	22,372,477	100	31,228,295	29,235,142	100	39,476,408
1955						
Alabama	4,676,829	19	6,220,101	5,430,423	17	7,557,113
Ohio	6,366,284	26	10,279,820	7,878,302	24	13,582,986
Pennsylvania	5,004,194	20	7,928,908	7,072,385	22	9,639,106
Other States [1]	8,853,576	35	11,702,786	12,056,907	37	15,528,693
Total	24,900,883	100	36,131,615	32,438,017	100	46,307,898

[1] California, Colorado, Illinois, Indiana, Kentucky, Maryland, Michigan, Minnesota, New York, Tennessee, Texas, and West Virginia.

TRANSPORTATION

As in previous years, truck transportation predominated in 1955. Shipments by rail accounted for only one-third of the total tonnage. Waterway transportation of slag products continued to play a minor but important role locally. Examination of freight rates and charges by the Interstate Commerce Commission revealed that the average distance for slag products from source to market was somewhat greater in the Southern States.[2]

TABLE 3.—Shipments of iron blast-furnace slag in the United States, 1954–55, by method of transportation

[National Slag Association]

Method of transportation	1954		1955	
	Short tons	Percent of total	Short tons	Percent of total
Rail	11,011,987	38	12,100,659	37
Truck	17,574,770	60	19,421,684	60
Waterway	648,385	2	915,674	3
Total	29,235,142	100	32,438,017	100

CONSUMPTION AND USES

As processed-slag stockpiles are comparatively small and constant from year to year, production virtually equals quantities "sold" and "used"; therefore, these terms are used synonymously throughout this chapter.

Screened, Air-Cooled Slag.—The quantity of screened, air-cooled slag sold or used and the value per ton were higher in 1955 than in any preceding year. The major uses were as aggregate and railroad ballast. Of the 24 million short tons processed in this manner, railroad ballast and highway-airport, bituminous, and portland-cement concrete construction consumed 90 percent. The output increased more than 2 million tons or 11 percent over the 1954 figure. Usage in concrete block increased by 22 percent in quantity. Railroad ballast increased 711,402 short tons, or 21 percent, while its use as a filter trickling medium increased 28 percent over the 1954 figure. Consumption of slag in built-up roofing and in mineral-wool production was 14 and 12 percent, respectively, higher than in the previous year. A continued decline in the volume of air-cooled slag for agricultural use was noted. Other uses were as aggregate in the construction of parking lots and driveways, in the manufacture of concrete pipe and glass and in various types of fill.

Unscreened, Air-Cooled Slag.—The consumption of unscreened, air-cooled slag in 1955 was 809,461 short tons valued at $596,540, only a nominal increase over 1954. This type of slag was a relatively small part of the total output.

[2] Interstate Commerce Commission, Increased Freight Rates: Ex Parte No. 196, vol. 298, 1956, pp. 279–352.

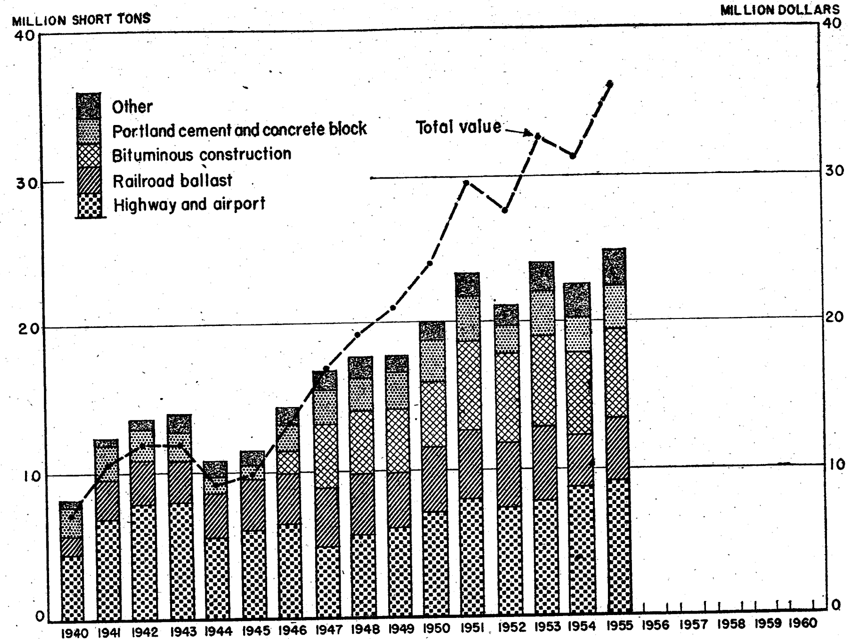

FIGURE 1.—Quantity of screened, air-cooled iron blast-furnace slag sold or used in the United States, 1940–55, by uses, and total value.

TABLE 4.—Air-cooled iron blast-furnace slag sold or used by processors in the United States, 1954–55, by uses

[National Slag Association]

Use	Screened		Unscreened	
	Short tons	Value	Short tons	Value
1954				
Aggregate in—				
Portland-cement concrete construction	2,431,652	$3,606,096		
Bituminous construction (all types)	5,510,995	8,163,329		
Highway and airport construction [1]	8,650,822	12,438,326	447,837	$304,617
Manufacture of concrete block	670,500	912,749		
Railroad ballast	3,448,240	3,605,477		
Mineral wool	484,244	668,545		
Roofing (cover material and granules)	396,056	873,034		
Sewage trickling filter medium	50,239	84,815		
Agricultural slag, liming	9,861	15,442		
Other uses	719,868	860,482	360,711	232,590
Total	22,372,477	31,228,295	808,548	537,207
1955				
Aggregate in—				
Portland-cement concrete construction	2,984,249	4,796,019		
Bituminous construction (all types)	6,120,369	9,512,590		
Highway and airport construction [1]	9,171,796	13,658,458	736,405	557,628
Manufacture of concrete block	816,009	1,128,525		
Railroad ballast	4,159,642	4,445,428		
Mineral wool	542,049	783,977		
Roofing (cover material and granules)	450,387	1,036,451		
Sewage trickling filter medium	64,118	110,330		
Agricultural slag, liming	7,435	11,662		
Other uses	584,829	648,175	73,056	38,912
Total	24,900,883	36,131,615	809,461	596,540

[1] Other than in portland-cement concrete and bituminous construction.

Granulated Slag.—Granulated slag was used mainly as a raw material in cement manufacturing and as an aggregate in road construction. Total consumption increased 11 percent over the 1954 figure to reach a record 3 million short tons in 1955. Forty-four percent was used as a raw material in the manufacture of hydraulic cement, 42 percent as highway construction and fill material, 8 percent for concrete-block manufacture, and the remainder for agricultural slag and miscellaneous uses. Base and subgrade material is shown separately from fill in the 1955 report, because the increased use of slag for base and subgrade has become more significant. Granulated slag for agricultural purposes increased 63 percent in quantity, recovering from the 1954 low; indications were toward its use in place of screened, air-cooled slag because of its increased ability to hydrolyze in the soil. In addition, reports indicated that slag was growing in acceptance as a liming material and soil conditioner. The United States Department of Agriculture and other organizations continued studying the effectiveness of slag as a soil-liming material and as a supplier of plant nutrients.[3] The concrete-block industry used appreciably less granulated and more expanded slag in 1955.

Expanded Slag.—Production in 1955 reached an alltime record of 2.9 million short tons valued at 8 million dollars, increases of 11 and 28 percent, respectively, over 1954. The major quantity was used in lightweight concrete block and lightweight concrete. Slag was reported to be used more for concrete-block manufacture than any other lightweight aggregate.[4]

TABLE 5.—Granulated and expanded iron blast-furnace slag sold or used by processors in the United States, 1954–55, by uses

[National Slag Association]

Use	Granulated		Expanded	
	Short tons	Value	Short tons	Value
1954				
Highway construction (base and subgrade)	1,384,125	$957,545		
Fill (road, etc.)				
Agricultural slag, liming	44,405	64,264		
Manufacture of hydraulic cement	1,430,775	(1)		
Aggregate for concrete-block manufacture	319,700	354,475	2,412,477	$5,738,031
Aggregate in lightweight concrete			92,309	190,870
Other uses	276,000	135,800	94,326	269,921
Total	3,455,005	(2) 1,512,084	2,599,112	6,198,822
1955				
Highway construction (base and subgrade)	615,869	694,653		
Fill (road, etc.)	997,869	440,078		
Agricultural slag, liming	72,160	107,228		
Manufacture of hydraulic cement	1,675,643	(1)		
Aggregate for concrete-block manufacture	307,288	295,988	2,728,747	7,398,149
Aggregate in lightweight concrete			105,113	351,754
Other uses	167,000	80,330	57,984	211,563
Total	3,835,829	(2) 1,618,277	2,891,844	7,961,466

[1] Data not available.
[2] Excludes value of slag used for hydraulic cement manufacture.

[3] Doscher, D. G., Water-Granulated Blast-Furnace Slag and Its Effect on Soil Fertility: Rock Products, vol. 58, No. 5, May 1955, pp. 86, 122.
[4] Peck, Roy L., Block Industry Passes Two-Billion Mark. Producers Expect 1956 to be Better Year: Pit and Quarry, vol. 48, No. 7, January 1956, pp. 286–288.

PRICES

Increases in the average value were reported for most uses; producers indicated that these changes were related to wage increases, additional costs of equipment and supplies, and general market conditions. There was a decrease in the value of granulated slag used in manufacturing concrete blocks, thereby offsetting the previous year's increase. The values of screened, air-cooled slag ranged from $1.07 for railroad ballast to $2.30 for built-up roofing. Screened, air-cooled slag increased 5 cents per ton over 1954; the greatest increase was in bituminous construction, with an average rise in value of 7 cents per ton over the previous year. The values of unscreened, air-cooled slag ranged from $0.53 to $0.76; the average value, which advanced 8 cents, was $0.74 per ton. Expanded slag averaged $2.75 per short ton, an increase of 37 cents over the previous year. A sharp increase was reported in the use of expanded slag for lightweight concrete. Expanded slag for concrete block increased 33 cents per ton over the 1954 figure.

TABLE 6.—Average value per short ton of iron blast-furnace slag sold or used by processors in the United States, 1954–55, by uses

[National Slag Association]

Use	Air-cooled		Granulated	Expanded
	Screened	Unscreened		
1954				
Aggregate in—				
Portland-cement concrete construction	$1.48			[1] $2.07
Bituminous construction (all types)	1.48			
Highway and airport construction [2]	1.44	$0.68		
Manufacture of concrete block	1.36		$1.11	2.38
Railroad ballast	1.05			
Mineral wool	1.38			
Roofing (cover material and granules)	2.20			
Sewage trickling filter medium	1.69			
Agricultural slag, liming	1.57		1.45	
Road fill, etc			.69	
Other uses	1.20	.64	.49	2.86
1955				
Aggregate in—				
Portland-cement concrete construction	1.61			[1] 3.35
Bituminous construction (all types)	1.55			
Highway and airport construction [2]	1.49	.76	[3] 1.13	
Manufacture of concrete block	1.38		.96	2.71
Railroad ballast	1.07			
Mineral wool	1.45			
Roofing (cover material and granules)	2.30			
Sewage trickling filter medium	1.72			
Agricultural slag, liming	1.57		1.49	
Road fill, etc			.45	
Other uses	1.11	.53	.48	3.65

[1] Lightweight concrete.
[2] Other than in portland-cement and bituminous construction.
[3] Highway construction for base and subgrade material.

RECOVERY OF IRON

Recovery of iron by magnetic and handpicking methods for reuse in blast furnaces continued to be an important function of the slag industry. In 1955, 376,995 tons of iron slag (about 60 percent iron), representing more than 1 percent of the slag processed, was returned to the furnaces, an increase of 25 percent over 1954.

EMPLOYMENT

Plant and yard personnel of the industry totaled 1,964 in 1955 and man-hours of production 4,897,804; this compares with 1,915 employees and 4,716,547 man-hours in 1954.

The industry conducted an educational program and interplant safety contest designed to maintain and improve safety measures.[5]

TECHNOLOGY

The technical development of slag processing was outlined in a number of reports during the year. The technologic aspect of the blast-furnace-slag industry of the United States—its growth from a minor position in 1900 to its present stage of development—was presented at a meeting of the American Institute of Mining and Metallurgical Engineers.[6] The characteristics and metallurgical reactions of iron-blast-furnace slag are discussed in a paper presented during a visit of the Joint Metallurgical Societies to France.[7] A report was issued on the utilization of iron-blast-furnace slag in Germany in the past 15 years,[8] and a history of foamed slag in Great Britain was published.[9] The need for close cooperation of the furnace operator and the slag processor is emphasized in an article on the processing of slag in the United States.[10] A general article was published on how to work with slag aggregates.[11] A report on foreign methods for granulating blast-furnace slags emphasizes the hydraulic properties of the sand produced.[12] Another example of the wide interest in the use of blast-furnace slag for production of cement is a study made in India.[13]

Slag Cement.—Investigations of the durability and strength of concretes by the Bureau of Public Roads disclosed some noteworthy data on the effect of slag-cement blends and air-entrained and non-air-entrained portland cements.[14] In an experiment conducted in Poland to determine the influence of the drying temperature of slag cement on the quality of the cement, it was found that low-temperature drying substantially increased its strength.[15] In Europe, cements were produced by grinding high-alumina granulated blast-furnace slag with anhydrite and an alkali catalyst (lime or portland cement).[16] Construction of airfields and highways by the North Atlantic Treaty

[5] Pit and Quarry, vol. 47, No. 7, January 1955, pp. 134, 136.
[6] Rock Products (abs.), vol. 58, No. 4, April 1955, p. 153.
[7] Kosakevitch, Paul, Foaming of Blast-Furnace and Open-Hearth Slags: Iron Trade and Coal Rev., vol. 171, No. 4595, Oct. 7, 1955, pp. 857–858.
[8] Wentz, B., [Utilization of Slag Cements for Airfield and Roadmaking]: Silicates Industriels (German), vol. 20, May 1955, pp. 189–193.
[9] Gallai-Hatchard, [History of Development of Foamed-Slag Production in Great Britain to Date]: Silicates Industriels, vol. 20, January 1955, pp. 13–24.
[10] Bauman, E. W., Close Cooperation of Furnace Operator and Slag Processor; Blast-Furnace and Steel Plant, vol. 43 No. 6, June 1955, pp. 650–653.
[11] Smith, A. C., How to Work with Aggregates: Construction Methods and Equipment, vol. 37, No. 8, August 1955, pp. 54–59.
[12] Grosstuck, P., Methods for the Production of Slag Sand: Jour. Iron and Steel Inst. (abs.), vol. 179, par. 2, p. 183.
[13] Khadilkar, Slag Cement and Its Use as Low-Heat Cement: Jour. Sci. Ind. Res. (India), vol. 14A, 1955, pp. 385–388.
[14] Grieb, W. E., and Werner, G., Cement and Concretes: Public Roads Abs., vol. 22, pt. 2, No. 126, 1955, pp. 46–49.
[15] Kurdowski, Zdzilaw, [Influence of Slag-Drying Temperature on the Quality of Blast-Furnace Cement]: Zement Wapno-Gips, vol. 10, No. 19, 1955, pp. 201–207.
[16] Rock Products (abs.), [Slag-Cement]: vol. 58, No. 5, May 1955, p. 43; Zement-Kalk-Gips, vol. 7, No. 12, 1954, p. 449.

Organization (NATO) in France put slag cement to severe tests.[17] At Oberhausen, Germany, a slag-cement brick plant was converted from air to steam-hardening process, which was reported to have many advantages in production and mechanization.[18] A foreign experiment on slag-concrete-block thermal properties is described.[19] Another foreign study was made on the influence of lime and calcium sulfates on the setting time of blast-furnace slag cement. It showed that cements containing calcium sulfate in the state of low solubility induced by heat treatment are not subject to setting failure, whereas cements containing sulfates in the form of a semihydrate do encounter setting difficulties.[20] A study was made of the activation of blast-furnace slags by sodium hydroxide and showed the resulting changes produced in cement and concrete.[21] A comparative study was made of the grindability, abrasiveness, and hydraulic properties of semidry, granulated, and wet-granulated blast-furnace slags. Tests showed that slags granulated by the semidry method are preferable in compounding cements.[22]

Plasters.—A patent was issued for mixtures of granulated slag, expanded vermiculite, and gypsum to be used as plaster. The mix consisted essentially of 2½ cubic feet of aggregate to 100 pounds of gypsum plaster binder. The aggregate was composed of 20 to 60 percent by volume of granulated blast-furnace slag having a dry density between 12 and 40 pounds per cubic foot and from 40 to 80 percent by volume of expanded vermiculite having a dry density of less than 15 pounds per cubic foot.[23]

Agricultural Slag.—The agricultural uses of slag and its physiological importance to plants were reported in several articles. The results of many extensive and carefully conducted tests were favorable to slag as a liming material. One report includes a bibliography of these tests along with a discussion of slag potentialities in agriculture, including its preparation, properties, and relative advantages compared with other liming materials.[24] Two other articles recommend the use of granulated slag as a fertilizer and soil conditioner. Granulated slag was reported to be superior to air-cooled slag and proved by experiment to be superior to limestone in most cases both in productive yield and nutritional value.[25]

Slag Wool.—The sulfur content of slag wool was reported to be present as sulfide with some sulfate, the sulfide being mainly in the form of calcium sulfide and distributed throughout; whereas, the sulfate was concentrated in surface layers, presumably as a result of

[17] MacGowan, Gault, Slag-Cement Experience in France: Rock Products, vol. 58, No. 2, February 1955, pp. 112–115, 122.

[18] Mussgnug, G., Conversion of the Slag-Cement Brick Plant from the Air to the Steam Hardening Process: Iron and Steel Inst. (abs.), vol. 180, pt. 4, August 1955, p. 384.

[19] Epshtein, A. S., New Data on Thermal-Conductivity Coefficients of Slag Concretes: Chem. Abs., vol. 50, No. 1, Feb. 10, 1956, p. 547.

[20] Blondiau, L., and Blondiau, Y., [Is Blast-Furnace Slag Liable to Fail to Set? How is One to Prevent It?]: Silicates Industriels, vol. 20, January 1955, pp. 32–35.

[21] Manche, H., [Activation of Slags by Sodium Hydroxide]: Silicates Industriels, vol. 20, April 1955, pp. 144–146.

[22] Chemical Abstracts, vol. 50, No. 8, Apr. 25, 1956, p. 6015.

[23] Ziegler, G. E. (assigned to Zonolite Corp.), Aggregate Composition of Granulated and Expanded Vermiculite: U. S. Patent 2,715,583, Aug. 16, 1955.

[24] Whittaker, Colin W., Blast-Furnace Slag in Agriculture: Pit and Quarry, vol. 48, No. 3, September 1955, pp. 139–156.

[25] Chichilo, P. D., and Whittaker, C. W., Trace Elements in Agricultural Slags: Agronomy Jour., vol. 15, No. 1 (reprint), January 1955, pp. 1–5.
Barbier, G., and Trocme, S., Mechanism of the Fertilizing Action of Dephosphorizing Slags: Jour. Iron and Steel Inst. (abs.), vol. 179, pt. 2, February 1955, p. 183.

oxidation. Small quantities of sulfur could be extracted with water from the fibers, the amount depending on the ph of the water.[26]

Another article on slag wool gives the details of plant operation, the technique of fiber formation, and its properties and uses.[27]

Lightweight Slag.—A patent was issued on a method of producing a foamed dry slag that facilitates the removal of the slag from the pouring bed. The apparatus consists of a tiltable pouring bed, which in the working position lies beneath a troughlike ladle resting on bearings. The arrangement is devised so that the ladle pours the slag into the bed, where water is supplied through nozzles from the bottom. At the end of the foaming process, the water is drained out through the nozzles, and the bed is tilted on its axis to facilitate loading into a conveyor or car below.[28] A patent was also issued to provide an improved foaming bed for blast-furnace slag. It claims to overcome the drawback of nozzles being damaged by emptying. It has nozzles that can be easily exchanged individually and which convey the water through the bottom of the slag bed.[29] Another patent was issued on a method of making lightweight slag by intercepting a cascading stream of molten slag with a jet or stream of air thereby breaking the slag into particles, which then pass through an atomized water spray for expansion. By varying the mixture and technique of operation, a variation in product results. Expanded slag made by this process is stated to have high strength.[30] The Kinney-Osborne process is described in several publications.[31]

---

[26] Sehweite, H. E., and Zagar, L., The State of Combination and Behavior of Sulfur in Blast-Furnace Slag and Slag Wool: Jour. Iron and Steel Inst. (abs.), vol. 179, pt. 1, January 1955, p. 183.

[27] Iron and Steel Institute (abs.), vol. 179, pt. 2, February 1955, p. 183.

[28] Vorwerk, O. K. (assigned to Hüttenwork Rheinhausen A. G.), Method of and Device for Making Porous Materials from Fiery Molten Masses, Especially Blast-Furnace Slag: U. S. Patent 2,702,967, Mar. 1, 1955.

[29] Klotzbach, G. A., Foaming Bed for the Foaming of Fiery Molten Masses: U. S. Patent 2,700,849, Feb. 1, 1955.

[30] Osborne, F., Method and Apparatus for Making Lightweight Slags: U. S. Patent 2,702,407, Feb. 22, 1955.

[31] Kinney, S. P., and Osborne, Fred, Profitable Returns From Expansion of Blast-Furnace Slag for Lightweight Aggregate: Blast Furnace and Steel Plant (reprint), May 1955, pp. 3–11; New Method Expands Slag for Aggregate Use: Iron and Steel Eng., vol. 32, No. 6, June 1955, pp. 127–128.

Slate

By D. O. Kennedy [1] and Nan C. Jensen [2]

PRODUCTION of slate in the United States declined less than 1 percent in 1955 compared with 1954. Sales of dimension slates decreased in quantity but increased in value, whereas sales of granules and flour increased in quantity but decreased in value. A small quantity of slate was used in expanded form as a lightweight aggregate.

In the period 1952–55 about one-fifth of the slate production consisted of dimension slates and four-fifths crushed slate, each of about the same value. The average value of slate production was just under $13 million a year for this period.

TABLE 1.—Salient statistics of the slate industry in the United States, 1954–55

Domestic production (sales by producers)	1954			1955				
	Quantity		Value	Quantity		Value	Percent of change in—	
	Unit of measurement	Approximate equivalent short tons		Unit of measurement	Approximate equivalent short tons		Quantity (unit as reported)	Value
Roofing slate	*Squares* 117,729	43,549	$2,401,087	*Squares* 121,480	45,611	$2,568,213	+3	+7
Mill stock:	*Sq. ft.*			*Sq. ft.*				
Electrical slate	250,292	1,801	392,588					
Structural and sanitary slate	1,533,196	12,088	1,103,926	2,304,631	17,584	2,079,521	+29	+39
Grave vaults and covers								
Blackboards and bulletin boards [1]	1,295,911	2,989	808,872	970,716	2,407	603,288	−25	−25
Billiard-table tops	116,338	918	72,937	100,939	741	64,406	−13	−12
Total mill stock	3,195,737	17,796	2,378,323	3,376,286	20,732	2,747,215	+6	+16
Flagstones, etc.[2]	14,824,636	90,281	1,569,409	12,774,370	74,478	1,266,937	−14	−19
Total slate as dimension stone		151,626	6,348,819		140,821	6,582,365	−7	+4
Granules, flour, and other [3]		609,295	6,611,795		619,619	6,331,412	+2	−4
Grand total		760,921	12,960,614		760,440	12,913,777		

[1] A small quantity of school slates included with blackboards and bulletin boards.
[2] Includes slate used for walkways, stepping stones, and miscellaneous uses.
[3] Includes a small quantity of crushed slate used for lightweight aggregate.

[1] Assistant chief, Branch of Construction and Chemical Materials.
[2] Statistical assistant.

DOMESTIC PRODUCTION

Although slate was produced in 9 States, the production from 3 States (New York, Pennsylvania, and Vermont) supplied 65 percent of the total quantity and 79 percent of the total value of all slate produced in the United States. The number of operators decreased from 57 in 1954 to 55.

Electrical slate and a small amount of flagging were produced by Maine's only slate operator from the one underground slate mine in the United States. The total production from Maine increased 31 percent in value in 1955 compared with 1954.

One of the active slate producers in New York during 1954 was idle in 1955, but addition of a new producer maintained the total number at 13 for the year. Production in 1955 decreased over 20 percent in quantity and value compared with 1954 owing almost entirely to a decrease in the production of flagging. Flagging and granules were the major slate products of New York, composing 76 percent of the quantity and 85 percent of the value of the total output.

TABLE 2.—Slate sold by producers in the United States, 1946–50 (average) and 1951–55, by States and uses

	Operators	Roofing		Mill stock		Other uses (value)[1]	Total value
		Squares (100 square feet)	Value	Square feet	Value		
1946–50 (average)	79	183,018	$3,500,434	2,676,758	$1,587,103	$7,036,932	$12,124,469
1951	77	205,120	4,357,412	3,168,540	2,127,387	8,049,528	14,534,327
1952	70	145,640	3,067,513	2,725,660	2,049,895	7,589,243	12,706,651
1953	68	142,292	3,005,649	2,940,527	2,220,504	7,412,312	12,638,465
1954	57	117,729	2,401,087	3,195,737	2,378,323	8,181,204	12,960,614
1955							
Arkansas	1					(2)	(2)
California	3					(2)	(2)
Georgia	2					(2)	(2)
Maine	1			(2)	(2)	(2)	(2)
Maryland	1					(2)	(2)
New York	13	82	5,587	4,438	847	1,338,281	1,344,715
Pennsylvania	17	72,638	1,458,594	2,495,467	1,722,889	1,239,815	4,421,298
Vermont	13	(2)	(2)	(2)	(2)	3,408,476	4,438,638
Virginia	4	(2)	(2)			(2)	820,124
Undistributed		48,760	1,104,032	876,381	1,023,479	1,611,777	1,889,002
Total	55	121,480	2,568,213	3,376,286	2,747,215	7,598,349	12,913,777

[1] Flagging and similar products, granules, and flour.
[2] Included with "Undistributed"; figure withheld to avoid disclosure of individual company confidential data.

Slate production in Pennsylvania was concentrated in Northampton County, with 1 producer in the adjoining Lehigh County and 1 producer in York County. The 17 operators who were active in 1954 continued to produce during 1955 all types of dimension and crushed slate, with roofing slates the largest single item, amounting to 33 percent of the total value of slate production in the State.

TABLE 3.—Slate sold by producers in Pennsylvania, 1946–50 (average) and 1951–55, by uses

Year	Operators	Roofing slate		Mill stock					
				Electrical		Structural and sanitary		Vaults and covers	
		Squares (100 square feet)	Value	Square feet	Value	Square feet	Value	Square feet	Value
1946–50 (average)	24	123,796	$2,140,351	54,296	$32,761	581,684	$382,293	44,742	$21,869
1951	25	134,180	2,681,072	13,830	16,167	983,930	580,119	12,570	10,336
1952	18	93,200	1,866,479	2,630	3,518	1,022,390	589,845	8,890	7,028
1953	18	86,116	1,688,167	7,425	7,751	[1] 1,203,956	[1] 702,155	(1)	(1)
1954	17	77,819	1,487,870	(1)	(1)	[1] 1,093,590	[1] 735,172	(1)	(1)
1955	17	72,638	1,458,594	(1)	(1)	[1] 1,423,812	[1] 1,055,195	(1)	(1)

Year	Mill stock—Continued						Other uses (value)	Total value
	Blackboards and bulletin boards		Billiard-table tops		School slates			
	Square feet	Value	Square feet	Value	Square feet	Value		
1946–50 (average)	1,017,844	$525,631	246,036	$137,705	321,768	$10,844	$1,346,896	$4,598,350
1951	1,133,770	667,011	207,490	131,081	237,500	11,943	1,591,141	5,688,870
1952	[2] 922,860	[2] 553,509	121,250	73,571	(2)	(2)	1,393,698	4,487,648
1953	[2] 1,080,034	[2] 699,098	71,851	43,316	(2)	(2)	1,279,125	4,419,612
1954	[2] 1,295,911	[2] 808,872	116,338	72,937	(2)	(2)	1,314,588	4,419,439
1955	[2] 970,716	[2] 603,288	100,939	64,406	(2)	(2)	1,239,815	4,421,298

[1] Electrical and vaults and covers included with structural and sanitary to avoid disclosure of individual company confidential data.
[2] A small quantity of school slates included with blackboards and bulletin boards.

Production in Vermont during 1955 consisted principally of roofing slate, structural slate, flagging, and granules. The total output decreased slightly in 1955 because of a lower production of roofing slate and granules than in 1954. Although 5 of the 1954 producers ceased operations, 2 new producers entered the industry in Vermont, resulting in 13 operators for 1955 compared with 16 in 1954. The entire production of slate in Vermont came from Rutland County.

Roofing was the principal slate product of Virginia, and the increased production of this commodity in 1955 accounted for most of the 75-percent increase in value for the State. The four producers in 1954 continued operations in 1955. Separate figures cannot be given for the various products—roofing slates, flagging, and granules. Most of the output came from Buckingham County.

Except for some flagging in California, the entire production of slate in Arkansas, California, Georgia, and Maryland was crushed slate—mainly granules and flour. Production in 1955 in Arkansas, Georgia, and California increased but in Maryland decreased. Again in 1955 the use of expanded slate as a lightweight aggregate was reported by a Georgia producer.

CONSUMPTION AND USES

Dimension Slate.—Roofing and mill stocks, which are cut to specified shapes and sizes, together with flagging and related products, are classed as dimension slate.

TABLE 4.—Dimension slate sold by producers in the United States, 1946–50 (average) and 1951–55

Year	Roofing			Mill stock		Other [1]		Total	
	Squares	Approximate equivalent short tons	Value	Approximate short tons	Value	Approximate short tons	Value	Approximate short tons	Value
1946–50 (average)	183,018	69,000	$3,500,434	13,104	$1,587,103	47,880	$779,346	129,984	$5,866,883
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
1953	142,292	53,470	3,005,649	16,995	2,220,504	82,438	1,458,651	152,903	6,684,804
1954	117,729	43,549	2,401,087	17,796	2,378,323	90,281	1,569,409	151,626	6,348,819
1955	121,480	45,611	2,568,213	20,732	2,747,215	74,478	1,266,937	140,821	6,582,365

[1] Includes flagstones, walkways, stepping stones, and miscellaneous slate.

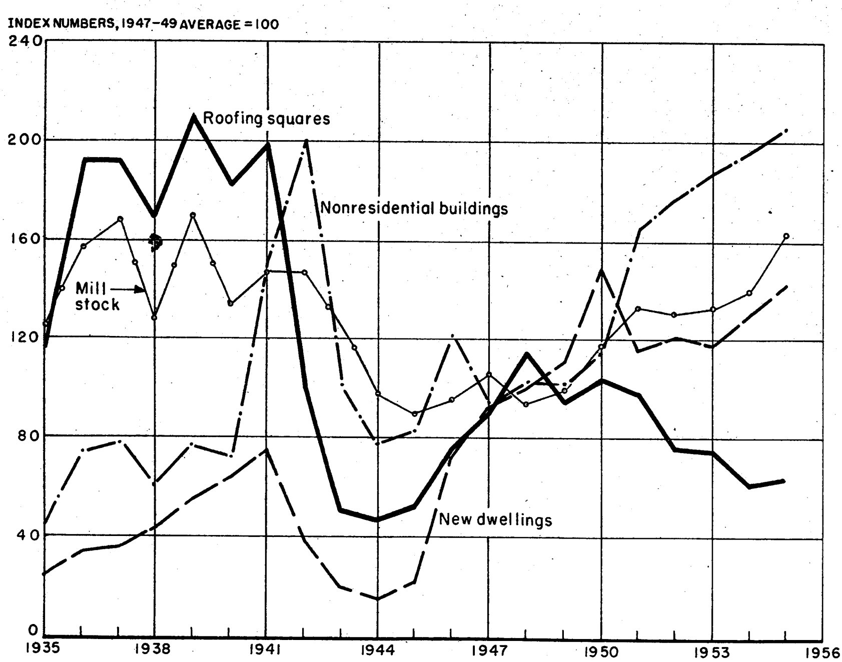

FIGURE 1.—Sales of roofing slate and mill stock compared with number of new dwelling units and value of certain new nonresidential construction, adjusted to 1947–49 prices, 1935–55. Data on number of new dwelling units in nonfarm areas from U. S. Department of Labor; data on nonresidential construction from U. S. Department of Commerce and U. S. Department of Labor.

The consumption of roofing slate followed the trend in residential building until 1948. Since then slate has faced increasing competition from other types of roofing materials, and sales of roofing slate have fallen far below the level of new residential construction. This is shown graphically in figure 1. Sales of roofing slate are also graphed in figure 2.

Mill stock was used for blackboards in schools and for steps, baseboards, and other units in office buildings and nonresidential construction. As indicated in figure 1, sales of mill stock gained in 1955 but did not pace this type of construction. Other materials were used to a greater degree as substitutes for slate in these fields.

Figure 2 shows graphically the value of slate sold, by principal uses, including blackboards and bulletin slates, which are classed as mill stock.

Sales of slate for flagstones, walkways, stepping stones, and other uses decreased in 1955. These sales, combined with mill-stock sales other than blackboards and bulletin boards, are shown as miscellaneous sales in figure 2.

Crushed Slate.—Since 1952 sales of granules, flour, and other crushed slates represented nearly four-fifths of the total weight of slate sold, but the total sales value was approximately the same as that of the other one-fifth. The total value of crushed slate is pictured in figure 2.

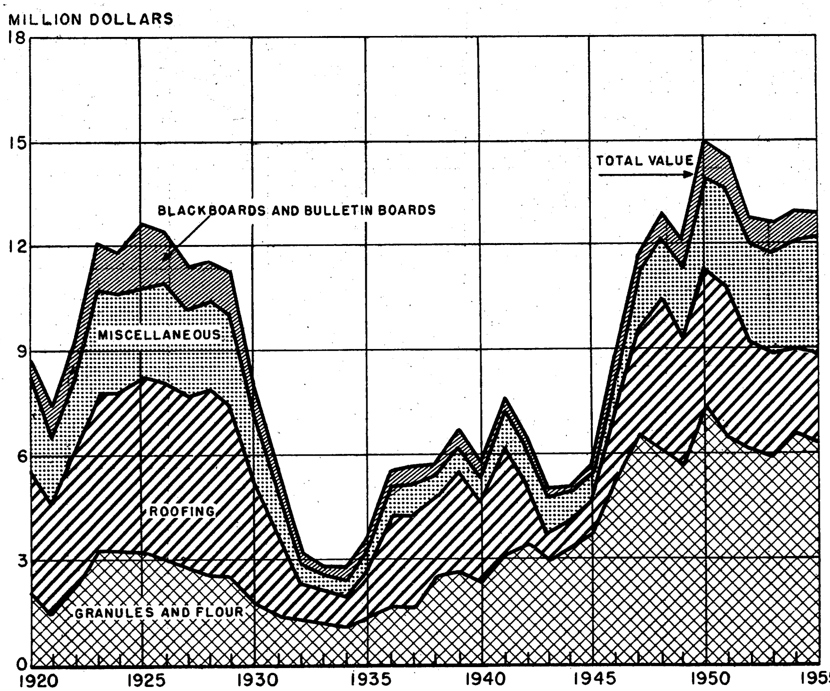

FIGURE 2.—Value of slate sold in the United States, 1920–55, by principal uses.

TABLE 5.—Crushed slate (granules and flour) sold by producers in the United States, 1946–50 (average) and 1951–55

Year	Granules		Flour		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	533,054	$5,590,670	158,124	$666,916	691,178	$6,257,586
1951	500,320	5,771,971	147,890	754,646	648,210	6,526,617
1952	451,870	5,390,202	141,520	729,645	593,390	6,119,847
1953	395,881	5,105,429	149,805	848,232	545,686	5,953,661
1954	[1] 474,336	[1] 5,889,062	134,959	722,733	609,295	6,611,795
1955	[1] 466,604	[1] 5,539,315	153,015	792,097	619,619	6,331,412

[1] Includes a small quantity of crushed slate used for lightweight aggregate.

PRICES

Roofing Slates.—Competition from other materials since 1948 has prevented roofing slate from sharing the general increase in prices of building material, as revealed in figure 3. The value at the quarries increased from $20.40 per square in 1954 to $21.14 in 1955. In New York only a small quantity was sold, at a price of $68.13 in 1955

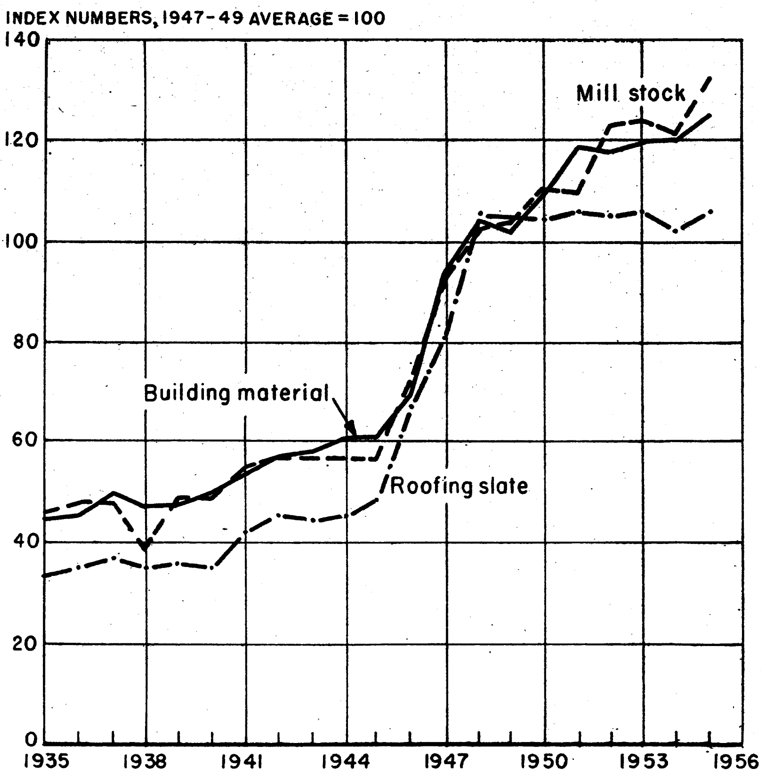

FIGURE 3.—Average selling price of slate compared with wholesale prices of building materials in general, 1935–55. Wholesale prices from U. S. Department of Labor.

compared with $44.95 in 1954; in Pennsylvania the 1955 price was $20.08 per square, compared with $19.12 in 1954. There were so few producers in Vermont and Virginia that sales in these States were grouped and gave an average price of $22.64 in 1955, compared with $22.74 in 1954.

Mill Stock.—The average price of mill stock was 81 cents per square foot in 1955, compared with 74 cents in 1954. The average price of electrical slates dropped from $1.57 per square foot in 1954 to $1.32 in 1955; structural and sanitary slates increased in value from 72 cents per square foot in 1954 to 80 cents in 1955; blackboards and bulletin boards showed little change at 62 cents per square foot in 1955; and billiard-table tops increased from 63 cents per square foot in 1954 to 64 cents in 1955.

Granules and Flour.—The average price of granules decreased from $12.42 per ton in 1954 to $11.87 in 1955, and the price of flour decreased from $5.36 per ton to $5.18.

FOREIGN TRADE [3]

Imports.—Slate was imported mainly from Italy and Portugal, with a smaller amount from West Germany. The value of imports increased slightly in 1955 compared with 1954.

TABLE 6.—Slate imported for consumption in the United States, 1946–50 (average) and 1951–55, by countries

[U. S. Department of Commerce]

Country	1946–50 (average)	1951	1952	1953	1954 [1]	1955 [1]
North America:						
Canada	$412	$10,257	$4,117	$2,790		$323
Mexico	49					
Total	461	10,257	4,117	2,790		323
South America: Brazil			1,201			
Europe:						
Germany	(2)	8,241	[3] 26,623	[3] 35,299	[3] $23,013	[3] 10,886
Italy	20,299	187,702	121,366	127,076	74,480	75,314
Netherlands			219			
Norway	195				1,996	
Portugal	5,926	45,561	79,743	57,481	45,262	61,675
Spain	85		846			
Switzerland	153	64	63			
United Kingdom	451	12	1,993	1,403		24
Total	27,109	241,580	230,853	221,259	144,751	147,899
Asia:						
China	47					
Japan	86	295	98	96		23
Total	133	295	98	96		23
Africa: Union of South Africa						600
Oceania: Australia		70				
Grand total	27,703	252,202	236,269	224,145	144,751	148,845

[1] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be comparable to years prior to 1954.
[2] Less than $1.
[3] West Germany.

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

Exports.—Exports of all products except structural slate and slate flour decreased in 1955, resulting in a 7-percent decrease in total exports for 1955, compared with 1954. Most of the slate was exported to Canada.

TABLE 7.—Slate exported from the United States, 1946–50 (average) and 1951–55, by uses [1]

Use	1946–50 (average)	1951	1952	1953	1954	1955
Roofing	$10,931	$4,138	$15,110	$9,132	$17,129	$12,801
School slate [2]	20,545	3,891	2,355	1,796	(3)	(3)
Electrical	7,462	13,819	10,041	23,225	9,085	----------
Blackboards	65,205	51,056	62,992	89,346	[3] 91,257	[3] 107,566
Billiard tables	55,229	88,669	85,657	65,129	71,961	
Structural (including floors and walkways)	422,662	294,007	201,748	175,770	231,312	271,268
Slate granules and flour						
Total	582,034	455,580	377,903	364,398	420,744	391,635

[1] Figures collected by the Bureau of Mines from shippers of products named.
[2] Includes slate used for pencils and educational toys.
[3] School slates included with blackboards; in 1955, with blackboards and billiard-table tops.

TECHNOLOGY

The Bureau of Mines issued a publication on slate in 1955.[4] In addition to descriptions of the slate districts of the United States and the mining and preparation of dimension slates, reference is made to the importance of utilizing waste from slate quarries. The methods used at one British quarry to prepare slate flour for market were described.[5]

A new machine for splitting slates was patented.[6] Interest in the utilization of waste slate was shown by the number of patents issued for utilizing slate as lightweight aggregate [7] and as fillers in various products.[8]

[4] Bowles, Oliver, Slate: Bureau of Mines Inf. Circ. 7719, 1955, 12 pp.
[5] Toll, R. W., Slate Powder From Cornwall: Mining Mag. (London), vol. 93, No. 2, August 1955, pp. 76–78.
[6] Lake, E. T., Slate-Splitting Machine: U. S. Patent 2,713,860, July 26, 1955.
[7] Willson, C. D., Cement-Bound Lightweight Aggregate Masses: U. S. Patent 2,703,289, Mar. 1, 1955.
Old, A. F., and Gibson, R. F., Lightweight Aggregate and Apparatus and Process: U. S. Patent 2,721,069, Oct. 18, 1955.
[8] Ford, J. G., and Denault, C. L., Asbestos Fiber Electrical Insulating Member, Impregnated With Methyl Hydrogen Polysiloxane: U. S. Patent 2,717,219, Sept. 6, 1955.
Ray, H. G., Artificial Lumber Products and Their Manufacture: U. S. Patent 2,717,420, Sept. 13, 1955.
Christensen, J. C., and Fair, W. F., Jr., Composite Coated Structural Articles: U. S. Patent 2,727,832, Dec. 20, 1955.

Sodium and Sodium Compounds

By Robert T. MacMillan [1] and Annie L. Marks [2]

IN 1955 THE PRODUCTION of both soda ash and salt cake from natural deposits was the highest on record. An important factor in the increased soda-ash output was the continued expansion at the large trona deposit in Wyoming. A new producer of salt cake from Searles Lake brines helped to swell the salt-cake total.

DOMESTIC PRODUCTION

Most soda ash (sodium carbonate) used in the United States was manufactured from salt by the ammonia soda process; however, an increasing proportion (11 percent in 1955) has been produced from natural deposits in California and Wyoming. The production of manufactured soda ash increased 4 percent over 1954, nearly equaling the 1951 record, while natural-soda-ash production increased 16 percent to a new production record. The outlook for soda ash as a whole was stable, with a continuing annual-production increase of about 4 percent per year.[3]

TABLE 1.—Manufactured sodium carbonate produced [1] and natural sodium carbonates sold or used by producers in the United States, 1946–50 (average) and 1951–55

Year	Manufactured soda ash (ammonia-soda process) [2]	Natural sodium carbonates [3]	
	Short tons	Short tons	Value
1946–50 (average)	4,258,313	[4] 269,803	[4] $5,524,005
1951	5,093,927	350,688	8,368,037
1952	4,442,450	323,479	7,828,033
1953	4,879,396	419,206	10,627,460
1954	[5] 4,701,364	527,282	13,536,345
1955	[5] 4,906,971	613,594	15,000,966

[1] U. S. Bureau of the Census.
[2] In 1954 reported as total crude bicarbonate. Before January 1953 reported as 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 in 1948–49.
[5] Preliminary figure.

In California, natural soda ash was produced from lake brines of Owens and Searles Lakes. American Potash & Chemical Corp. and West End Chemical Co. operated their respective plants at Trona and Westend on Searles Lake, while Columbia Southern Corp., a

[1] Commodity specialist.
[2] Statistical assistant.
[3] Miller, R. C., Soda-Ash Target: 6 Million: Chem. Eng., vol. 62, No. 7, July 1955, pp. 298–302.

subsidiary of Pittsburgh Plate Glass Co., operated a plant near Bartlett on Owens Lake.

In Wyoming a large deposit of trona was mined at a depth of about 1,500 feet and converted to sodium carbonate at Westvaco by Intermountain Chemical Corp., a subsidiary of Food Machinery & Chemical Corp.

Improvements and modernization, including sinking of a third shaft, were reported underway at the Westvaco mine. Production was expected to increase approximately 8 percent.[4]

A new $3 million soda-ash plant of Dow Chemical Co. Texas Division was completed at Freeport, Tex. The new plant produced granular crystals by a process differing markedly from the Solvay process used by major producers for many years.[5]

In 1955 the total United States production of sodium sulfate (crude salt cake), including both the manufactured and natural varieties, increased about 3 percent over the previous year. This increase was more than supplied by an increase of 14 percent in salt cake produced from natural sources.

The new plant of West End Chemical Co., Westend on Searles Lake, and increased production facilities of American Potash & Chemical Corp., also at Searles Lake, contributed to the record production of natural salt cake in 1955.

Sodium sulfate recovery by West End Chemical Co. was reported to be unique in that crystallization was caused by chilling rather than evaporation. The brine was chilled in a triple-effect refrigeration cycle. Sodium sulfate decahydrate was crystallized, separated from the brine in a classifier, and dehydrated in a special evaporator.

The following firms and individuals reported production of natural sodium sulfates: American Potash & Chemical Corp. plant at Trona on Searles Lake; Ozark-Mahoning Co., producing from subterranean brines at Monahans, Tex.; William E. Pratt, from deposits in Wyoming; Iowa Soda Products Co. plant at Rawlins, Wyo.; and West End Chemical Co. plant on Searles Lake.

Although production of salt cake from natural sources has increased greatly in recent years, the greater part was still produced as a byproduct or coproduct of several important chemical industries. Among these were the Mannheim plants for producing hydrochloric acid, rayon plants, cellophane plants, and plants producing sodium dichromate, phenol, boric acid, formic acid and lithium salts.

According to the Bureau of the Census, United States Department of Commerce, the production of metallic sodium in 1955 was 114,700 short tons (preliminary figure) compared with 126,887 tons in 1954, a decrease of nearly 10 percent. Substantially all the metal was produced in Downs cells by electrolysis of mixtures of salt (NaCl) and calcium chloride. The metal was produced at 4 plants by the following 3 companies: National Distillers Chemical Co. plant at Ashtabula, Ohio; E. I. du Pont de Nemours & Co., Inc., plant at Niagara Falls, N. Y.; and Ethyl Corp. plants at Baton Rouge, La., and Houston, Tex.

---

[4] Pit and Quarry, vol. 48, No. 4, October 1955, p. 19; vol. 48, No. 5, November 1955, p. 82.
[5] Chemical and EngineeringNews, Dow Ships First Soda Ash: Vol. 33, No. 42, Oct. 17, 1955, p. 4396.

TABLE 2.—Sodium sulfate produced and sold or used, by producers in the United States, 1946–50 (average) and 1951–55

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
1946–50 (average)	597,749	179,288	149,418	218,939	$2,841,262
1951	707,388	219,942	233,666	(3)	(3)
1952	662,373	177,929	202,813	236,825	3,217,000
1953	685,184	204,159	219,751	248,230	3,340,760
1954	[4] 663,476	[4] 145,093	[4] 237,744	249,701	3,890,303
1955	[4] 685,215	[4] 150,248	[4] 288,788	284,549	5,381,313

[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 confidential data.
[4] Preliminary figure.

CONSUMPTION AND USES

Soda ash continued to be one of the major chemical commodities. Thousands of tons was used in producing glass, nonferrous metals, pulp and paper, soap, detergents, water softeners, cleansers, textiles, petroleum products, caustic and bicarbonate soda, and other chemicals.

Consumption of soda ash in the glass industry was estimated to be higher than in 1954. Increased consumption was also estimated for the detergents, rayon, and paper industries. The expanding aluminum industry required greater supplies of soda ash. It was estimated that more than ¼ ton of soda ash is required for makeup in producing 1 ton of primary aluminum.

Soda-ash-consumption estimates from Chemical Engineering, used in previous issues of the Minerals Yearbook, were not available for 1955.

Salt cake was principally consumed by the kraft-pulp industry in digesting wood pulp to produce fiber for papermaking.[6] Continued expansion of the kraft-pulp facilities was expected to increase the demand for salt cake. Other uses of salt cake were in manufacturing glass, detergents, ceramics, mineral stock feeds, pharmaceuticals, and chemicals.

The cutback in metallic sodium production was partly explained by changes in methods used in hydrogenation of fats, oils, and high alcohols. Hydrogenation, using hydrogen gas and a catalyst such as nickel, was supplanting the use of metallic sodium to some extent in this field.

The manufacture of tetraethyl lead (TEL) for use as a gasoline antiknock continued to absorb a high percentage of metallic-sodium production.

Pharmaceuticals and chemicals, such as sodium peroxide, sodium amide, sodium hydride, and sodium cyanide, also consumed sodium.

A titanium plant using a sodium-reduction process began producing in England in 1955; an American plant also using a sodium reduction

[6] Chemical and Engineering News, Sodium Sulfate—Five-Source Item: Vol. 33, No. 39, Sept. 26, 1955, p. 4098.

process was nearing completion. However, future expansion of the titanium industry was not expected to depend exclusively on sodium-reduction methods. The development of sodium and sodium alloys as heat-transfer mediums for atomic powerplants continued to advance.

PRICES

Prices of soda ash and salt cake increased during the year while the quotations for sodium metal remained the same as in 1954.

According to Oil, Paint and Drug Reporter, soda ash, dense, 58 percent carlots, works, was quoted per 100 pounds at $1.40 in bulk and $1.70 in paper bags from January through September. From October to the year end the quotations were increased to $1.50 and $1.80, respectively. During the same periods and on the same basis, quotations per 100 pounds for light soda ash were $1.35 and $1.65. These increased in October to $1.45 and $1.75 for the bulk and packaged varieties, respectively.

Bulk salt cake, works, 100 percent Na_2SO_4 basis, was quoted in Oil, Paint and Drug Reporter at $24 per ton in January and $28 per ton for the remainder of the year. Sodium sulfate, technical, anhydrous, bags, carlots, delivered, was quoted at $52 per ton throughout the year. Quotations for detergent-grade and rayon-grade sodium sulfate were steady at $34 and $31 per ton.

Sodium metal in tank cars, works, was quoted at $0.16 per pound. The price was $0.17 per pound for bricks in greater than 14,000-pound lots. In smaller quantities the bricks sold for $0.17½ per pound.

FOREIGN TRADE [7]

Imports of sodium sulfate in 1955 increased 5 percent over the previous year. Over half was supplied by Canada. Belgium, West Germany, Japan, France, and Mexico supplied smaller tonnages. Total imports of sodium sulfate were approximately 18 percent of domestic production.

Exports of sodium carbonate and sodium sulfate decreased slightly in 1955; however, exports represented only 3 and 4 percent, respectively, of the domestic production of these commodities.

TABLE 3.—Sodium sulfate imported for consumption in the United States, 1946–50 (average) and 1951–55

[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
1946–50 (average)	36,784	$487,166	29	$582	1,162	$22,457	37,975	$510,205
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
1953	53,468	875,599			7,730	206,645	61,198	1,082,244
1954	116,403	2,062,172			2,109	78,768	118,512	2,140,940
1955	120,795	2,412,372			3,679	117,411	124,474	2,529,783

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

TABLE 4.—Sodium carbonate and sodium sulfate exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Sodium carbonate		Sodium sulfate	
	Short tons	Value	Short tons	Value
1946–50 (average)	104,051	$5,083,335	(1)	(1)
1951	155,146	6,903,150	25,634	$797,360
1952	105,933	4,031,110	27,909	781,582
1953	165,405	5,819,304	28,192	804,887
1954	163,548	5,527,442	24,965	822,684
1955	151,799	4,882,800	24,561	870,182

[1] Data not separately classified before 1949. 1949: 14,440 short tons ($510,000); 1950: 16,834 short tons ($422,263).

TECHNOLOGY

Sodium Sulfate.—One of the processes by which the American Potash & Chemical Corp. produces salt cake from Searles Lake brines was described in an article.[8] The concentrated brine was pumped from underneath and sprayed onto the dry surface of the lake during the winter when the prevailing temperature was low enough to cause crystallization of Glauber's salt from the brine. Stacks of crude salt 14 feet high, 600 feet wide, and 3,000 feet long were formed. In summer, when the temperature was too high for crystallization, the crop was harvested and processed at the company plant.

A new sulfite process developed in Sweden for pulping pinewood was described in an article.[9] The process was said to be adaptable to American practice and would recover many of the reagent chemicals. This process offers a saving in operating costs and reduces stream pollution, an important consideration for pulp mills. The inevitable losses of reagent are made up with sodium sulfate.

Sodium.—A third edition of the Liquid-Metals Handbook, designated "Sodium—NaK Supplement" was released by the Atomic Energy Commission. Subjects covered included chemical and physical properties, heat transfer, system design, safety protection, and applications.

A patent was issued describing a method of producing sodium which comprises reacting sodium ferrite, ferrate, or hypoferrite with iron at a temperature of at least 1,100° C. under a partial pressure of sodium vapor of not more than 2 mm. of mercury.[10]

WORLD REVIEW

NORTH AMERICA

Canada.—Production of salt cake from natural deposits and lake brines in Saskatchewan increased 8 percent over 1954. The Government-owned Saskatchewan Minerals Corp. reopened the plant at

[8] Chemical and Engineering News, vol. 33, No. 42, Oct. 17, 1955, p. 4400.
[9] Chemical Engineering, New Sulfite Pulp From Pine Cuts Pollution: Vol. 62, No. 12, December 1955, p. 134.
[10] Hansley, V. L. (Assigned to E. I. du Pont de Nemours & Co.), Method of Producing Sodium: U. S. Patent 2,710,798, June 14, 1955.

Chaplin and planned to expand facilities at Bishopric. Private plants continued to operate at Palo, Ormiston, and Gladmar.[11]

The royalty on salt cake mined from Government leases was reduced 20–30 percent, retroactive to April 1, 1955.[12] The reduction of royalty was based on a formula involving the magnitude of production and the selling price. Less royalty was required of the small producers.

SOUTH AMERICA

Colombia.—The Colombian Government lowered the tariff on rayon-type caustic soda from $0.06 per kilogram plus 15 percent ad valorem to $0.16 per kilogram and 6 percent ad valorem, based on official exchange rates. The tariff on caustic for other purposes remained unchanged at the higher rate.

EUROPE

France.—Soda-ash production in France was reported to be 800,277 short tons in 1955, a substantial increase over the 1954 production.

ASIA

India.—Soda-ash requirements of India were expected to increase from the present 115,000 tons per year to 300,000 tons by 1960. It was questionable whether the proposed new plants at Porbander in Saurashtra State and Tuticorin in Madras State would increase total production sufficiently to meet the demand.[13]

Indonesia.—The Indonesian Government has begun building a 10 ton-per-day electrolytic caustic soda plant along with a bleaching powder plant and a water purifying installation.[14]

Israel.—A new chlorine-caustic plant at Haifa was expected to begin producing in late fall of 1955. In addition to a daily production of 8.3 tons of caustic soda and 7.5 tons of chlorine, the plant was expected to produce muriatic acid and agricultural chemicals.[15]

AFRICA

Kenya.—Output of soda ash in Kenya in 1955 totaled 139,713 short tons, compared with 107,603 short tons in 1954.[16]

OCEANIA

Australia.—Soda-ash and caustic soda requirements of Australia increased 10 percent during 1955. Additional production for meeting the demand was coming from the recently completed plant of Imperial Chemical Industries of Australia and New Zealand, Ltd., Botany, New South Wales.[17]

---

[11] Chemical and Engineering News, vol. 33, No. 5, Jan. 31, 1955, p. 422.
[12] Northern Miner, Sodium Sulfate Royalty Is Cut in Saskatchewan: Vol. 41, No. 21, Aug. 18, 1955, p. 11.
[13] Chemical Week, vol. 76, No. 25, June 18, 1955, p. 33. Canada Foreign Trade, vol. 104, No. 2, July 23, 1955, p. 25.
[14] Chemical Age, vol. 73, No. 1890, Oct. 1, 1955, p. 732.
[15] Chemical and Engineering News, vol. 33, No. 18, May 2, 1955, p. 1881.
[16] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 4, April 1956, p. 36.
[17] Chemical Age, vol. 73, No. 1892, Oct. 15, 1955, p. 842.

Stone

By Wallace W. Key[1] and Nan C. Jensen[2]

TONNAGEWISE stone was one of the leading mineral commodities mined in 1955, being exceeded only by coal, and sand and gravel. Its growth paralleled the ever-increasing demands of general building and highway construction and other consuming industries. Low prices were maintained in the face of rising costs by using highly efficient plants.

Financing methods suspended action on the 1955 highway bill, at least temporarily; but the groundwork was laid, and the industry, in general, felt that continued expansion was warranted.

TABLE 1.—Stone sold or used by producers in the United States,[1] 1946–50 (average) and 1951–55, by kinds

Year	Granite		Basalt and related rocks (traprock)		Marble		Limestone	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	15,347,768	$39,289,274	20,190,362	$28,242,895	243,160	$10,363,762	159,306,758	$206,583,468
1951	20,288,467	49,405,475	29,404,512	42,914,706	256,339	10,641,219	205,479,815	287,675,332
1952	22,279,002	51,531,884	29,760,760	46,437,787	238,048	10,888,353	217,105,542	308,244,992
1953	23,485,156	55,110,162	30,097,694	46,479,615	453,800	12,190,552	225,126,119	317,971,834
1954	23,450,347	56,704,986	30,807,781	49,593,585	538,384	13,794,048	[2, 3] 316,443,037	[2, 3] 423,565,121
1955	26,097,156	60,310,232	35,850,613	57,279,405	1,092,179	19,786,276	[3] 363,378,689	[3] 491,297,026

Year	Sandstone		Other stone[4]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	6,881,688	$17,947,220	15,645,280	$14,359,152	217,615,016	$316,785,771
1951	8,792,232	24,979,317	21,320,568	20,332,981	285,541,933	435,949,030
1952	8,649,584	25,004,372	23,553,491	22,730,718	301,586,427	464,838,106
1953	8,655,161	28,270,960	19,023,713	23,305,593	306,841,643	483,328,716
1954	[5] 12,118,698	[5] 35,321,029	16,287,499	[2] 20,178,596	[2, 6] 411,074,169	[2, 6] 613,398,181
1955	[5] 13,445,778	[5] 39,142,704	17,706,414	22,531,119	[6] 470,692,173	[6] 709,677,307

[1] Includes Territories of the United States, possessions, and other areas administered by the United States. 1946–53 excludes stone used for abrasives and in making cement and lime.
[2] Revised figure.
[3] Includes limestone, cement rock, and dolomite used in making cement, lime, and dead-burned dolomite.
[4] Includes mica schist, conglomerate, argillite, various light-color volcanic rocks, serpentine not used as marble, soapstone sold as dimension stone, etc.
[5] Includes ground sandstone, quartz, and quartzite used for abrasives and other uses.
[6] Includes: 1954—11,428,423 tons of oystershell valued at $14,240,816; 1955—13,121,344 tons, $19,330,545.

[1] Commodity specialist.
[2] Statistical assistant.

TABLE 2.—Stone sold or used by producers in the United States,[1] 1954–55, by uses

Use	1954		1955	
	Quantity	Value	Quantity	Value
Dimension stone:				
Building stone:				
Rough construction .... short tons..	462,024	$2,553,325	365,563	$2,195,010
Cut stone, slabs, and mill blocks [2] ....cubic feet..	14,267,398	[3] 40,176,140	17,684,714	49,767,751
Approximate equivalent in short tons........	1,071,648		1,331,142	
Rubble .... short tons..	389,701	904,014	374,559	1,372,171
Monumental stone .... cubic feet..	2,842,456	18,105,085	2,936,382	17,294,278
Approximate equivalent in short tons........	235,203		243,225	
Paving blocks .... number..	208,204	18,247	1,053,775	127,328
Approximate equivalent in short tons........	977		5,950	
Curbing .... cubic feet..	1,554,943	3,408,017	1,468,889	3,915,898
Approximate equivalent in short tons........	128,117		120,830	
Flagging .... cubic feet..	1,203,088	1,932,473	1,405,331	2,049,927
Approximate equivalent in short tons........	94,613		109,959	
Total dimension stone (quantities approximate, in short tons)........	2,382,283	[3] 67,097,301	2,551,228	76,722,363
Crushed and broken stone:				
Riprap .... short tons..	7,642,332	10,979,042	10,285,771	13,680,155
Concrete and roadstone .... do....	216,614,445	289,441,803	256,454,230	338,593,129
Railroad ballast .... do....	15,172,606	14,871,002	15,870,781	16,757,595
Furnace flux (limestone) .... do....	33,161,736	40,933,952	40,068,165	52,905,898
Refractory stone [4] .... do....	[3] 1,078,142	[3] 5,191,218	1,169,330	5,777,984
Agriculture (limestone) .... do....	18,247,121	30,199,337	18,360,040	29,455,066
Portland and natural cement (limestone, cement rock, and oystershell) .... short tons..	[3] 73,493,313	[3] 75,390,117	84,209,324	89,664,629
Lime and dead-burned dolomite [5] .... do....	[3] 15,245,917	[3] 20,024,246	16,409,221	21,515,742
Other uses .... do....	[3] 28,036,274	[3] 59,270,163	25,314,083	64,604,746
Total crushed and broken stone .... do....	[3] 408,691,886	[3] 546,300,880	468,140,945	632,954,944
Grand total (quantities approximate, in short tons)........	[3] 411,074,169	[3] 613,398,181	470,692,173	709,677,307

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] To avoid disclosure of individual outputs, dimension stone for refractory use is included with building stone.
[3] Revised figure.
[4] Ganister (sandstone and quartzite) and dolomite.
[5] Limestone (1954–55) and oystershell (1955).

TABLE 3.—Stone sold or used by noncommercial producers in the United States,[1] 1954–55, by uses

(Included in total production)

Use	1954		1955	
	Short tons	Value	Short tons	Value
Building stone	20,264	$72,560	10,386	$69,333
Rubble	13,680	21,582	13,500	29,963
Riprap	2,088,485	2,079,071	3,461,320	3,548,185
Concrete and roadstone	17,457,130	21,327,653	33,199,972	37,937,548
Agricultural (limestone)	501,496	675,252	315,209	449,334
Other uses	2,295,479	1,911,338	985,885	1,103,837
Total	22,376,534	26,087,456	37,986,272	43,138,200

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.

TABLE 4.—Stone sold or used by producers in the United States, 1954–55, by States

State	1954		1955	
	Short tons	Value	Short tons	Value
Alabama	7,393,530	$11,608,937	8,269,355	$11,867,191
Arizona	1,205,452	1,914,315	1,600,939	2,328,566
Arkansas	4,604,067	5,929,638	6,176,313	8,025,634
California	23,303,756	37,541,114	24,726,276	37,893,386
Colorado	1,804,004	2,112,093	2,149,019	3,508,053
Connecticut	[1] 2,829,198	[1] 4,269,430	[1] 3,641,992	[1] 5,451,550
Delaware	(2)	(2)	78,791	227,450
Florida	[1] 14,225,356	[1] 16,832,066	[1] 17,027,967	[1] 22,966,008
Georgia	8,057,600	21,384,227	[1] 7,488,452	[1] 14,249,830
Idaho	2,329,005	3,012,613	1,524,810	1,866,076
Illinois	26,407,088	31,134,135	28,865,724	35,621,394
Indiana	11,181,838	27,460,119	14,124,406	34,679,589
Iowa	13,240,087	16,388,141	15,705,412	18,555,176
Kansas	10,377,008	12,941,822	[1] 12,470,616	[1] 15,887,269
Kentucky	10,129,725	13,285,786	11,933,899	15,579,312
Louisiana	(2)	(2)	1,243,486	1,662,715
Maine	1,023,709	2,355,385	1,192,361	2,542,228
Maryland	5,064,526	8,265,521	[1] 5,342,968	[1] 8,800,044
Massachusetts	2,942,435	9,039,590	4,128,003	11,381,164
Michigan	27,758,443	21,904,517	33,635,612	28,908,784
Minnesota	[1] 2,629,456	[1] 7,485,291	[1] 3,004,521	[1] 7,042,840
Mississippi	[3] 181,418	[3] 181,418	572,816	572,816
Missouri	18,615,739	24,695,110	22,714,765	31,250,757
Montana	1,319,829	1,385,239	1,273,600	1,199,619
Nebraska	2,660,170	3,511,494	3,081,247	4,177,361
Nevada	1,832,781	2,010,592	1,611,942	2,608,900
New Hampshire	72,486	473,298	(2)	(2)
New Jersey	5,772,200	12,109,950	[1] 8,357,599	[1] 17,527,890
New Mexico	771,630	714,037	1,573,441	1,546,665
New York	19,410,121	31,425,701	22,812,222	37,919,063
North Carolina	10,133,728	15,625,331	10,903,366	16,532,910
North Dakota	1,419	3,784	77,366	80,560
Ohio	32,626,737	47,802,169	33,272,567	49,841,246
Oklahoma	[1] 9,238,811	[1] 9,146,995	10,933,355	12,295,274
Oregon	5,872,353	8,617,795	7,741,937	9,417,834
Pennsylvania	40,521,756	61,193,419	44,437,623	70,056,080
Rhode Island	(2)	(2)	(2)	(2)
South Carolina	[1] 2,861,953	[1] 4,233,270	3,455,388	4,920,697
South Dakota	1,614,818	4,928,855	2,262,246	5,679,444
Tennessee	14,040,187	22,046,016	[1] 16,248,126	[1] 24,609,344
Texas	[1, 3] 25,840,338	[1, 3] 29,343,684	27,321,444	33,543,782
Utah	1,127,461	1,545,841	1,925,867	2,650,480
Vermont	436,870	8,178,389	581,749	11,061,196
Virginia	10,893,972	[3] 18,137,501	11,965,890	19,869,675
Washington	5,366,890	9,526,534	6,593,212	10,579,631
West Virginia	7,314,934	11,743,440	5,898,585	9,714,168
Wisconsin	8,289,373	16,187,738	[1] 12,180,452	[1] 18,843,272
Wyoming	1,616,015	1,665,302	1,303,399	2,033,800
Undistributed	[3] 1,500,391	[3] 3,553,089	2,362,666	12,773,745
Total [4]	[3] 406,440,663	[3] 604,850,731	465,793,792	700,350,468
Alaska	283,734	465,423	265,740	289,589
American Samoa	57,600	15,000	9,011	3,948
Canton Island	2,600	5,000	500	1,500
Guam	842,660	2,275,182	1,241,466	3,351,958
Hawaii	[5] 1,483,027	[5] 2,990,632	1,414,304	2,884,354
Johnston Island	98	300	12,090	32,550
Midway Island	490	1,500	------	------
Panama Canal Zone	187,446	245,170	169,485	239,280
Puerto Rico	[3, 5] 1,751,996	[3, 5] 2,492,827	1,783,910	2,515,760
Virgin Islands	3,939	17,134	875	4,900
Wake Island	780	1,300	1,000	3,000
Undistributed	19,136	37,982	------	------
Total [6]	[3] 4,633,506	[3] 8,547,450	4,898,381	9,326,839
Grand total [4]	[3] 411,074,169	[3] 613,398,181	470,692,173	709,677,307

[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] Included with "Undistributed."
[3] Revised figure.
[4] Includes stone used for abrasives and in making cement and lime, and oystershell for various uses.
[5] Certain territory or area totals are incomplete, the portion not included being combined with "Undistributed."
[6] Includes stone used in making cement and lime.

DIMENSION STONE

Dimension stone in 1955 continued to be at a disadvantage in competition with other building materials, largely because of the heavy expense for transporting it. Mainly in construction where the builder insisted on beauty and durability as the first considerations in the selecting of materials was stone used. But despite encroachments by artificial products, there was a rising demand for almost all varieties of stone in 1955. Dimension stone and crushed stone are considered separately in this chapter. Dimension stone refers to blocks and slabs of natural stone, most of which are sawed or cut to definite shapes and sizes. Dimension stone is used principally for constructing masonry walls and memorials. Stone continued predominant in construction of many public buildings. Dimension stone was produced by about 445 operators in 38 States and 2 Territories and remained a $75-million-plus industry.

Dimension stone dominated the memorial field. In 1955, thousands of mausoleums and tombstones were added. For monumental purposes the "reputation" of a stone influenced very largely the extent of its use.

TABLE 5.—Dimension stone sold or used by producers in the United States,[1] 1954–55, by kinds and uses

Kind and use	1954	1955	Change from 1954, percent
Granite:			
Building stone:			
Rough construction......short tons..	49,215	80,117	+63
Value......	$519,112	$587,496	+13
Average per ton......	$10.55	$7.33	−31
Cut stone, slabs, and mill blocks......cubic feet..	703,365	948,196	+35
Value......	$4,902,183	$5,784,153	+18
Average per cubic foot......	$6.97	$6.10	−12
Rubble......short tons..	185,647	140,930	−24
Value......	$365,487	$285,339	−22
Monumental stone......cubic feet..	2,601,136	2,576,451	−1
Value......	$15,442,632	$13,972,579	−10
Average per cubic foot......	$5.94	$5.42	−9
Paving blocks......number..	208,204	1,053,775	+406
Value......	$18,247	$127,328	+598
Curbing......cubic feet..	1,520,198	1,410,612	−7
Value......	$3,257,440	$3,743,861	+15
Total:			
Quantity......approximate short tons..	634,354	634,504	------
Value......	$24,505,101	$24,500,756	------
Basalt and related rocks (traprock):			
Building stone:			
Rough construction......short tons..	52,205	57,632	+10
Value......	$357,769	$209,300	−41
Average per ton......	$6.85	$3.63	−47
Rubble......short tons..	------	2,060	------
Value......	------	$6,420	------
Total:			
Quantity......short tons..	52,205	59,692	+14
Value......	$357,769	$215,720	−40
Marble:			
Building stone (cut stone, slabs, and mill blocks)..cubic feet..	754,282	1,005,127	+33
Value......	$7,192,409	$9,213,268	+28
Average per cubic foot......	$9.54	$9.17	−4
Monumental stone......cubic feet..	241,320	359,931	+49
Value......	$2,662,453	$3,321,699	+25
Average per cubic foot......	$11.03	$9.23	−16
Total:			
Quantity......approximate short tons..	84,626	116,029	+37
Value......	$9,854,862	$12,534,967	+27

See footnotes at end of table.

TABLE 5.—Dimension stone sold or used by producers in the United States,[1] 1954–55, by kinds and uses—Continued

Kind and use	1954	1955	Change from 1954, percent
Limestone:			
Building stone:			
Rough construction ... short tons	303, 241	153, 483	−49
Value	$868, 725	$521, 068	−40
Average per ton	$2. 86	$3. 39	+19
Cut stone, slabs, and mill blocks ... cubic feet	9, 172, 174	11, 151, 186	+22
Value	$18, 392, 364	$23, 296, 714	+27
Average per cubic foot	$2. 01	$2. 09	+4
Rubble ... short tons	183, 136	186, 886	+2
Value	$445, 605	$605, 426	+36
Flagging ... cubic feet	151, 824	284, 498	+87
Value	$147, 176	$176, 116	+20
Total:			
Quantity ... approximate short tons	1, 174, 389	1, 182, 459	+1
Value	$19, 853, 870	$24, 599, 324	+24
Sandstone:			
Building stone:			
Rough construction ... short tons	57, 363	74, 331	+30
Value	$807, 719	$877, 146	+9
Average per ton	$14. 08	$11. 80	−16
Cut stone, slabs, and mill blocks ... cubic feet	3, 288, 762	4, 230, 727	+29
Value	$7, 167, 848	$9, 237, 203	+29
Average per cubic foot	$2. 18	$2. 18	----------
Rubble ... short tons	17, 185	25, 398	+48
Value	$82, 648	$190, 751	+131
Curbing ... cubic feet	51, 649	58, 277	+13
Value	$149, 279	$172, 037	+15
Flagging ... cubic feet	1, 005, 823	1, 043, 191	+4
Value	$1, 738, 953	$1, 761, 491	+1
Total:			
Quantity ... approximate short tons	401, 488	503, 757	+25
Value	$9, 946, 447	$12, 238, 628	+23
Miscellaneous stone:[2]			
Building stone ... cubic feet	348, 815	349, 478	----------
Value	[3] $2, 521, 336	$2, 236, 413	−11
Average per cubic foot	[3] $7. 23	$6. 40	−11
Rubble ... short tons	3, 733	19, 285	+417
Value	$10, 274	$284, 235	+2, 667
Flagging ... cubic feet	28, 537	77, 642	+172
Value	$47, 642	$112, 320	+136
Total:			
Quantity ... approximate short tons	35, 221	54, 787	+56
Value	[3] $2, 579, 252	$2, 632, 968	+2
Total dimension stone, excluding slate:			
Quantity ... approximate short tons	2, 382, 283	2, 551, 228	+7
Value	[3] $67, 097, 301	$76, 722, 363	+14
Slate as dimension stone[4] ... approximate short tons	151, 626	140, 821	−7
Value	$6, 348, 819	$6, 582, 365	+4
Total dimension stone, including slate:			
Quantity ... approximate short tons	2, 533, 909	2, 692, 049	+6
Value	[3] $73, 446, 120	$83, 304, 728	+13

[1] Includes Hawaii and Puerto Rico.
[2] Includes soapstone, mica schist, volcanic rocks, argillite, and other varieties that cannot be classified in the principal groups.
[3] Revised figure.
[4] Details of production, by uses, are given in the Slate chapter of this volume.

The total sales of dimension stone in 1955 increased 6 percent in quantity and 13 percent in value compared with 1954. These figures include slate, but details of that industry are given in the separate chapter on Slate. The preceding table presents salient statistics for 1954 and 1955.

The statistical coverage of the dimension-stone industries has been defined in previous issues of this chapter.

457676—58——67

BUILDING STONE

Building stone in 1955 remained the principal form in which dimension stone was sold. The advent of the steel and concrete age destroyed forever many old uses for dimension stone; however, stone was still favored in the more dignified structures, and total sales of building stone increased in 1955 by 10 percent compared with the previous year. The unit value also increased 10 percent over 1954.

TABLE 6.—Building stone sold or used by producers in the United States [1] in 1955, by kinds

Kind	Rough			
	Construction		Architectural	
	Cubic feet	Value	Cubic feet	Value
Granite	970,729	$587,496	274,245	$765,492
Basalt	685,951	209,300		
Marble			283,272	1,004,839
Limestone	1,828,040	521,068	4,112,536	4,830,739
Sandstone	951,812	877,146	1,400,520	2,380,946
Miscellaneous				
Total	4,436,532	2,195,010	6,070,573	8,982,016

Kind	Finished				Total	
	Sawed		Cut			
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value
Granite [2]	411,698	$1,894,895	262,253	$3,123,766	1,918,925	$6,371,649
Basalt					685,951	209,300
Marble	392,316	2,776,336	329,539	5,432,093	1,005,127	9,213,268
Limestone	5,476,216	9,889,916	1,562,434	8,576,059	12,979,226	23,817,782
Sandstone	2,246,575	5,507,642	583,632	1,348,615	5,182,539	10,114,349
Miscellaneous	[3] 349,478	[3] 2,236,413			349,478	2,236,413
Total	[3] 8,876,283	[3] 22,305,202	2,737,858	18,480,533	22,121,246	51,962,761

[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 in the form of dimension stone increased slightly in tonnage and decreased slightly in value compared with 1954. The average unit value was virtually unchanged. Production of all types of granite dimension stone increased in tonnage and value in 1955, except for rubble and dressed monuments. Granite used for curbing decreased in quantity but increased in value. Both the volume and value of sales increased considerably for paving block compared with the previous year.

Granite was quarried in 21 States, with Massachusetts, Vermont, and Georgia leading in value of production.

Monumental granite sales of the Barre district in Vermont, exclusive of small quantities sold for construction or as crushed stone, are shown in tables 8 and 9.

TABLE 7.—Granite (dimension stone) sold or used by producers in the United States in 1955, 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	10	589	$12,550	[1]	[1]	61	$1,019	80	$440	[1]	[1]	4,785	$88,050			435	$3,911	22,753	$938,804
Colorado	4							368	3,742	[1]	[1]	[1]	[1]					1,245	48,670
Connecticut	5	1,282	8,807	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]					4,550	14,517	4,332	133,760
Georgia	21	[1]	[1]	[1]	[1]	[1]	[1]	65,944	148,990	626,658	$1,374,782	187,919	988,232	[1]	[1]	[1]	[1]	181,879	3,447,761
Maine	7	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]			[1]	[1]	15,236	879,221
Maryland	2	27,043	205,727															27,043	205,727
Massachusetts	7	10,238	174,614	12,545	$32,678	311,889	1,720,400	6,415	11,647	[1]	[1]	[1]	[1]	35,075	$6,052	926,268	2,541,561	121,670	4,858,788
Minnesota	19	830	12,000	[1]	[1]	[1]	[1]	46,838	27,279	41,924	191,708	109,411	1,184,195					69,963	2,525,292
Missouri	1			5,772	19,802					24,225	158,550							2,505	178,352
New Hampshire	1	[1]	[1]			[1]	[1]	[1]	[1]							[1]	[1]	[1]	[1]
New York	1							[1]	[1]							[1]	[1]	[1]	[1]
North Carolina	8	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]	[1]
Oklahoma	7									54,262	202,210	20,726	217,978					6,187	420,188
Oregon	1									[1]	[1]							[1]	[1]
Pennsylvania	3	2,680	25,432									4,500	55,325					8,058	80,757
South Carolina	1									[1]	[1]							[1]	[1]
South Dakota	9			2,250	5,000	20,037	83,048			52,586	106,678	168,475	2,202,933					19,711	2,397,659
Texas	1	[1]	[1]			[1]	[1]					[1]	[1]					[1]	[1]
Vermont	4							[1]	[1]	[1]	[1]	[1]	[1]					72,656	4,659,918
Washington	3							[1]	[1]	[1]	[1]	[1]	[1]			[1]	[1]	500	13,454
Wisconsin	9	[1]	[1]	[1]	[1]					[1]	[1]	51,840	855,149					9,668	1,200,343
Undistributed		37,455	148,366	253,678	708,012	341,964	3,214,194	21,285	93,241	1,162,346	5,537,358	66,794	809,431	1,018,700	121,276	479,359	1,183,872	76,098	2,512,062
Total	124	80,117	587,496	274,245	765,492	673,951	5,018,661	140,930	285,339	1,962,001	7,571,286	614,450	6,401,293	1,053,775	127,328	1,410,612	3,743,861	634,504	24,500,756
Average unit value			$7.33		$2.79		$7.45		$2.02		$3.86		$10.42		$0.12		$2.65		$38.61
Short tons (approximate)		[2]		22,665		55,658				161,000		51,631		5,950		116,553			

[1] Included with "Undistributed" to avoid disclosure of individual company confidential data.
[2] 970,729 cubic feet (approximate).

TABLE 8.—Monumental granite sold by quarrymen in the Barre district, Vermont, 1946–50 (average) and 1951–55

Year	Cubic feet	Value	Year	Cubic feet	Value
1946–50 (average)	954, 906	$3, 669, 266	1953	975, 735	$5, 043, 890
1951	853, 963	4, 100, 912	1954	800, 970	4, 604, 795
1952	599, 544	3, 010, 130	1955	(1)	(1)

[1] Figure withheld to avoid disclosure of individual company confidential data.

TABLE 9.—Estimated output of monumental granite in the Barre district, Vermont, 1953–55

[Barre Granite Association, Inc.]

	1953	1954	1955
Total quarry output, rough stock cubic feet	976, 176	800, 970	808, 075
Shipped out of Barre district in rough do	195, 235	160, 194	161, 615
Manufactured in Barre district do	780, 941	640, 776	646, 460
Light stock consumed in district do	520, 627	427, 184	430, 974
Dark stock consumed in district do	260, 314	213, 592	215, 486
Number of cutters in district	2, 422	2, 422	2, 400
Average daily wage	$15. 00	$15. 12	$15. 28
Average number of days worked	240	240	240
Total payroll for year	$8, 719, 200	$8, 788, 627	$8, 801, 280
Estimated overhead	4, 359, 600	4, 394, 313	4, 400, 640
Estimated value of light stock	2, 577, 105	2, 653, 881	2, 779, 775
Estimated value of dark stock	1, 728, 482	1, 804, 852	1, 734, 672
Estimated polishing cost	1, 964, 554	1, 611, 952	1, 272, 717
Estimated sawing cost	1, 537, 477	1, 261, 527	1, 272, 717
Total value of granite	20, 886, 418	20, 515, 152	20, 261, 801

BASALT AND RELATED ROCKS (TRAPROCK)

Because of their dark color, basalt and related rocks are not used extensively as building stones. Sales for rough construction increased over 1954, as the number of plants reporting increased from 3 to 5. The value dropped considerably compared with the previous year.

Basalt and related dark rocks used for memorials are classed in the trade as "black granite," and data for them are 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 1955, 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, 150	$1, 500	1, 150	$1, 500
Hawaii	1			460	920	460	920
Oregon	1	1, 032	$10, 320			1, 032	10, 320
Pennsylvania [1]	2	56, 600	198, 980	450	4, 000	57, 050	202, 980
Total	5	[2] 57, 632	209, 300	2, 060	6, 420	59, 692	215, 720
Average unit value			$3. 63		$3. 12		$3. 61

[1] Includes a small quantity of dressed architectural and monumental stone.
[2] 685,951 cubic feet (approximate).

MARBLE

Dimension marble used for construction and memorial work increased 37 percent in quantity and 27 percent in value, but compared with 1954 the average value per cubic foot dropped 72 cents. The average value of marble sold for memorial purposes in 1955 was $9.23 compared with $11.03 per cubic foot in 1954; for building construction its value was $9.17 per cubic foot in 1955 and $9.54 in 1954.

TABLE 11.—Marble (dimension stone) sold by producers in the United States' 1954–55, by uses

Use	1954		1955	
	Cubic feet	Value	Cubic feet	Value
Building stone:				
Rough:				
Exterior	130,091	$547,293	185,968	$618,970
Interior	65,171	189,065	97,304	385,869
Finished:				
Exterior	103,033	884,075	297,705	2,974,787
Interior	455,987	5,571,976	424,150	5,233,642
Total exterior	233,124	1,431,368	483,673	3,593,757
Total interior	521,158	5,761,041	521,454	5,619,511
Total building stone	754,282	7,192,409	1,005,127	9,213,268
Monumental stone (rough and finished)	241,320	2,662,453	359,931	3,321,699
Total building and monumental	995,602	9,854,862	1,365,058	12,534,967
Approximate short tons	84,626		116,029	

TABLE 12.—Marble (dimension stone) sold by producers in the United States in 1955, 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)
Colorado	2	2,573	$11,844			2,573	218	$11,844
Georgia	2	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Maryland	1	597	18,900			597	51	18,900
Missouri	3	(1)	(1)	(1)	(1)	(1)	(1)	(1)
North Carolina	1	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Tennessee	13	(1)	(1)	(1)	(1)	397,213	33,763	3,578,493
Vermont	8	334,205	2,649,177	152,442	$1,349,526	486,647	41,365	3,998,703
Undistributed		667,752	6,533,347	207,489	1,972,173	478,028	40,632	4,927,027
Total	32	1,005,127	9,213,268	359,931	3,321,699	1,365,058	116,029	12,534,967
Average unit value			$9.17		$9.23			[2] $9.18
Short tons (approximate)		85,435		30,594				

[1] Included with "Undistributed" to avoid disclosure of individual company confidential data.
[2] Average value per cubic foot.

LIMESTONE

Almost all limestone blocks cut to definite shapes and sizes were used for building purposes. Some was employed for flagging and a negligible quantity for memorials. Sales of all classifications of limestone increased, except that used in rough construction. Unit value increased substantially over the previous year.

TABLE 13.—Limestone (dimension stone) sold or used by producers in the United States in 1955, 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)
California	3	(1)	(1)			(1)	(1)	552	$1,656			(1)	(1)
Colorado	1							211	2,100			211	$2,100
Connecticut	1	(1)	(1)									(1)	(1)
Florida	2			(1)	(1)							(1)	(1)
Georgia	2	1,799	$4,335					448	1,280			2,247	5,615
Hawaii	2							618	1,236			618	1,236
Illinois	8	(1)	(1)	(1)	(1)	2,700	$6,800	914	4,883	18,401	$12,427	3,411	27,642
Indiana	21			3,725,392	$4,204,560	5,547,378	14,289,137	(1)	(1)	(1)	(1)	692,335	18,529,265
Iowa	2							903	1,255			903	1,255
Kansas	12	(1)	(1)	32,474	16,671	270,776	690,560	13,486	19,547	(1)	(1)	40,875	731,665
Maryland	2	250	1,000					184	736			434	1,736
Michigan	4	(1)	(1)			(1)	(1)	(1)	(1)	11,765	10,000	29,907	113,912
Minnesota	5	3,132	97,875	18,164	45,410	(1)	(1)	9,016	50,367	31,926	73,419	26,950	903,473
Missouri	15	12,427	44,500	7,059	1,500	7,733	14,995	30,574	229,615	4,813	3,819	44,667	294,429
Nevada	2	1,074	2,148			30,670	10,408	160	800			3,841	13,356
Ohio	1	7,187	14,347									7,187	14,347
Oklahoma	3	(1)	(1)			(1)	(1)			1,129	576	2,177	15,962
Pennsylvania	4	27,777	112,418					80,915	178,937			108,692	291,355
Puerto Rico	10	82,421	180,913					3,656	6,929			86,077	187,842
Tennessee	2	1,632	1,332									1,632	1,332
Texas	9	2,574	2,574	116,093	131,435	226,369	716,382			1,778	3,545	27,532	853,936
Wisconsin	21	5,185	23,961	89,458	187,098	547,218	1,121,259	11,607	41,299	51,608	51,441	71,855	1,425,058
Undistributed		8,025	35,665	123,896	244,065	405,806	1,616,434	33,642	64,786	163,078	20,889	30,908	1,183,808
Total	133	153,483	521,068	4,112,536	4,830,739	7,038,650	18,465,975	186,886	605,426	284,498	176,116	1,182,459	24,599,324
Average unit value			$3.39		$1.17		$2.62		$3.24		$0.62		$20.80
Short tons (approximate)		(2)		299,755		520,549				21,786			

[1] Included with "Undistributed" to avoid disclosure of individual company confidential data.
[2] 1,828,040 cubic feet (approximate).

The Bedford-Bloomington (Ind.) area continued to produce most of the rough blocks and finished dimension limestone in the United States, its output contributing 75 percent of the total value. Sales by firms operating quarries in the district, as shown in table 14, also include a minor quantity of crushed-stone byproducts. Many dimension-limestone producers utilize the scrap resulting from the block and slab production to supply local crushed-stone markets. Sales by mill operators in the area of finished limestone processed from purchased stone are shown in table 15. Table 16 shows sales by operating quarries in the Carthage district, Missouri.

TABLE 14.—Limestone sold by producers in the Indiana oolitic limestone district, 1946–50 (average) and 1951–55, by classes

Year	Construction					
	Rough block		Sawed and semifinished		Cut	
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value
1946–50 (average)	2, 086, 028	$1, 720, 533	2, 028, 640	$2, 552, 605	720, 090	$3, 112, 099
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
1953	2, 154, 832	2, 380, 991	3, 212, 325	4, 813, 448	682, 185	3, 739, 549
1954	2, 494, 128	3, 140, 464	4, 058, 697	6, 381, 376	995, 585	5, 045, 986
1955	3, 259, 736	3, 877, 770	4, 405, 165	7, 776, 581	1, 142, 213	6, 512, 556

Year	Construction—Continued			Other uses [1]		Total	
	Total						
	Cubic feet	Short tons (approximate)	Value	Short tons	Value	Short tons (approximate)	Value
1946–50 (average)	4, 834, 758	350, 522	$7, 385, 237	131, 666	$254, 427	482, 188	$7, 639, 664
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
1953	6, 049, 342	438, 577	10, 933, 988	154, 556	284, 068	593, 133	11, 218, 056
1954	7, 548, 410	547, 260	14, 567, 826	135, 842	408, 273	683, 102	14, 976, 099
1955	8, 807, 114	638, 516	18, 166, 907	201, 059	575, 068	839, 575	18, 741, 975

[1] Rough construction, rubble, and other stone.

TABLE 15.—Purchased Indiana limestone sold by mills in the Indiana oolitic limestone district, 1946–50 (average) and 1951–55, by classes

Year	Sawed and semifinished		Cut		Total	
	Cubic feet	Value	Cubic feet	Value	Cubic feet	Value
1946–50 (average)	145,248	$194,872	873,726	$3,830,968	1,018,974	$4,025,840
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
1953	173,991	308,338	605,824	3,168,816	779,815	3,477,154
1954	881,588	1,567,847	1,028,713	5,244,156	1,910,301	6,812,003
1955	786,476	1,593,709	970,737	5,590,072	1,757,213	7,183,781

TABLE 16.—Limestone and marble sold by producers in the Carthage district, Jasper County, Mo., 1946–50 (average) and 1951–55, 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
1946–50 (average)	66,472	$610,027	5,186	$27,934	71,658	6,090	$637,961	257,538	$469,807	263,628	$1,107,768
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	110,088	9,358	790,194	226,274	448,249	235,632	1,238,443
1953	127,550	714,854	1,926	15,269	129,476	11,006	730,123	235,065	439,341	246,071	1,169,464
1954	58,772	798,256	1,396	11,478	60,168	5,114	809,734	247,460	455,729	252,574	1,265,463
1955	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)	244,996	1,533,444

[1] Figure withheld to avoid disclosure of individual company confidential data.

SANDSTONE

Sales of dimension sandstone increased 25 percent in quantity and 23 percent in value over 1954. Increases in sales were reported for all uses, but the unit value was slightly less in 1955.

Ohio continued to be the principal producing State, contributing 35 percent of the total tonnage and over half of the value. The leading quarries were in the Amherst area in the northern part of the State. The Crab Orchard area in Cumberland County, Tenn., maintained second place in value of sales, followed by the bluestones of New York, the sales of which were considerably higher than in 1954. Table 18 presents salient statistics of these thin-splitting sandstones of New York and Pennsylvania, known as bluestones.

TABLE 17.—Sandstone (dimension stone) sold or used by producers in the United States in 1955, 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	2	872	$6,107	25,641	$40,000									12,821	$14,000	3,872	$60,107
Arizona	9	(1)	(1)					(1)	(1)	(1)	(1)			340,080	302,149	42,034	504,141
Arkansas	3	4,500	80,000					99,853	$105,446					2,173	1,956	12,152	187,402
California	2	1,933	16,472	(1)	(1)											(1)	(1)
Colorado	15	22,024	416,977					27,307	44,568	754	$7,960			52,910	50,770	29,038	520,275
Georgia	2									900	3,200			5,084	22,000	1,297	25,200
Indiana	2					309,308	$577,778									24,126	577,778
Kansas	1	(1)	(1)			(1)	(1)							(1)	(1)	(1)	(1)
Kentucky	3	1,334	21,256	10,024	11,538					500	2,500	361	$270	1,687	2,140	2,836	37,704
Maryland	1													17,500	19,000	1,400	19,000
Massachusetts	1							3,300	26,200							264	26,200
Michigan	3	7,188	56,940					2,000	6,000	1,543	7,508			6,663	8,962	9,429	79,410
Missouri	2									(1)	(1)			(1)	(1)	(1)	(1)
Nevada	6	150	2,775	(1)	(1)			(1)	(1)	358	6,500			9,410	14,930	(1)	(1)
New Mexico	1							129	250	50	250			1,290	1,800	160	2,300
New York (bluestone)	10	(1)	(1)	49,018	82,840	(1)	(1)	36,464	183,452	(1)	(1)	3,948	3,970	224,139	436,400	33,446	1,035,037
North Carolina	1													15,957	8,762	1,277	8,762
Ohio	8			299,298	616,005	1,857,094	4,601,964	85,667	503,305			53,968	167,797	151,189	365,028	177,424	6,254,099
Oklahoma	4	507	6,591					2,700	2,400	142	1,420			4,000	2,400	1,152	12,811
Oregon	1	2,250	1,500													2,250	1,500
Pennsylvania [2]	21	26,471	162,867	12,331	10,451			81,620	110,723	16,454	92,353			119,949	232,288	60,174	608,682
Tennessee	12			892,862	1,357,663			12,230	38,670					71,382	271,843	76,165	1,668,176
Texas	1	934	6,747													934	6,747
Utah	3	2,628	59,802					6,410	11,250					795	1,209	3,190	72,261
Virginia	1	290	2,320											1,786	2,145	433	4,465
Washington	2	(1)	(1)	(1)	(1)			(1)	(1)							(1)	(1)
Wisconsin	5	400	200					19,326	32,900	40	48			1,638	834	2,117	33,982
Wyoming	1									170	5,000					170	5,000
Undistributed		2,850	36,592	111,346	262,449	80,173	327,900	206,626	283,451	4,487	64,012			2,738	2,875	18,417	487,589
Total	123	74,331	877,146	1,400,520	2,380,946	2,246,575	5,507,642	583,632	1,348,615	25,398	190,751	58,277	172,037	1,043,191	1,761,491	503,757	12,238,628
Average unit value			$11.80		$1.70		$2.45		$2.31		$7.51		$2.95		$1.69		$24.29
Short tons (approximate)		(3)		108,093		165,528		44,508				4,277		81,622			

[1] Included with "Undistributed" to avoid disclosure of individual company operations.
[2] Includes 187,323 cubic feet of bluestone (approximately 15,829 tons) valued at $208,495 sold for rough construction, rubble, and flagging.
[3] 951,812 cubic feet (approximate).

TABLE 18.—Bluestone (dimension stone) sold or used in the United States, 1946–50 (average) and 1951–55[1]

Year	Cubic feet	Value	Year	Cubic feet	Value
1946–50 (average)	332,060	$440,253	1953	322,156	$602,248
1951	253,935	464,200	1954	313,898	935,968
1952	318,198	583,970	1955	583,135	1,243,532

[1] New York and Pennsylvania were the only producing States.

MISCELLANEOUS STONE

Types of stone other than those included in the major groups already discussed are covered in table 19. The principal types in this classification are mica schist, argillite, light-colored volcanic rocks (such as rhyolite), soapstone, and greenstone. The quantity sold in 1955 increased 56 percent, but the value increased only 2 percent compared with 1954.

TABLE 19.—Miscellaneous varieties of stone (dimension stone) sold or used by producers in the United States in 1955, 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
California	10	(1)	(1)	(1)	(1)	786	$15,360	(1)	(1)
Maryland	5	12,074	$71,124	(1)	(1)	(1)	(1)	13,976	$85,305
New Mexico	1	902	821	440	$402			1,342	1,223
New York	1	130	905			381	6,419	511	7,324
Oregon	3	(1)	(1)	(1)	(1)			1,319	32,480
Pennsylvania	4	5,557	16,474			3,790	60,571	9,347	77,045
Virginia	2	(1)	(1)			(1)	(1)	(1)	(1)
Washington	1	(1)	(1)	(1)	(1)			(1)	(1)
Wyoming	1			75	2,270			75	2,270
Undistributed		10,288	2,147,089	18,770	281,563	1,594	29,970	28,217	2,427,321
Total	28	[2] 28,951	2,236,413	19,285	284,235	[3] 6,551	112,320	54,787	2,632,968
Average unit value			$77.25		$14.74		$17.15		$48.06

[1] Included with "Undistributed" to avoid disclosure of individual company confidential data.
[2] Approximately 349,478 cubic feet.
[3] Approximately 77,642 cubic feet.

CONSUMPTION AND USES

The diverging trend from stone in nonresidential construction is indicative of the rapidly growing role of alternate construction materials and the increasing application of stone veneer.

Dimension-stone sales, by kinds, for the past 40 years are shown graphically in figure 1. Figure 2 compares sales indexes of building limestone with all types of building stone and the contract values of nonresidential construction, where the most extensive usage occurs.

Because stone generally was more costly than substitute materials, it was used chiefly for high-grade buildings, where appearance and architectural dignity were important attributes.

Dimension stone is well adapted to ornamental uses, but again substitutes offered considerable competition.

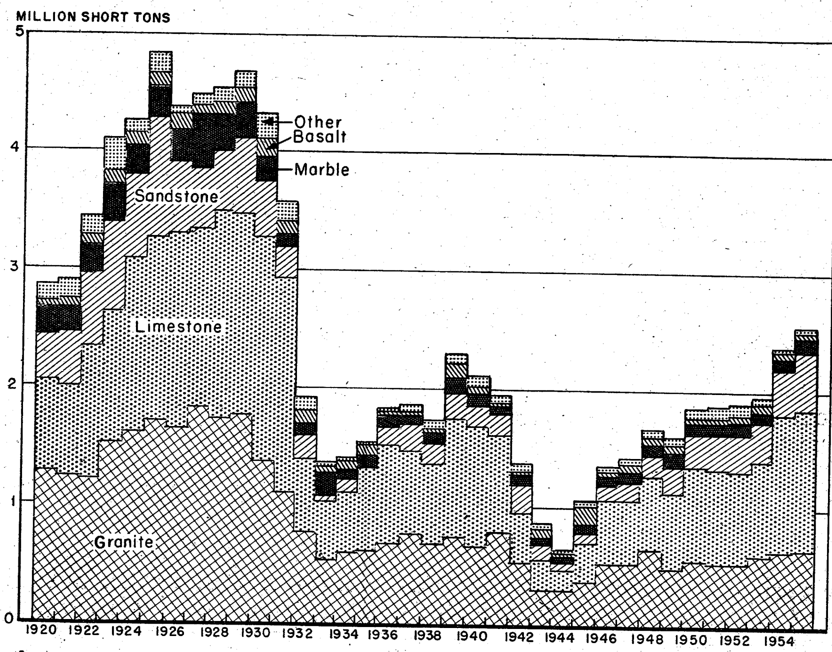

FIGURE 1.—Sales of dimension stone in the United States, by kinds, 1920–55

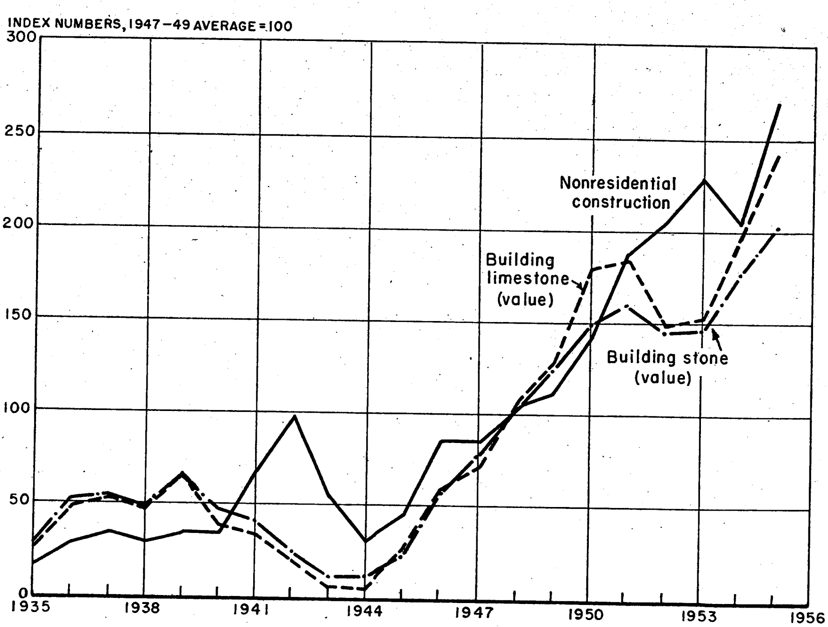

FIGURE 2.—Sales of all building stone compared with sales of building limestone and value of all nonresidential construction, 1935–55.

TECHNOLOGY

The development of specifications for each type of building stone progressed slowly owing to the need for research work and data that would provide means for establishing proper test methods and criteria.[3]

The jet-piercing method of penetrating stone was under experimental study in New England quarries, while other sections of the country watched its achievements with interest. Jet piercing was adapted to dimension-stone use from its original application in the tough, abrasive taconites of the iron ranges.[4]

A trade publication was available on dimension granite used as curbstone, rubble, and other highway applications.[5]

An index of building stones was compiled.[6]

A Bureau of Mines information circular was published on the distribution, qualities, and characteristics of memorial stone.[7]

A specifications manual was available on limestone as dimension stone.[8]

WORLD REVIEW

North America

Canada.—Granite in Canada was quarried mainly for the building and monumental trades and the waste material sold as byproduct crushed stone. Domestic production was centered chiefly in Quebec.[9] The import value of granite totaled $400,000 in 1955, about half of which came from the United States.

Dimension-limestone production of 88,000 tons increased slightly compared with 1954. There was a marked increase in production from Manitoba, offsetting decreases in Ontario and Quebec.[10]

Marble production increased in quantity over 1954, but the value declined. At three locations in Quebec, rough blocks were quarried to be dressed for use in building construction. A number of undeveloped occurrences of good-quality marble were reported along Hudson Bay and the Flin Flon branches of the Canadian National Railways.[11]

Jamaica.—According to the Public Works Department, production of quarried limestone totaled 196,283 cubic yards and crushed limestone 184,351 cubic yards in 1955. Because of the increased private construction, the Public Works Department estimated that its share of the total quantity quarried had declined from 75 to 70 percent.[12]

Europe

Finland.—A small increase in dimension-granite production was reported from Finland. High transportation cost was given as the

---

3 American Society for Testing Materials, Bull. 203, January 1955, p. 11.

4 Carlson, R. M., Fletcher, R. A., Jr., and Mould, C. B. (H. E. Fletcher Co., West Chelmsford, Mass.), paper pres. at February 1955 AIME Meeting, Chicago, Ill.

5 Fletcher, H. E., Standardized Granite Highway Products: Vol. 20, 1955, 24 pp.

6 Building Stone Institute, An Index of Building Stones: Am. Inst. Architects File 8, 1956, 11 pp.

7 Bowles, Oliver, Memorial Stone: Bureau of Mines Inf. Circ. 7720, 1955, 6 pp.

8 Ilco Specification Manual (Indiana Limestone Co., Inc., Bedford, Ind.), 1955, 21 pp.

9 Canada Department of Mines and Technical Survey, Granite in Canada, 1955 (Prelim.): Ottawa, 5 pp.

10 Canada Department of Mines and Technical Survey, Limestone (Structural) in Canada, 1955 (Prelim.): Ottawa, 2 pp.

11 Canada Department of Mines and Technical Survey, Marble in Canada, 1955 (Prelim.): Ottawa, 3 pp.

12 Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 3, March 1955, p. 43.

reason why the export of granite to the leading customer countries—the United States and Canada—did not regain the million-dollar-a-year level attained before World War II.[13]

Italy.—Output of marble blocks in Italy increased to 616,191 short tons in 1955, slightly more than in the previous year.[14]

Africa

South-West Africa.—Marble was produced for the first time in 1954 in this area. Of the 411 tons produced, half was shipped to the Union of South Africa. An extensive occurrence of marble was reported in the Karibib district.[15]

CRUSHED AND BROKEN STONE

Over 468 million tons of crushed and broken stone valued at 633 million dollars was produced in the United States during 1955. This output represented a 15-percent increase in quantity and 16-percent rise in value over the previous year and established an alltime record. The average value was $1.35 a ton. Tonnage gains were recorded in all classifications except that used for sugar manufacture. Detailed data on asphaltic stone and slate granules and flour are given in the Asphalt and Slate chapters of the Minerals Yearbook.

TABLE 20.—Crushed and broken stone sold or used by producers in the United States,[1] 1954–55, by principal uses

Use	1954			1955		
	Short tons	Value		Short tons	Value	
		Total	Average		Total	Average
Concrete and roadstone	216,614,445	$289,441,803	$1.34	256,454,230	$338,593,129	$1.32
Railroad ballast	15,172,606	14,871,002	.98	15,870,781	16,757,595	1.06
Portland and natural cement [2]	[3] 73,493,313	[3] 75,390,117	[3] 1.03	84,209,324	89,664,629	1.06
Furnace flux (limestone)	33,161,736	40,933,952	1.23	40,068,165	52,905,898	1.32
Agricultural limestone	18,247,121	30,199,337	1.66	18,360,040	29,455,066	1.60
Lime and dead-burned dolomite [4]	[3] 15,245,917	[3] 20,024,246	1.31	16,409,221	21,515,742	1.31
Riprap	7,642,332	10,979,042	1.44	10,285,771	13,680,155	1.33
Alkali works	5,329,939	4,659,840	.87	5,753,468	6,280,552	1.09
Refractory [5]	[3] 1,078,142	[3] 5,191,218	[3] 4.81	1,169,330	5,777,984	4.94
Asphalt filler	1,007,358	2,907,688	2.89	1,405,477	4,366,991	3.11
Glass factories	[3] 858,251	[3] 2,403,080	[3] 2.80	904,491	2,626,962	2.90
Calcium carbide works	709,453	611,565	.86	719,428	621,536	.86
Sugar factories	788,210	2,141,351	2.72	661,004	1,624,636	2.46
Paper mills	484,372	1,150,428	2.38	518,381	1,208,742	2.33
Other uses	[3] 18,858,691	[3] 45,396,211	[3] 2.41	15,351,834	47,875,327	3.12
Total	[3] 408,691,886	[3] 546,300,880	1.34	468,140,945	632,954,944	1.35
Asphaltic stone	1,337,822	3,686,227	2.76	1,427,207	4,110,719	2.88
Slate granules and flour [6]	609,295	6,611,795	10.85	619,619	6,331,412	10.22

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.
[2] Limestone, cement rock, and oystershell.
[3] Revised figure.
[4] Limestone (1954–55) and oystershell (1955).
[5] Ganister and dolomite.
[6] Includes a small quantity of crushed slate used for lightweight aggregate.

[13] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 3, March 1956, pp. 27–28.
[14] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 4, April 1956, p. 33.
[15] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 42.

TABLE 21.—Crushed stone for concrete and roadstone and railroad ballast sold or used by producers in the United States,[1] 1946–50 (average) and 1951–55

Year	Concrete and roadstone		Railroad ballast		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	118, 090, 708	$144, 810, 078	17, 421, 564	$15, 181, 235	135, 512, 272	$159, 991, 313
1951	168, 766, 088	216, 418, 613	21, 368, 552	20, 336, 868	190, 134, 640	236, 755, 481
1952	187, 114, 163	245, 976, 919	21, 383, 068	20, 019, 095	208, 497, 231	265, 996, 014
1953	189, 158, 785	251, 514, 832	20, 778, 410	20, 533, 252	209, 937, 195	272, 048, 084
1954	216, 614, 445	289, 441, 803	15, 172, 606	14, 871, 002	231, 787, 051	304, 312, 805
1955	256, 454, 230	338, 593, 129	15, 870, 781	16, 757, 595	272, 325, 011	355, 350, 724

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.

TABLE 22.—Crushed stone for concrete and roadstone and railroad ballast sold or used by producers in the United States in 1955, by States

State	Concrete and roadstone		Railroad ballast		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	1, 246, 079	$1, 520, 215	(1)	(1)	[2] 1, 246, 079	[2] $1, 520, 215
Alaska	8, 726	17, 000	----	----	8, 726	17, 000
American Samoa	9, 011	3, 948	----	----	9, 011	3, 948
Arizona	341, 636	330, 390	----	----	341, 636	330, 390
Arkansas	[2] 1, 574, 507	[2] 1, 637, 426	(1)	(1)	[2] 1, 574, 507	[2] 1, 637, 426
California	11, 047, 258	12, 426, 429	168, 823	$177, 225	11, 216, 081	12, 603, 654
Canton	500	1, 500	----	----	500	1, 500
Colorado	209, 065	337, 908	----	----	209, 065	337, 908
Connecticut	[2] 3, 034, 347	[2] 4, 088, 115	322, 461	374, 256	[2] 3, 356, 808	[2] 4, 462, 371
Delaware	63, 920	191, 760	----	----	63, 920	191, 760
Florida	[2] 13, 394, 698	[2] 16, 732, 609	65, 745	105, 516	[2] 13, 460, 443	[2] 16, 838, 125
Georgia	[2] 5, 304, 826	[2] 7, 290, 874	830, 208	903, 080	[2] 6, 135, 034	[2] 8, 193, 954
Guam	1, 241, 466	3, 351, 958	----	----	1, 241, 466	3, 351, 958
Hawaii	1, 366, 406	2, 848, 853	----	----	1, 366, 406	2, 848, 853
Idaho	[2] 330, 191	[2] 299, 605	[2] 97, 136	[2] 89, 990	975, 174	929, 541
Illinois	20, 825, 065	26, 711, 592	839, 866	987, 725	21, 664, 931	27, 699, 317
Indiana	8, 302, 582	10, 060, 054	270, 255	308, 536	8, 572, 837	10, 368, 590
Iowa	10, 828, 339	12, 743, 504	(1)	(1)	[2] 10, 828, 339	[2] 12, 743, 504
Johnston	12, 090	32, 550	----	----	12, 090	32, 550
Kansas	7, 391, 915	9, 851, 626	[2] 724, 621	[2] 342, 804	[2] 8, 116, 536	[2] 10, 194, 430
Kentucky	[2] 9, 217, 156	[2] 12, 221, 629	367, 404	391, 637	[2] 9, 584, 560	[2] 12, 613, 266
Louisiana	[2] 31, 657	[2] 31, 657	----	----	[2] 31, 657	[2] 31, 657
Maine	479, 053	814, 214	----	----	479, 053	814, 214
Maryland	[2] 3, 292, 992	[2] 5, 127, 217	(1)	(1)	4, 006, 888	6, 200, 812
Massachusetts	3, 336, 645	4, 867, 622	[2] 38, 870	[2] 46, 644	[2] 3, 375, 515	[2] 4, 914, 266
Michigan	4, 823, 019	5, 148, 657	231, 439	249, 506	5, 054, 458	5, 398, 163
Minnesota	[2] 1, 989, 918	[2] 2, 154, 465	435, 343	480, 393	[2] 2, 425, 261	[2] 2, 634, 858
Missouri	11, 812, 194	14, 811, 126	856, 884	282, 980	12, 669, 078	15, 094, 106
Montana	[2] 8, 810	[2] 13, 554	261, 484	287, 375	[2] 270, 294	[2] 300, 929
Nebraska	(1)	(1)	----	----	(1)	(1)
Nevada	382, 671	436, 757	312, 031	319, 544	694, 702	756, 301
New Hampshire	(1)	(1)	----	----	(1)	(1)
New Jersey	[2] 6, 226, 605	[2] 12, 536, 522	271, 677	528, 450	[2] 6, 498, 282	[2] 13, 064, 972
New Mexico	[2] 804, 596	[2] 884, 081	301, 768	224, 048	[2] 1, 106, 364	[2] 1, 108, 129
New York	[2] 12, 044, 888	[2] 20, 938, 924	[2] 647, 578	[2] 842, 817	15, 528, 682	27, 020, 109
North Carolina	[2] 9, 712, 616	[2] 13, 550, 968	(1)	(1)	[2] 9, 712, 616	[2] 13, 550, 968
North Dakota	39, 621	40, 000	----	----	39, 621	40, 000
Ohio	14, 078, 398	17, 102, 510	1, 230, 062	1, 407, 704	15, 308, 460	18, 510, 214
Oklahoma	[2] 7, 847, 490	[2] 9, 390, 127	[2] 191, 768	[2] 180, 691	9, 330, 918	10, 174, 602
Oregon	6, 117, 702	6, 991, 936	540, 059	565, 415	6, 657, 761	7, 557, 351
Panama Canal Zone	158, 685	228, 480	----	----	158, 685	228, 480
Pennsylvania	14, 598, 676	21, 697, 471	[2] 470, 249	[2] 763, 528	[2] 15, 068, 925	[2] 22, 460, 999
Puerto Rico	433, 894	915, 702	480	960	434, 374	916, 662
Rhode Island	(1)	(1)	----	----	(1)	(1)
South Carolina	[2] 2, 454, 759	[2] 3, 365, 337	519, 269	696, 662	[2] 2, 974, 028	[2] 4, 061, 999
South Dakota	1, 099, 528	1, 616, 232	(1)	(1)	[2] 1, 099, 528	[2] 1, 616, 232
Tennessee	[2] 12, 132, 695	[2] 14, 553, 144	588, 207	579, 584	[2] 12, 720, 902	[2] 15, 132, 728
Texas	[2] 11, 834, 249	[2] 14, 178, 184	[2] 582, 123	[2] 574, 045	[2] 12, 416, 372	[2] 14, 752, 229
Utah	(1)	(1)	(1)	(1)	288, 478	216, 445
Vermont	[2] 12, 776	[2] 24, 162	(1)	(1)	[2] 12, 776	[2] 24, 162
Virginia	[2] 5, 228, 388	[2] 7, 225, 007	[2] 360, 001	[2] 418, 661	6, 998, 658	9, 615, 611
Virgin Islands	875	4, 900	----	----	875	4, 900
Wake	900	2, 700	----	----	900	2, 700
Washington	[2] 4, 317, 816	[2] 5, 177, 946	(1)	(1)	[2] 4, 317, 816	[2] 5, 177, 946
West Virginia	1, 374, 743	2, 188, 805	141, 196	200, 494	1, 515, 939	2, 389, 299
Wisconsin	[2] 10, 054, 936	[2] 9, 361, 002	[2] 142, 354	[2] 172, 713	[2] 10, 197, 290	[2] 9, 533, 715
Wyoming	280, 370	271, 152	[2] 305, 001	[2] 278, 424	[2] 585, 371	[2] 549, 576
Undistributed	13, 692, 282	20, 243, 023	3, 756, 419	3, 976, 188	10, 360, 335	14, 575, 130
Grand total	256, 454, 230	338, 593, 129	15, 870, 781	16, 757, 595	272, 325, 011	355, 350, 724

[1] Included with "Undistributed."
[2] To avoid disclosing company confidential data total is incomplete, the portion not included being combined as "Undistributed."

COMMERCIAL AND NONCOMMERCIAL OPERATIONS

In contrast with strictly commercial operations, the noncommercial represent tonnages reported by States, counties, municipalities, and other Government agencies as being produced by themselves or by contractors for consumption by these agencies. Table 23 shows the production of crushed stone for concrete and roadstone during recent years by both types of operations. Noncommercial operations during 1955 gained 90 percent in tonnage over 1954, compared with a 12-percent gain for commercial, reversing the trend of the previous year.

TABLE 23.—Crushed stone for concrete and roadstone sold or used by commercial and noncommercial operators in the United States,[1] 1946–50 (average) and 1951–55

(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
1946–50 (average)	105, 831, 824	$1. 23	----------	90	12, 258, 884	$1. 21	----------	10	118, 090, 708	----------
1951	149, 995, 593	1. 30	+15	89	18, 770, 495	1. 15	+16	11	168, 766, 088	+15
1952	168, 385, 083	1. 32	+12	90	18, 729, 080	1. 26	----------	10	187, 114, 163	+11
1953	169, 352, 364	1. 33	+1	90	19, 806, 421	1. 29	+6	10	189, 158, 785	+1
1954	199, 157, 315	1. 35	+18	92	17, 457, 130	1. 22	−12	8	216, 614, 445	+15
1955	223, 254, 258	1. 35	+12	87	33, 199, 972	1. 14	+90	13	256, 454, 230	+18

[1] Includes Territories of the United States, possessions, and other areas administered by the United States.

GRANULES

Minnesota Mining & Manufacturing Co. was reported to be continuing investigation of roofing-granule potential in the Somerville, N. J., area.

According to report, over 85 percent of American homes had granule-coated asphalt roofs in 1955.[16]

To meet the tremendous growth in demand in the South, a $2.5 million roofing-granule plant began operation in South Carolina.[17]

[16] Gillson, J. L., Industrial Minerals: Min. Cong. Jour., vol. 42, No. 2, February 1956, pp. 126–136.
[17] American Roofing and Siding Contractor, vol. 45, No. 2, February 1955, pp. 11, 27.

TABLE 24.—Roofing granules [1] sold or used in the United States, 1946–50 (average) and 1951–55, by kinds

Year	Natural		Artificially colored [2]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	448, 736	$3, 773, 292	1, 093, 985	$17, 788, 672	1, 542, 721	$21, 561, 964
1951	422, 973	3, 714, 634	1, 184, 544	20, 809, 752	1, 607, 517	24, 524, 386
1952	368, 454	3, 350, 290	1, 250, 741	22, 772, 567	1, 619, 195	26, 122, 857
1953	336, 506	3, 186, 653	1, 282, 325	24, 632, 971	1, 618, 831	27, 819, 624
1954	343, 824	3, 208, 170	1, 362, 504	26, 876, 999	1, 706, 328	30, 085, 169
1955	365, 870	3, 406, 445	1, 470, 517	30, 451, 516	1, 836, 387	33, 857, 961

[1] Manufactured from stone, slate, slag, and brick.
[2] A small quantity of brick granules is included with artificially colored granules.

SIZE OF PLANTS

Eighty-five more crushed-stone plants reported in 1955 than in 1954, bringing the total number to 2,175, with a total output of over 430 million tons. The average production per plant increased 7 percent. During the year 572 plants produced less than 1 percent of the total output. On the other hand, the 65 plants that produced over 900,000 tons each contributed 28 percent of the total. Table 25 shows additional details of the size pattern of the industry in 1955.

TABLE 25.—Number and production of commercial crushed-stone plants in the United States,[1] 1954–55, by size of output

Size of output	1954				1955			
	Number of plants	Total production of plants (short tons)	Percent of total	Cumulative total (short tons)	Number of plants	Total production of plants (short tons)	Percent of total	Cumulative total (short tons)
Less than 1,000 tons	84	32, 833	0. 01	32, 833	72	27, 028	0. 01	27, 028
1,000 to 25,000	488	5, 096, 405	[2] 1. 32	5, 129, 238	500	5, 302, 973	1. 23	5, 330, 001
25,000 to 50,000	272	10, 059, 196	[2] 2. 60	15, 188, 434	277	9, 697, 328	2. 25	15, 027, 329
50,000 to 75,000	188	12, 157, 918	[2] 3. 15	27, 346, 352	212	13, 093, 127	3. 04	28, 120, 456
75,000 to 100,000	[2] 180	[2] 15, 522, 555	4. 02	[2] 42, 868, 907	172	14, 874, 663	3. 46	42, 995, 119
100,000 to 200,000	337	48, 338, 059	[2] 12. 51	[2] 91, 206, 966	348	49, 225, 994	11. 44	92, 221, 113
200,000 to 300,000	[2] 172	[2] 42, 148, 055	[2] 10. 91	[2] 133, 355, 021	172	41, 636, 015	9. 68	133, 857, 128
300,000 to 400,000	107	36, 868, 126	[2] 9. 54	[2] 170, 223, 147	127	43, 936, 954	10. 21	177, 794, 082
400,000 to 500,000	[2] 91	[2] 41, 071, 912	[2] 10. 63	[2] 211, 295, 059	92	41, 534, 508	9. 66	219, 328, 590
500,000 to 600,000	[2] 49	[2] 26, 401, 279	[2] 6. 83	[2] 237, 696, 338	54	29, 242, 462	6. 80	248, 571, 052
600,000 to 700,000	[2] 33	[2] 21, 505, 618	[2] 5. 57	[2] 259, 201, 956	42	26, 897, 286	6. 25	275, 468, 338
700,000 to 800,000	20	14, 029, 773	[2] 3. 63	[2] 273, 231, 729	23	17, 283, 082	4. 02	292, 751, 420
800,000 to 900,000	9	7, 638, 400	[2] 1. 98	[2] 280, 870, 129	19	16, 106, 969	3. 75	308, 858, 389
900,000 tons and over	[2] 60	[2] 105, 479, 167	[2] 27. 30	[2] 386, 349, 296	65	121, 320, 170	28. 20	430, 178, 559
Total	[2] 2, 090	[2] 386, 349, 296	100. 00	[2] 386, 349, 296	2, 175	430, 178, 559	100. 00	430, 178, 559

[1] Includes Alaska, Guam (1954), Hawaii, and Puerto Rico.
[2] Revised figure.

METHODS OF TRANSPORTATION

Truck haulage continued to be the major method of transportation, and rail haulage continued to decline in 1955, reaching a new low of 19 percent. Waterways provided relatively minor but locally important transportation facilities. Large trucks gained favor over smaller ones. The rocker-type unit with the short turning radius replaced more of the rigid-frame types. More attention was directed toward roadbuilding and maintenance in 1955 by the trucking industry as a result of the proposed highway program. Enlarged roadbuilding programs increased the demand for trucks, and the new roads, which in some instances provided more direct routes, gave the trucks a further competitive advantage over rail haulage.

TABLE 26.—Crushed stone sold or used in the United States[1] in 1955, by methods of transportation

Method of transportation	Commercial operations		Commercial and noncommercial [2] operations	
	Short tons	Percent of total	Short tons	Percent of total
Truck	218, 099, 884	51	256, 062, 270	55
Rail	88, 499, 463	21	88, 499, 463	19
Waterway	48, 491, 274	11	48, 491, 274	10
Unspecified	75, 087, 938	17	75, 087, 938	16
Total	430, 178, 559	100	468, 140, 945	100

[1] Includes Territories of the United States, possessions, and other areas administered by the United States. Includes transportation of 107,923,981 tons of stone used in making cement and lime and oystershell for various uses, as follows: By truck, 34,969,987 tons; rail, 7,042,018; waterway, 14,067,320; and unspecified methods, 51,844,656.

[2] Entire output of noncommercial operations assumed to be moved by truck.

GRANITE

Both the quantity and value of crushed-granite production increased in 1955. Tonnages were higher for all uses except riprap, which lost in tonnage but increased in value. North Carolina continued as the principal producer, followed by Georgia and South Carolina.

BASALT AND RELATED ROCKS (TRAPROCK)

Commercial traprock normally includes basalt, gabbro, diorite, and other dark, igneous rocks widely used for concrete and roadstone and for railroad ballast. It is also used for riprap and such "other uses" as fill material, roofing granules, etc. The sales of crushed and broken traprock in 1955 were 16 percent greater in quantity and value than in 1954. The sales of all uses increased except in the "other" category. The average unit value decreased from $1.60 in 1954 to $1.59 in 1955. New Jersey was the leading producer, followed by Oregon, Washington, Connecticut, and Pennsylvania.

457676—58——68

TABLE 27.—Granite (crushed and broken stone) sold or used by producers in the United States in 1955, by States and uses

State	Riprap		Concrete and roadstone		Railroad ballast		Other uses [1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alaska	49,148	$21,691							49,148	$21,691
Arizona	2,160	2,777	36,741	$58,250					38,901	61,027
Arkansas			2,700	2,700					2,700	2,700
California	138,614	271,062	2,482,709	2,767,335	(2)	(2)	(2)	(2)	2,719,544	3,210,255
Colorado	1,773	2,659							1,773	2,659
Connecticut	(2)	(2)							(2)	(2)
Delaware			63,920	191,760			14,871	$35,690	78,791	227,450
Georgia	(2)	(2)	4,734,595	6,529,588	708,507	$734,493	(2)	(2)	5,923,422	8,729,902
Idaho			174,440	173,233					174,440	173,233
Maine	(2)	(2)	(2)	(2)					(2)	(2)
Maryland	22,963	52,815	55,357	158,924					78,320	211,739
Massachusetts	57,125	147,280	853,888	1,498,273	38,870	46,644	64,464	177,499	1,014,347	1,869,696
Minnesota	(2)	(2)	(2)	(2)	432,962	475,474	(2)	(2)	576,567	823,124
Missouri	316	1,131							316	1,131
Montana	(2)	(2)							(2)	(2)
Nevada			382,671	436,757					382,671	436,757
New Hampshire			(2)	(2)					(2)	(2)
New Jersey	(2)	(2)	(2)	(2)			(2)	(2)	520,663	930,255
North Carolina	(2)	(2)	7,337,429	10,386,811	(2)	(2)	(2)	(2)	7,878,491	11,004,765
North Dakota	37,745	40,560							37,745	40,560
Oklahoma			570,000	855,900					570,000	855,900
Oregon	9,083	12,976	2,664	1,195			(2)	(2)	(2)	(2)
Rhode Island			(2)	(2)					(2)	(2)
South Carolina	(2)	(2)	2,454,759	3,365,337	519,269	696,662	(2)	(2)	3,146,989	4,172,329
South Dakota			100	500					100	500
Tennessee			(2)	(2)					(2)	(2)
Texas	(2)	(2)							(2)	(2)
Vermont			12,776	24,162					12,776	24,162
Virginia			(2)	(2)	(2)	(2)	(2)	(2)	1,352,539	1,878,536
Washington			(2)	(2)			(2)	(2)	24,627	92,238
Wyoming	5,161	17,827	53,050	32,250	305,001	278,424	35,173	22,610	398,385	351,111
Undistributed	169,130	255,955	1,971,636	3,023,987	509,512	576,322	1,151,370	2,431,963	479,397	687,756
Total	493,218	826,733	21,189,435	29,506,962	2,514,121	2,808,019	1,265,878	2,667,762	25,462,652	35,809,476
Average unit value		$1.68		$1.39		$1.12		$2.11		$1.41

[1] Includes stone used for fill material, poultry grit, road base, roofing rock, stone sand, stucco, terrazzo, and unspecified uses.
[2] Included with "Undistributed" to avoid disclosure of individual company confidential data.

TABLE 28.—Basalt and related rocks (traprock) (crushed and broken stone) sold or used by producers in the United States in 1955, by States and uses

State	Riprap		Concrete and roadstone		Railroad ballast		Other uses [1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alaska	63,325	$63,325							63,325	$63,325
American Samoa			3,161	$2,823					3,161	2,823
California	(2)	(2)	1,846,273	2,433,866	(2)	(2)	4,080	$1,190	1,922,201	2,546,321
Connecticut	100,319	169,442	3,034,347	4,088,115	322,461	$374,256			3,457,127	4,631,813
Hawaii	3,230	6,783	1,081,222	2,453,955			24,962	6,240	1,109,414	2,466,978
Idaho	1,231	858	(2)	(2)	97,136	89,990	(2)	(2)	604,681	570,771
Maryland	(2)	(2)	(2)	(2)	(2)	(2)			692,908	1,040,345
Massachusetts	64,070	50,267	2,381,866	3,228,102	(2)	(2)	(2)	(2)	2,495,731	3,544,538
Montana	(2)	(2)	8,810	13,554	(2)	(2)			(2)	(2)
New Jersey	890,403	1,728,491	6,193,196	12,444,102	271,677	528,450	71,775	111,251	7,427,051	14,812,294
New Mexico	20,722	17,400							20,722	17,400
New York	(2)	(2)	(2)	(2)	(2)	(2)			(2)	(2)
North Carolina			(2)	(2)					(2)	(2)
Oregon	168,838	135,649	5,787,724	6,637,740	527,926	563,682	5,809	968	6,490,297	7,338,039
Panama Canal Zone			57,435	115,980					57,435	115,980
Pennsylvania	6,200	9,400	2,154,853	3,498,139	(2)	(2)	(2)	(2)	2,770,048	6,576,047
South Dakota			47,520	48,160					47,520	48,160
Texas			(2)	(2)					(2)	(2)
Virginia			707,302	1,184,604					707,302	1,184,604
Virgin Islands			875	4,900					875	4,900
Washington	465,174	484,171	3,972,618	4,731,809	(2)	(2)	(2)	(2)	4,675,622	5,417,857
Wisconsin	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
Undistributed	83,189	150,864	3,905,820	6,632,348	1,058,982	1,559,450	356,390	3,493,361	3,245,501	6,681,490
Total	1,866,701	2,816,650	31,183,022	47,518,197	2,278,182	3,115,828	463,016	3,613,010	35,790,921	57,063,685
Average unit value		$1.51		$1.52		$1.37		$7.80		$1.59

[1] Includes stone sold for fill material, roofing granules, and unspecified uses.
[2] Included with "Undistributed" to avoid disclosure of individual company confidential data.

MARBLE

Large quantities of waste material, consisting either of defective blocks or cuttings and spalls from marble-dressing operations, accumulate in the quarrying and processing of marble blocks. This byproduct material is marketed for a variety of uses. Marble (relatively pure calcium carbonate) is interchangeable with high-calcium limestone for various uses. The average value varies from one area to another owing to diversity in use. In some States marble, as terrazzo or marble flour, is marketed as a high-priced product, while in other States, as roadstone or concrete aggregate, it may be sold relatively cheap. The average unit value for crushed and broken marble decreased $1.25 to $7.43.

TABLE 29.—Marble (crushed and broken stone) sold by producers in the United States in 1955, by States [1]

State	Active plants	Short tons	Value	State	Active plants	Short tons	Value
Alabama	3	(2)	(2)	North Carolina	1	(2)	(2)
Arizona	1	41	$820	Tennessee	8	16,034	$204,532
California	1	(2)	(2)	Texas	2	(2)	(2)
Colorado	1	8	200	Vermont	2	111,883	546,246
Georgia	3	(2)	(2)	Virginia	1	(2)	(2)
Maryland	1	9,021	190,000	Washington	5	(2)	(2)
Missouri	1	8,500	102,000	Undistributed		830,573	6,206,251
Nevada	1	(2)	(2)				
New Jersey	1	(2)	(2)	Total	34	976,150	7,251,309
New Mexico	1	90	1,260	Average unit value			$7.43
New York	1	(2)	(2)				

[1] Includes stone used for acid neutralizer, agriculture, asphalt filler, cast stone, chemicals, concrete and roadstone, coal-mine dusting, filter beds, mineral food, poultry grit, roofing, spalls, 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 confidential data.

LIMESTONE

Limestone occurs in every State in some form, and sales were reported to the Bureau of Mines from 44 States and 2 Territories. Because of its wide occurrence it is, in many areas, the most convenient kind of stone for highway or building construction and railroad ballast. The overall cost of quarrying and crushing limestone is generally lower than that of the harder rocks. Limestone is an essential chemical raw material for many metallurgical, chemical, and processing industries. As a result of these various favorable conditions, limestone is by far the most widely used type of stone in the United States. In 1955 limestone constituted 77 percent of all crushed and broken stone sold.

Sales in 1955 were 12 percent higher in quantity and 13 percent in value than in 1954.

The rise in limestone output for 1955 parallels the increase in concrete-pavement construction (fig. 3), where much limestone is used. Sales of all uses increased in tonnage except railroad ballast. The unit value remained substantially the same as in 1954.

Details by States and uses are shown in table 30. A further breakdown of the miscellaneous uses for crushed limestone is given in table 31.

TABLE 30.—Limestone (crushed and broken stone) sold or used by producers in the United States in 1955, by States and uses

State	Riprap		Fluxing stone		Concrete and road-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	(1)	(1)	1,859,090	$2,926,606	1,145,037	$1,316,905	(1)	(1)	329,389	$473,425	4,513,412	$4,041,836	7,943,152	$8,888,665
Arizona			86,010	112,326	106,345	90,790					813,535	961,540	1,005,890	1,164,656
Arkansas			(1)	(1)	1,571,807	1,634,726			96,022	159,581	(1)	(1)	(1)	(1)
California	7,944	$6,929	61,501	223,682	716,294	820,178			576	4,653	11,681,468	19,921,944	12,467,783	20,977,386
Colorado			(1)	(1)	121,553	257,238			(1)	(1)	(1)	(1)	1,991,705	2,764,444
Connecticut			(1)	(1)	(1)	(1)			60,053	238,270	(1)	(1)	156,033	507,097
Florida	100,000	125,000			13,394,698	16,732,609	65,745	$105,516	392,653	1,324,136	2,350,529	3,025,078	16,303,625	21,312,339
Georgia					570,231	761,286	121,701	168,587	(1)	(1)	(1)	(1)	1,379,607	2,041,352
Hawaii					274,979	351,629			924	2,540	17,704	17,782	293,607	371,951
Idaho	5,320	3,500	(1)	(1)					(1)	(1)	(1)	(1)	(1)	(1)
Illinois	173,098	214,306	298,675	531,206	20,825,065	26,711,592	839,866	987,725	2,600,215	3,341,049	4,124,792	3,793,788	28,861,711	35,579,666
Indiana	455,815	487,673	118,930	147,296	8,302,582	10,060,054	270,255	308,536	2,078,669	2,575,569	2,181,694	1,993,418	13,407,945	15,572,546
Iowa	615,121	728,357	(1)	(1)	10,828,339	12,743,504	(1)	(1)	1,399,844	1,988,306	2,790,748	3,001,072	15,704,509	18,553,921
Kansas	(1)	(1)			6,907,857	9,285,330	(1)	(1)	444,090	634,807	3,005,925	3,168,051	10,807,155	13,571,210
Kentucky	418,282	423,384	(1)	(1)	9,217,156	12,221,629	367,404	391,637	1,255,305	1,584,348	(1)	(1)	11,921,870	15,521,272
Maine	20	98							48,368	207,103	(1)	(1)	(1)	(1)
Maryland	(1)	(1)	3,500	5,950	3,236,793	4,967,451	(1)	(1)	29,502	125,413	1,172,215	1,788,189	4,518,973	7,026,450
Massachusetts	1,243	1,916	(1)	(1)					(1)	(1)	312,615	651,184	395,100	940,695
Michigan	(1)	(1)	15,717,028	13,657,112	4,718,524	4,995,094	231,439	249,506	633,483	612,501	(1)	(1)	33,491,731	28,561,799
Minnesota	60,468	97,160	425	1,500	1,989,918	2,154,465	2,381	4,919	235,014	335,674	42,835	197,233	2,331,041	2,790,951
Mississippi									89,000	89,000	483,816	483,816	572,816	572,816
Missouri	1,151,562	1,186,786	(1)	(1)	11,576,254	14,672,969	22,000	32,000	2,304,996	3,319,837	(1)	(1)	21,238,920	28,555,958
Montana	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)			606,178	503,306	715,799	655,422
Nebraska	953,777	1,007,670	100	150	(1)	(1)			246,414	429,029	(1)	(1)	3,073,573	4,153,613
Nevada			(1)	(1)							(1)	(1)	(1)	(1)
New Jersey	(1)	(1)	(1)	(1)	33,409	92,420			126,696	435,076	228,017	1,185,165	409,160	1,772,911
New Mexico			(1)	(1)	(1)	(1)	130,462	48,890			(1)	(1)	276,306	354,896
New York	(1)	(1)	(1)	(1)	12,044,888	20,938,924	647,578	842,817	430,169	1,048,467	6,335,133	7,607,837	19,863,903	31,323,805
North Carolina					2,139,059	2,935,522			5,115	8,696			2,144,174	2,944,218
Ohio	188,695	244,303	5,327,551	7,005,785	13,899,164	16,815,751	1,230,062	1,407,704	2,048,856	3,316,692	10,056,802	12,927,452	32,751,130	41,717,687
Oklahoma	(1)	(1)			7,041,864	8,271,336	191,768	180,691	75,529	89,356	(1)	(1)	8,826,553	10,123,738
Oregon			6,790	14,259	56,764	74,329			5,433	20,395	752,285	1,335,745	821,272	1,444,728
Pennsylvania	74,517	128,242	9,950,775	16,714,426	11,456,772	16,626,853	261,923	457,006	712,029	2,300,887	17,423,863	22,006,827	39,879,879	58,234,241
Puerto Rico	9,000	18,000			433,894	915,702	480	960	11,000	22,000	1,243,459	1,371,256	1,697,833	2,327,918
Rhode Island									(1)	(1)			(1)	(1)
South Carolina					(1)	(1)			(1)	(1)			(1)	(1)

See footnotes at end of table.

TABLE 30—Limestone (crushed and broken stone) sold or used by producers in the United States in 1955, by States and uses—Con.

State	Riprap		Fluxing stone		Concrete and road-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
South Dakota	22,728	$23,680	------	------	368,679	$575,526	------	------	------	------	369,213	$556,911	760,620	$1,156,117
Tennessee	25,858	19,108	72,249	$97,238	12,132,495	14,552,544	588,207	$579,584	671,570	$919,397	2,630,153	2,988,940	16,120,532	19,156,811
Texas	38,160	45,737	590,168	669,464	6,702,994	7,145,785	582,123	574,045	96,605	98,259	6,065,300	6,693,635	14,075,350	15,226,925
Utah	------	------	([1])	([1])	([1])	([1])	([1])	([1])	------	------	([1])	([1])	1,444,517	2,149,799
Vermont	([1])	([1])	([1])	([1])	([1])	([1])	([1])	([1])	59,958	289,445	169,902	1,371,695	343,069	1,832,167
Virginia	([1])	([1])	547,182	845,515	4,519,086	6,034,403	348,871	408,460	585,165	1,134,031	([1])	([1])	9,712,370	14,151,393
Washington	------	------	([1])	([1])	([1])	([1])	------	------	([1])	([1])	1,388,049	3,720,577	1,425,514	3,837,924
West Virginia	------	------	2,813,611	4,689,624	1,360,402	2,150,123	141,196	200,494	57,666	133,152	1,511,369	2,502,093	5,884,244	9,675,486
Wisconsin	36,573	47,677	([1])	([1])	9,935,936	9,263,502	142,354	172,713	886,536	1,257,112	([1])	([1])	11,348,336	11,170,285
Wyoming	31,129	178,800	([1])	([1])	188,820	199,902	([1])	([1])	------	------	([1])	([1])	833,783	1,595,354
Undistributed	890,072	1,433,716	2,614,580	5,263,759	1,498,634	2,310,982	405,349	496,781	343,196	936,860	30,330,176	33,798,702	4,995,140	6,417,090
Total	5,259,382	6,422,042	40,068,165	52,905,898	179,316,292	228,681,053	6,591,164	7,618,571	18,360,040	29,455,066	[2]112,601,187	[2]141,615,072	362,196,230	466,697,702
Average unit value	------	$1.22	------	$1.32	------	$1.28	------	$1.16	------	$1.60	------	$1.26	------	$1.29

[1] Included with "Undistributed" to avoid disclosure of individual company confidential data.
[2] Includes limestone, dolomite, and cement rock used in making cement, lime, and dead-burned dolomite; does not include oystershell.

TABLE 31.—Limestone (crushed and broken stone) sold or used by producers in the United States[1] for miscellaneous uses, 1954–55

Use	1954		1955	
	Short tons	Value	Short tons	Value
Alkali works	5,329,939	$4,659,840	5,753,468	$6,280,552
Calcium carbide works	709,453	611,565	719,428	621,536
Cement—portland and natural	[2] 71,053,464	[2] 72,239,010	79,997,834	84,350,238
Coal-mine dusting	353,483	1,466,601	499,398	2,206,222
Filler (not whiting substitute):				
Asphalt	1,007,358	2,907,688	1,405,477	4,366,991
Fertilizer	433,590	865,122	449,902	850,645
Other	557,250	2,032,445	762,076	2,605,959
Filter beds	108,089	177,815	136,050	204,472
Glass factories	802,808	2,105,351	848,799	2,304,530
Lime and dead-burned dolomite	[2] 15,245,917	[2] 20,024,246	15,596,017	20,821,903
Limestone sand	1,466,842	1,832,621	741,854	924,377
Limestone whiting [3]	536,847	3,774,614	498,375	4,268,213
Magnesia works (dolomite) [4]	150,181	376,812	103,951	311,853
Mineral food	457,199	2,785,076	473,689	2,751,042
Mineral (rock) wool	48,859	167,734	19,386	46,181
Paper mills	484,372	1,150,428	518,381	1,208,742
Poultry grit	92,512	754,832	119,303	780,394
Refractory (dolomite)	[2] 193,747	[2] 276,398	287,960	461,460
Road base	1,908,854	1,634,578	889,308	1,271,684
Sugar factories	788,210	2,141,351	661,004	1,624,636
Other uses [5]	[2] 1,100,737	[2] 3,480,010	648,297	1,919,185
Use unspecified	1,628,991	1,735,843	1,471,230	1,434,257
Total	[2] 104,458,702	[2] 127,199,980	112,601,187	141,615,072

[1] Includes Hawaii and Puerto Rico.
[2] Revised figure.
[3] 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.
[4] Includes stone for refractory magnesia.
[5] Includes stone for acid neutralization, carbon dioxide, chemicals (unspecified), concrete blocks and pipes, dyes, electric products, fill material, litter and barn snow, oil-well drilling, patching plaster, rayons, rice milling, roofing granules, silicones, spalls, stucco, terrazzo, artificial stone, target sheets, and water treatment.

Dolomite (calcium-magnesium carbonate) has a variety of uses, some quite distinct from those of high-calcium limestone. Dead-burned dolomite is used as a refractory lining for metallurgical furnaces; statistical data on this product are given in the Lime chapter of this volume. Raw dolomite is used as a refractory, particularly for patching furnace floors, and also a source of magnesium metal. Sales of dolomite and its primary calcined product—dolomitic lime—are listed by consuming industries in table 32.

TABLE 32.—Dolomite and dolomitic lime sold or used by producers in the United States for specified purposes, 1954–55

	1954		1955	
	Short tons	Value	Short tons	Value
Dolomite for—				
Basic magnesium carbonate [1]	150,181	$376,812	103,951	$311,853
Refractory uses	[2] 193,747	[2] 276,398	287,960	461,460
Dolomitic lime for—				
Refractory (dead-burned dolomite)	1,520,854	21,960,684	2,128,960	31,424,587
Paper mills	29,000	353,000	79,767	957,000
Total (calculated as raw stone)[3]	[2] 3,444,000		4,809,000	

[1] Includes dolomite for refractory magnesia.
[2] Revised figure.
[3] 1 ton of dolomitic lime is equivalent to 2 tons of raw stone.

TABLE 33.—Sales of fluxing limestone, 1946–50 (average) and 1951–55, 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
1946–50 (average)	24, 799, 574	$23,175,290	6, 332, 214	$6,755,414	530, 402	$623, 467	208, 232	$231, 793	31, 870, 422	$30,785,964
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
1953	32, 649, 747	40, 554, 295	7, 061, 676	10,976,971	944, 656	1, 216, 240	225, 225	293, 006	40, 881, 304	53, 040, 512
1954	26, 478, 048	32, 394, 883	5, 411, 626	7, 031, 010	1, 096, 080	1, 288, 560	175, 982	219, 499	33, 161, 736	40, 933, 952
1955	31, 674, 095	40, 379, 811	6, 577, 661	9, 932, 486	1, 423, 086	2, 018, 230	393, 323	575, 371	40, 068, 165	52, 905, 898

[1] Includes flux for copper, gold, lead, zinc, and unspecified smelters.
[2] Includes flux for foundries and for cupola and electric furnaces.

Production of oystershell was first reported to the Bureau of Mines in 1954. The first separate tables are included in this chapter. Over $19 million was received for oystershell in 1955, compared with $14 million in the previous year. Texas produced the major quantity as shown in table 34. A breakdown of uses for oystershell is shown in table 35.

TABLE 34.—Oystershell sold or used by producers in the United States, 1954–55

State	1954		1955	
	Short tons	Value	Short tons	Value
Florida	(1)	(1)	724, 342	$1, 653, 669
Louisiana	1, 114, 373	$2, 047, 500	1, 211, 829	1, 631, 058
Texas	10, 314, 050	12, 193, 316	11, 084, 797	14, 763, 238
Other States [2]	(1)	(1)	100, 376	1, 282, 580
Total	11, 428, 423	14, 240, 816	13, 121, 344	19, 330, 545

[1] Data not available.
[2] Includes: 1955—Maryland, New Jersey, Pennsylvania, and Virginia.

TABLE 35.—Oystershell sold or used by producers in the United States, 1954–55, by uses

Use	1954		1955	
	Short tons	Value	Short tons	Value
Concrete and roadstone	4, 677, 200	$5, 930, 350	5, 750, 728	$8, 164, 979
Cement	[1] 2, 439, 849	[1] 3, 151, 107	4, 211, 490	5, 314, 391
Lime			813, 204	693, 839
Poultry grit	[1] 4, 311, 374	[1] 5, 159, 359	604, 567	2, 574, 074
Other uses [2]			1, 741, 355	2, 583, 262
Total	[1] 11, 428, 423	[1] 14, 240, 816	13, 121, 344	19, 330, 545

[1] Revised figure.
[2] Includes alkali, asphalt filler, chemicals, magnesium metal, mineral food, paper, road base, road fill, and unspecified uses.

SANDSTONE, QUARTZ, AND QUARTZITE

The sales of crushed and broken sandstone, quartz, and quartzite in 1955 increased 10 percent and the value 6 percent over the preceding

TABLE 36.—Sandstone, quartz, and quartzite (crushed and broken stone) sold or used by producers in the United States in 1955, by States and uses

State	Refractory stone (ganister)		Riprap		Concrete and roadstone		Railroad ballast		Miscellaneous		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alabama	1,700	$4,000			101,042	$203,310			33,236	$51,054	135,978	$258,364
Arizona	(1)	(1)	53,449	$35,107	13,200	6,600			(1)	(1)	314,848	402,172
Arkansas	(1)	(1)			(1)	(1)					214,990	443,633
California	(1)	(1)	(1)	(1)	2,289,581	3,129,512	5,700	$7,609	261,315	734,611	2,935,544	4,867,335
Colorado	25,070	60,333	11,739	16,358	32,323	32,323					69,132	109,014
Connecticut									24,500	178,880	24,500	178,880
Georgia					(1)	(1)					(1)	(1)
Idaho					101,223	104,559	(1)	(1)	(1)	(1)	356,881	711,559
Illinois	506	12,299							96	1,787	602	14,086
Kansas			407,907	670,194	269,133	458,252	68,309	93,280			745,349	1,221,726
Kentucky					(1)	(1)			(1)	(1)	9,193	20,336
Maine			450	900	(1)	(1)			(1)	(1)	197,456	452,488
Michigan									50	100	50	100
Minnesota			(1)	(1)							(1)	(1)
Missouri									(1)	(1)	(1)	(1)
Montana	(1)	(1)	(1)	(1)			(1)	(1)	(1)	(1)	253,014	277,215
Nebraska			3,833	10,392							3,833	10,392
Nevada	629	3,145							9,086	86,316	9,715	89,461
New Mexico			298,740	110,100	352,268	218,933	161,306	165,558	17	100	812,331	494,691
New York			(1)	(1)	(1)	(1)					147,022	285,212
North Carolina					2,545	7,635			(1)	(1)	(1)	(1)
Ohio	114,650	1,380,217	24,725	108,037	179,234	286,759			18,217	80,100	336,826	1,855,113
Oklahoma					235,626	262,891					235,626	262,891
Oregon	(1)	(1)			91,203	97,718			(1)	(1)	(1)	(1)
Pennsylvania	334,908	2,019,891	(1)	(1)	892,109	1,410,757	208,326	306,522	(1)	(1)	1,449,270	3,769,791
South Dakota	(1)	(1)	(1)	(1)	294,131	560,698	(1)	(1)	(1)	(1)	593,958	1,145,660
Tennessee	(1)	(1)			200	600			(1)	(1)	(1)	(1)
Texas					(1)	(1)					(1)	(1)
Utah	(1)	(1)	3,750	3,000					(1)	(1)	215,361	287,070
Virginia							11,130	10,201	86,336	266,567	97,466	276,768
Washington			(1)	(1)					(1)	(1)	(1)	(1)
West Virginia					14,341	38,682					14,341	38,682
Wisconsin	140,275	938,963							487,752	3,975,263	628,027	4,914,226
Wyoming			1,086	3,365	38,500	39,000					39,586	42,365
Undistributed	263,632	897,676	507,811	1,001,443	2,914,416	3,807,217	268,241	287,224	1,282,469	2,718,038	3,101,122	4,474,846
Total	881,370	5,316,524	1,313,490	1,958,896	7,821,075	10,665,446	723,012	870,394	2,203,074	8,092,816	12,942,021	26,904,076
Average unit value		$6.03		$1.49		$1.36		$1.20		$3.67		$2.08

[1] Included with "Undistributed" to avoid disclosure of individual company confidential data.

year. The increases occurred in the production of riprap, in concrete and roadstone, and in railroad ballast. Decreases occurred in refractory stone and miscellaneous uses. The average unit value decreased 9 cents a ton to $2.08.

TABLE 37.—Sandstone, quartz, and quartzite (crushed and broken stone)[1] sold or used by producers in the United States,[2] 1954–55, for miscellaneous uses

Use	1954		1955	
	Short tons	Value	Short tons	Value
Abrasives	32,106	$184,573	29,301	$152,307
Ferrosilicon	139,221	515,989	223,088	668,052
Filter	34,722	111,399	23,435	46,870
Flux	308,900	338,700	392,765	751,178
Foundry	138,973	410,369	128,669	407,355
Glass	[3] 55,443	[3] 297,729	55,692	322,432
Other uses [4]	[3] 1,958,972	[3] 6,285,353	1,350,124	5,744,622
Total	2,668,337	8,144,112	2,203,074	8,092,816

[1] Includes ground sandstone, quartz, and quartzite. Friable sandstone is reported in the chapter on Sand and Gravel.
[2] Includes Puerto Rico (1954).
[3] Revised figure.
[4] Includes cement, filler, fill material, pottery, porcelain, tile, road base, roofing granules, spalls, stone sand, and unspecified uses.

MISCELLANEOUS STONE

Stone types that do not conform to the five principal varieties discussed are grouped statistically as miscellaneous stone. These include light-color volcanic rocks, schists, boulders from riverbeds, serpentine, chats, and flint. The output of miscellaneous stone increased 9 percent in quantity and 13 percent in value compared with 1954. California was the largest producer in 1955, followed by Oklahoma, Guam, and Missouri. The average unit value increased 5 cents to $1.13 a ton.

TABLE 38.—Miscellaneous varieties of stone (crushed and broken stone) sold or used by producers in the United States in 1955, by States and uses

State	Riprap		Concrete and roadstone		Railroad ballast		Other uses[1]		Total	
	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value	Short tons	Value
Alaska	116,538	$163,013	8,726	$17,000			28,003	$24,560	153,267	$204,573
American Samoa			5,850	1,125					5,850	1,125
Arizona			185,350	174,750			13,875	21,000	199,225	195,750
Arkansas	(2)	(2)	(2)	(2)	(2)	(2)			(2)	(2)
California	(2)	(2)	3,712,401	3,275,538	(2)	(2)	652,590	1,015,747	4,626,505	4,796,918
Canton			500	1,500					500	1,500
Colorado	500	500	55,189	48,347					55,689	48,847
Guam			1,241,466	3,351,958					1,241,466	3,351,958
Hawaii			10,205	43,269					10,205	43,269
Idaho	(2)	(2)	54,528	21,813					(2)	(2)
Johnston			12,090	32,550					12,090	32,550
Kansas	6,000	5,100	214,925	108,044	656,312	$249,524			877,237	362,668
Louisiana			31,657	31,657					31,657	31,657
Maine			49,249	73,293					49,249	73,293
Maryland			842	842					842	842
Massachusetts			100,891	141,247					100,891	141,247
Michigan			104,495	153,563					104,495	153,563
Missouri			235,940	138,157	834,884	250,980			1,070,824	389,137
Montana	152,600	76,300							152,600	76,300
Nevada	15,043	20,249			312,031	319,544	2,919	21,522	329,993	361,315
New Hampshire			(2)	(2)					(2)	(2)
New Mexico	162	147	452,328	665,148	10,000	9,600			462,490	674,895
New York	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)
North Carolina			233,583	221,000			93,424	140,136	327,007	361,136
North Dakota			39,621	40,000					39,621	40,000
Oklahoma			(2)	(2)	(2)	(2)			1,291,660	603,784
Oregon	68,161	72,840	179,347	180,954	12,133	1,733	245	613	259,886	256,140
Panama Canal	10,800	10,800	101,250	112,500					112,050	123,300
Pennsylvania			94,942	161,722			2,100	6,300	97,042	168,022
Rhode Island			(2)	(2)					(2)	(2)
South Dakota			389,098	431,348			451,239	500,000	840,337	931,348
Texas	(2)	(2)	(2)	(2)	(2)	(2)	(2)	(2)	724,216	699,916
Utah	(2)	(2)	(2)	(2)					262,799	141,350
Virginia			(2)	(2)			(2)	(2)	(2)	(2)
Wake			900	2,700			100	300	1,000	3,000
Washington	20,288	32,504	345,198	446,137			17,179	27,504	382,665	506,145
Wisconsin	1,449	1,878	119,000	97,500					120,449	99,378
Wyoming	31,400	37,700							31,400	37,700
Undistributed	930,039	1,234,803	3,214,107	4,082,830	1,938,942	1,513,402	78,993	83,360	3,676,420	4,985,525
Total	1,352,980	1,655,834	11,193,678	14,056,492	3,764,302	2,344,783	1,340,667	1,841,042	17,651,627	19,898,151
Average unit value		$1.22		$1.26		$0.62		$1.37		$1.13

[1] Includes stone for fill materials, flux, rock dust, roofing granules, and unspecified uses.
[2] Included with "Undistributed" to avoid disclosure of individual company operations.

CONSUMPTION AND USES

The continued increase in population, with resulting demands for homes, schools, industrial buildings, highways, and public works, in addition to industrial uses and national defense, have given impetus to the stone industry. The proposed national road-building program would offer opportunities for even greater utilization of stone products.

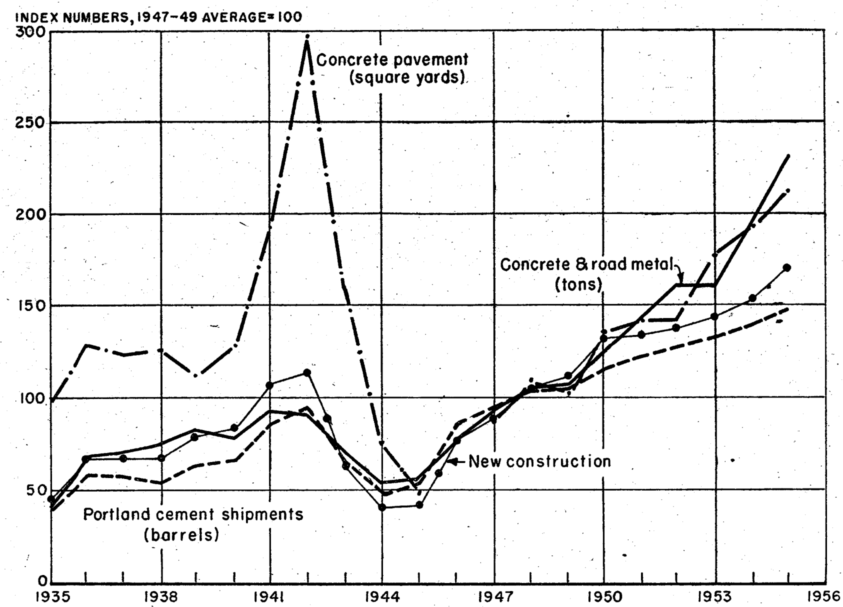

FIGURE 3.—Crushed-stone aggregates (concrete and roadstone) sold or used in the United States compared with shipments of portland cement, total new construction (value), and concrete pavements (contract awards, square yards), 1935–55.

[Data on construction from Construction Volume and Costs and on pavements from Survey of Current Business, U. S. Department of Commerce. Construction value adjusted to 1947–49 prices.]

Concrete aggregate is a major use for crushed stone. The relationship of crushed-stone output, cement shipments, and construction contract awards is shown graphically in figure 3.

Pig-iron production, which reached almost 77 million tons in 1955, surpassed all previous records. Accordingly, the demands for limestone furnace flux were unprecedented. To replace burned-out furnace linings and to keep them in repair placed an unusual burden on producers of dolomite for refractory use and of ganister for manufacture of silica brick. The relations of fluxing-stone output to pig-iron production and of refractory stone to steel-ingot manufacture over a 20-year period are indicated in figure 4.

The modern trends in road building and airfield construction require thicker base courses and wider pavements, resulting in the use of more crushed stone.

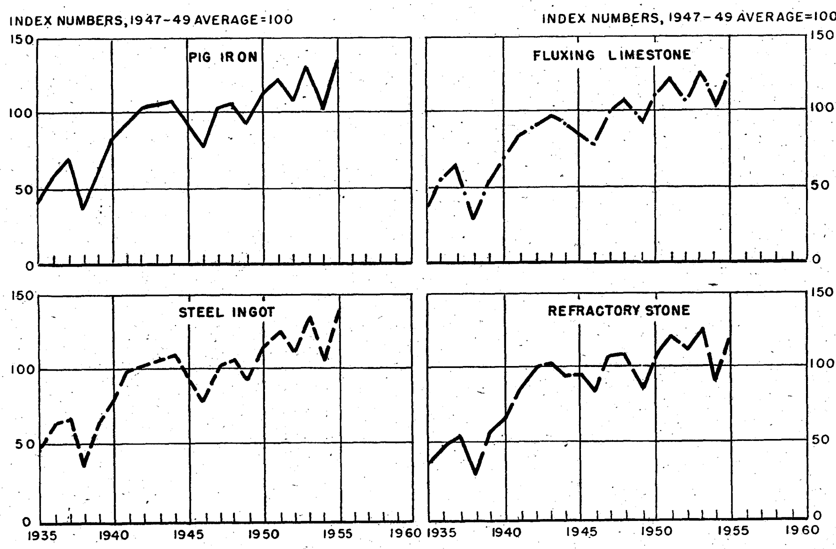

FIGURE 4.—Sales (tons) of fluxing limestone and refractory stone (including that used in making dead-burned dolomite) compared with production of steel ingot and pig iron, 1935–55.

[Statistics of steel-ingot production compiled by American Iron and Steel Institute.]

FOREIGN TRADE [18]

Imports of stone and whiting increased 7 percent in value of sales to $5,579,000 in 1955. An exception to the general overall increases in value was the substantial decrease in unit value of miscellaneous dressed stone. Crushed-stone imports increased considerably over 1954.

Exports of building and monumental stone decreased in quantity but increased in value in 1955 compared with the previous year. Crushed and broken stone increased in both tonnage and value. Other manufactures of stone declined 3 percent in value.

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

TABLE 39.—Stone and whiting imported for consumption in the United States, 1954–55, by classes

[U. S. Department of Commerce]

Class	1954 Quantity	1954 Value	1955 Quantity	1955 Value
Marble, breccia, and onyx:				
Sawed or dressed, over 2 inches thick...cubic feet..	317	$4,005	317	[1] $6,639
In blocks, rough, etc...do....	200,468	968,809	222,363	[1] 1,154,018
Slabs or paving tiles...superficial feet..	1,032,174	[1] 665,886	1,183,324	[1] 842,242
All other manufactures		[1] 1,189,515		[1] 1,289,949
Total		[1] 2,828,215		[1] 3,292,848
Granite:				
Dressed...cubic feet..	[2] 87,006	[1] 735,446	112,832	[1] 832,577
Rough...do....	62,579	296,948	42,092	[1] 157,267
Paving blocks, wholly or partly manufactured number..	487	17,818	7,406	30,576
Total		[1] 1,050,212		[1] 1,020,420
Quartzite...short tons..	163,484	575,684	132,700	389,181
Travertine stone (unmanufactured)...cubic feet..	90,981	[1] 189,319	89,983	[1] 217,556
Stone (other):				
Dressed: Travertine, sandstone, limestone, etc. cubic feet..	8,203	[1] 29,060	47,671	27,262
Rough (monumental or building stone)...do....	5,158	10,688	4,983	4,712
Rough (other)...short tons..	65,156	[1] 205,277	61,487	[1] 193,734
Marble chip or granito...do....	15,172	[1] 129,098	23,362	[1] 201,788
Crushed or ground, n. s. p. f.		[1] 5,793		[1] 26,567
Total		[1] 379,916		[1] 454,063
Whiting:				
Chalk or whiting, precipitated...short tons..	955	38,605	1,066	45,038
Whiting dry, ground, or bolted...do....	10,089	[1] 154,071	10,205	[1] 158,485
Whiting, ground in oil (putty)...do....	(3)	[1] 48	1	1,153
Total		[1] 192,724		[1] 204,676
Grand total		[1] 5,216,070		[1] 5,578,744

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce data known to be not comparable with earlier years.
[2] Revised figure.
[3] Less than 1 ton.

TABLE 40.—Stone exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Building and monumental stone		Crushed, ground or broken				Other manufactures of stone (value)
			Limestone		Other		
	Cubic feet	Value	Short tons	Value	Short tons	Value	
1946–50 (average)	248,939	$506,653	(1)	(1)	(1)	(1)	$407,149
1951	230,239	585,499	(1)	(1)	(1)	(1)	271,461
1952	277,551	648,833	803,029	$789,733	126,123	$1,631,358	314,502
1953	411,196	960,468	691,811	703,833	153,105	2,204,139	464,692
1954	466,177	1,009,313	570,013	702,526	142,622	2,395,903	406,227
1955	437,644	1,024,299	936,766	1,148,781	169,074	2,923,813	394,228

[1] Not separately classified before Jan. 1, 1952.

TECHNOLOGY

Drilling.—Notable advances were made in drilling by use of rotary and air-powered percussion drills for sinking blastholes. These were rapidly replacing churn drills, especially in limestone. The trend in 1955 was toward smaller diameter holes. Roller cone bits with tungsten carbide inserts and air flushing reportedly gave a drilling rate 3 to 4 times that of churn drills. Bit costs continued to be a primary problem. Overall costs per foot of hole advanced steadily.[19] The Bureau of Mines continued to develop relative drilling cost data of various diamond bits and hole sizes for several rock classes.

New and old quarry methods were combined in a drilling technique introduced to produce limestone from a high sloping face. The coyote method was tried without success, and the cost of drilling vertical holes as deep as the full face would have been prohibitive. A wagon drill was mounted inside a skid cage. The cage was then pulled by a winch truck from the toe of the slope to the top.[20]

The use of a newly developed wireline core barrel in diamond-drilling stands to increase core recovery and reduce costs was described.[21]

A handbook was published on the drillability of rocks and the equipment to be used.[22] An article discussed the progress made in rotary drilling hard rock, bit designs, and the use of chemical softeners.[23]

A survey was made of mobile and portable drilling units and light, medium, and heavy duty and rotary drills. An outline of specifications of typical exploration drills was included.[24]

Blasting.—A new blasting process employing a combination of established principles was reported to reduce greatly the cost of open-pit blasting. The explosive used is a mixture of commercial (fertilizer)-grade ammonium nitrate and carbon, which is very insensitive, and requires a cap-sensitive primer for detonation. A limiting factor is its lack of water resistance.[25]

A survey was made of explosive firing methods by various means, such as multishot and short delay, and also of the testing of firing equipment.[26] Another article indicated how contractors are capitalizing on the split-second-delay method and its advantages over instantaneous firing.[27] A high-speed film study of quarry blasting was continued in 1955 by the Bureau of Mines.

A British writer commented on the theory and practice of quarry rock blasting.[28]

An unusual blasting pattern has been utilized in a densely populated area. Effective shots were reportedly produced by using short periodic delay caps, gelatin-cored ammonium nitrate cartridges, and adequate stemming. The charge is broken into small increments with initial firing at the bottoms of the holes.[29]

---

[19] Gillson, J. L., Industrial Minerals: Min. Cong. Jour., vol. 42, No. 2, February 1956, pp. 126–136.
[20] Day, Ray, Lime Plant Ups Efficiency: Excavating Eng., vol. 59, No. 12, December 1955, pp. 36–39.
[21] Burnhart, V. N., Lower Diamond Drilling Costs With Wireline Core Barrel: Min. Eng., vol. 7, No. 6, June 1955, pp. 548–550.
[22] Davy Compressor Co. (Kent, Ohio), Drillers' Handbook on Rock: 1955, 58 pp.
[23] Shepherd, R., Rotary-Drilling Developments: Mine and Quarry Eng., vol. 21, No. 8, August 1955, pp. 329–335.
[24] Mining Engineering, vol. 7, No. 10, October 1955, pp. 933–936.
[25] Leach, Hugh J., Open-Pit Mining: Min. Eng., vol. 8, No. 9, February 1956, pp. 162–165.
[26] Westwater, R., Explosives for Quarry Engineering: Vol. 21, No. 10, October 1955, pp. 421–426.
[27] Roads and Streets, Millisecond-Delay Techniques: Vol. 98, No. 5, May 1955, pp. 73–78.
[28] Pearse, G. E., Rock Blasting: Mine and Quarry Eng., vol. 21, No. 1, January 1955, pp. 25–30.
[29] Excavating Engineer, Firm Blasts in Unusual Pattern: August 1955, pp. 44–45.

Plants.—Portable plants were improved both in speed of setting up and in reliability. Portable plants are especially advantageous where large, local, temporary demands for stone arise, such as for a new highway, airfield, or dam.

Automation in stationary plant control advanced in 1955. A one-man, pushbutton stockpiling system operated 650 feet from the quarry. The plant also maintained a dust-control system that reduced dust to a minimum.[30]

A pushbutton-controlled plant in Florida produced 40 tons per hour of finely ground agricultural limestone, using a rod mill instead of the usual hammer mill.[31]

In the absence of nearby sand deposits, two plants supplied the St. Lawrence Seaway with manufactured sand by grinding limestone and dolomite.[32]

An increase to almost double its previous capacity was achieved at one operation by adding supplementary fine-crushing equipment and an agricultural limestone plant, thus freeing the main plant to concentrate on roadstone and ballast. These changes were reported to be highly efficient and economical.[33]

A Kansas limestone operation originally started for a temporary airfield project has expanded its operations to cover three States. A heavy-duty apron feeder and a double-impeller breaker utilizing rock up to 53 by 60 inches made it possible to attain an output exceeding 800 tons per hour.[34]

A New York traprock (diabase) operation expanded 1 of its plants to 1,000 tons per hour, incorporating a 56 by 72 inch jaw crusher, one of the largest of its kind in the industry.[35]

A California plant launched a hilltop operation, producing 300 tons per hour with a well-organized operational flowsheet.[36]

A single efficient aggregate system was designed to supply a ready-mix concrete plant, a concrete-block plant, and a concrete pipe plant at the rate of 300 tons per hour, using a series of belt conveyors.[37]

A newly designed screen to remove flat particles was reported to reduce the proportion of flat pieces in aggregate from 60 percent to 5. Steel bars were welded to slotted screens, causing the particles to upend and drop through the slots as the material moved along the inclined screen.[38]

A Kentucky operation cut operating costs substantially by using two 360-hp. diesels, reported to be well below either the cost of purchased power or of the previously used steam plant.[39]

---

30 Rock Products, vol. 58, No. 10, October 1955, pp. 72–75.
31 Wright, C. E., Pushbutton-Controlled Fine-Grinding Limestone Plant: Rock Products, vol. 58, No. 4, April 1955, pp. 88-89, 186.
32 Gillson, J. L., Industrial Minerals: Min Cong. Jour., vol. 42, No. 2, February 1956, pp. 126–136.
33 Trauffer, Walter E., Three-in-One Ohio Operation Achieves High Flexibility: Pit and Quarry, vol. 47, No. 8, February 1955, pp. 56–58, 111.
34 Pit and Quarry, Kansas Limestone Producer Adds New Equipment for Peak Capacity: Vol. 47, No. 7, January 1955, pp. 149–151.
35 Pit and Quarry, New York Trap Rock Erects 1,000 T. P. H. Crushing Plant at Haverstraw to Serve New Quarry Level: Vol. 47, No. 12, June 1955, pp. 76–79.
36 This Earth, Blue Chips Off the Old Rocks: Vol. 8, No. 6, June 1955, pp. 10–11.
37 Rock Products, Single Aggregate Supply System Serves Block, Pipe and Ready-Mix Plants: Vol. 58, No. 5, May 1955, pp. 153–155.
38 Lenhart, Walter B., Removing Flat Stone With Special Screens and Crushers: Rock Products, vol. 58, No. 5, May 1955, pp. 62–65.
39 Pit and Quarry, Quarry Firm Beats High Cost of Purchased Power—Builds Own Power Plant: Vol. 48, No. 5, November 1955, pp. 94–98.

A New Jersey crushing plant was installed on the quarry floor and connected with the company's older plant by use of a belt conveyor in a tunnel.[40]

A Pennsylvania plant faced with increasing demands for aggregates also opened a second crusher on the quarry floor. This not only doubled the capacity but increased the overall operating efficiency and allowed a complete range of stone sizes to be prepared. The quarry was so conveniently situated that a relatively simple hauling operation was required.[41]

To meet the ever-growing problem of depleting reserves of sand and gravel in north central Texas, one company initiated an expansion program to include a crushed-stone operation. Many techniques of sand and gravel production were incorporated.[42]

Specifications and Tests.—Associations interested in aggregate production issued a number of publications, and presented many papers dealing with the problems of specifications, tests, and durability of aggregates for concrete and bituminous applications in 1955.

Because of a growing demand for stone, geological exploration and testing increased. In some States rapid progress was made along these lines in 1955.

Basic information on the mineralogical properties of limestone and dolomite was secured through a program designed to determine means for their better utilization.[43]

A practical method for measuring compressive strengths, elastic properties, and the energy requirements for crushing rocks and ores was published. Detailed procedures are given, together with comparative results on 11 minerals.[44]

A technique was published for distinguishing, in the field, between dolomitic limestones and high-calcium limestones. The procedure requires an application of two solutions on a fresh rock surface. A purple color indicates lack of magnesia.[45]

Tests indicate that the impact strength of limestone heated to 900° F. is about half its value at room temperature. An operator in New England has been taking advantage of this phenomenon, which is common to various minerals, by heating quartz to red heat in a rotary furnace and discharging it to a hammer mill.[46]

A grinding machine operating on a new principle of size reduction was invented. The machine reportedly accelerates the particles to high speed and then discharges them against a curved surface, where it is claimed the particles spin about their own axis and the centrifugal force thus created is sufficient to cause them to explode. Because the velocities are proportional to weight, the larger particles are reduced more quickly and a uniform product is obtained.[47]

---

[40] Gutschick, Kenneth A., Triple Capacity of Crushed Stone Plant: Rock Products, vol. 58, No. 10, October 1955, pp. 76–82, 86.
[41] Gutschick, Kenneth, A., Eastern Crushed-Stone Firm Doubles Output With New Plant on Quarry Floor: Pit and Quarry, vol. 47, No. 11, May 1955, pp. 169–172, 182.
[42] Pit and Quarry, Texas Gravel Producer Adds Crushed-Stone Plant: Vol. 48, No. 3, September 1955, pp. 82–85.
[43] Graf, Donald L., Research Program of the Illinois State Geological Survey in Carbonate Mineralogy: Pit and Quarry, vol. 48, No. 1, July 1955, pp. 159–162.
[44] Burbank, Benjamin B., Measuring the Crushing Resistance of Rocks and Ores: Pit and Quarry, vol. 47, No. 12, December 1955, pp. 102–106.
[45] Mann, Virgil L. J., Field Method of Distinguishing Limestone and Dolomite: Sedimentary Petrology, vol. 25, No. 1, January 1955, pp. 58–59.
[46] Mitchell, Will, Jr., Beneficiation in 1955: Eng. Min. Jour., vol. 8, No. 2, February 1956, pp. 184–194.
[47] Moore, J. K., Grinding Machine: U. S. Patent 2,707,594, May 3, 1955.

Some problems of the stone industry and their possible solution were outlined in an article.[48]

Agricultural Limestone.—Intensive, well-organized educational campaigns were initiated by the agricultural limestone industry to convince farmers of the need for liming land. The April and May issues of Rock Products magazine contain over a dozen major articles promoting the use of agricultural limestone.

The relative value of anhydrous ammonia and agstone in increasing soil fertility have been discussed.[49]

Silica.—A byproduct quartz from feldspar operations of North Carolina analyzed only 0.005 percent iron oxide. This was considered to be the lowest iron content of any silica produced commercially in the United States.[50]

A study conducted in southern Illinois indicated that some of the sandstone, if properly processed, may find wider use.[51]

Oystershell.—A well-designed modern plant on Tampa Bay went into production primarily to produce oystershell grit as a calcium carbonate source in poultry food. New products have been added and shipments have been made by truck as far as Alabama, Georgia, Tennessee, and the Carolinas.[52]

An 11½-million-dollar test highway in northern Illinois was approved by State Highway officials.[53]

Reclamation.—Aggregate producers have come to consider reclamation of worked-out areas a logical phase in the operating program. The current trend in zoning ordinances and land restrictions is forcing the industry to reappraise its efforts in that direction.[54]

WORLD REVIEW

North America

Canada.—Production of granite totaled 3 million tons in 1955 compared with nearly 13 million tons in 1954. The unusually high output in 1954 was due primarily to aggregate used in constructing the causeway linking Cape Breton Island with the Nova Scotia mainland. About 67 percent of the 1955 production was reported from Quebec.[55]

Limestone production increased 20 percent over 1954 to 23 million tons valued at C$30 million. A small quantity was exported to the United States, mainly for metallurgical flux, and to be used in the manufacture of paper.[56]

Roofing granules reached a record 148,000 tons valued at C$4 million, about 10 percent above the 1954 output. Imports from the United States also reached a new high of 12,000 tons in 1955.[57]

[48] Mining Engineering, Stone-Industry Production Problems Call for Research: Vol. 8, No. 3, March 1956, pp. 275–279.
[49] Rock Products, Agstone Needs With Nitrogen Solutions: Vol. 58, No. 6, June 1955, pp. 124–126.
[50] Gillson, J. L., Industrial Minerals: Min. Cong. Jour., vol. 42, No. 2, February 1956, pp. 126–136.
[51] Biggs, D. C., and Lamar, J. E., Illinois State Geol. Survey Rept. 188, 1955, 21 pp.
[52] Pit and Quarry, New Oystershell Plant Makes Wide Variety of Products: Vol. 47, No. 12, June 1955, pp. 115–117, 131.
[53] Rock Products, vol. 58, No. 2, February 1955, p. 28.
[54] Pit and Quarry, Rehabilitation, Conservation Return Good Profits to American Aggregates Corp: Vol. 48, No. 4, October 1955, pp. 80-91.
[55] Canada Department of Mines and Technical Survey, Granite in Canada, 1955 (Preliminary): Ottawa, 5 pp.
[56] Canada Department of Mines and Technical Survey, Limestone (General) in Canada, 1955 (Prelim.): Ottawa, 3 pp.
[57] Canada Department of Mines and Technical Survey, Roofing Granules, 1955 (Prelim.): Ottawa, 4 pp.

Nepheline syenite production totaled 120,484 tons valued at C$1,740,000 in 1954, an increase of about 6 percent over 1953. In 1954, capital expenditures of the only Canadian producer of nepheline syenite totaled more than C$300,000, in addition to plant and equipment.[58]

Europe

Austria.—Virtually all the dolomite imported in 1954 was from West Germany; although it amounted to only 1,000 tons, it was 10 times as great as in 1953. Exports of dolomite from Austria were on this same order of magnitude.[59]

Yugoslavia.—A deposit of good-quality quartz was reported, with an estimated reserve of 200,000 tons.

Asia

Philippines.—Surveys indicated that the overall potential reserves of limestone were enormous, but no detailed investigations were made. Limestone production in the Philippines in 1954 totaled 750,000 metric tons, of which about 90 percent was used for cement manufacturing.[60]

Africa

Rhodesia and Nyasaland.—Production of quartz in Southern Rhodesia totaled 6,354 short tons in 1954, an increase of 192 percent over 1953.[61]

Oceania

New Zealand.—One of the largest agricultural limestone plants in Oceania was operated in New Zealand. To promote production, the company entered the limestone spreading business, disposing of a considerable quantity in very hilly and wet areas by plane in year-round operations.[62]

---

[58] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 53.
[59] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 4, October 1955, p. 36.
[60] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 6, December 1955, pp. 34–35.
[61] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 2, August 1955, p. 49.
[62] Harrington, Lyn, Spreading Lime by Plane in New Zealand: Rock Products, vol. 58, No. 9, September 1955, pp. 90–94.

Strontium

By Albert E. Schreck[1] and Annie L. Marks[2]

THE RELATIVELY SMALL MARKET in 1955 for strontium minerals in the United States was supplied principally from foreign sources.

DOMESTIC PRODUCTION

In 1955 two minerals were commercial sources of strontium: Celestite (strontium sulfate) and strontianite (strontium carbonate); the former, because of its relative abundance and more widespread occurrence, was commercially more important.

A small tonnage of strontium minerals was shipped by Gene De Zan from a deposit near Ludlow, San Bernardino County, Calif., in 1955.

Deposits of strontium minerals are known to exist in many States (Arkansas, Arizona, California, Ohio, Michigan, Tennessee, Texas, and Washington). Since 1950 the only deposits mined were in San Bernardino and San Diego Counties, Calif., and Skagit County, Wash. Production from these deposits was small and erratic.

The major portion of the strontium minerals produced was consumed in manufacturing various strontium compounds, at the following plants: E. I. du Pont de Nemours & Co., Grasselli, N. J.; Foote Mineral Co., Philadelphia, Pa.; Barium Products, Ltd., Modesto, Calif.; and Pan Chemical Co., Los Angeles, Calif.

Production of strontium metal was small; in the past it has been produced by King Laboratories, Inc., Syracuse, N. Y., and Copper Metallurgical Associates, Cleveland, Ohio.

Strontium hydride in small quantities was produced by Metal Hydrides, Inc., Beverly, Mass.

CONSUMPTION AND USES

Virtually all of the strontium ore consumed was converted to various strontium compounds, the principal ones used being nitrate, oxalate, and peroxide. These compounds are utilized by the pyrotechnics industry because of their ability to impart a brilliant crimson color to a flame, the property required in manufacturing tracer bullets, railroad and highway warning fusees, marine distress signals and rockets, fireworks, and tactical military signaling devices.

[1] Commodity specialist.
[2] Statistical assistant.

Strontium carbonate is used in ceramics, primarily frits and glazes, and in the refining of zinc, where it is added to the feed solution to lower the lead content of the cathode zinc.

Other strontium compounds are used in greases, depilatories, corrosion inhibiters, medicines, plastics, stabilizers, and luminous paints.

Strontium metal in small quantities is used as a getter in removing traces of gas from vacuum tubes.

PRICES

The Oil, Paint and Drug Reporter quoted the following prices on strontium compounds during 1955: Strontium sulfate (celestite), air-floated, 90 percent, 325-mesh, bags, works, $56.70 to $66.15 per short ton. This price remained unchanged from the previous year. Strontium carbonate, pure, drums, 5-ton lots or more, works, 35 cents per pound; 1-ton lots, works, 37 cents per pound; technical, drums, works, 19 cents per pound. Strontium nitrate, barrels, carlots, works, $11.00 per 100 pounds; less than carlots, works, $12.00 per 100 pounds.

The average unit foreign value of imported strontium minerals in 1955 was $20.93 per short ton.

FOREIGN TRADE[3]

Imports of strontium minerals increased over 1954 but were lower than in any of the preceding 7 years. All imports came from the United Kingdom and Mexico.

TABLE 1.—Strontium minerals [1] imported for consumption in the United States, 1953–55, by countries, in short tons

[U. S. Department of Commerce]

Country	1953		1954		1955	
	Short tons	Value	Short tons	Value	Short tons	Value
North America:						
Canada	43	$521				
Mexico	2,441	30,248	1,906	$24,887	2,072	$27,400
Total	2,484	30,769	1,906	24,887	2,072	27,400
Europe: United Kingdom	4,413	93,077	1,385	28,397	4,053	100,781
Grand total	6,897	123,846	3,291	53,284	6,125	128,181

[1] Strontianite or mineral strontium carbonate and celestite or mineral strontium sulfate.

TECHNOLOGY

A patent was issued on the use of strontium chromate in a rust-inhibitive aluminum-pigment paint.[4] The paint is prepared by grinding strontium chromate and mixing it with aluminum-flake pigment. The resulting paste, when incorporated in a resin-oil

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

[4] Babcock, G. M., and Rethwisch, F. B., (assigned to Reynolds Metals Co., Richmond, Va.), Rust Inhibitive Aluminum Pigment Composition: U. S. Patent 2,701,772, Feb. 28, 1955.

vehicle to brushing consistency, produces a rust-inhibitive aluminum paint.

An article was published describing a process for producing colorless crystals of strontium titanate.[5] The crystals are produced under carefully standardized conditions by the flame-fusion process. The equipment used in making these crystals is reported to be capable of producing boules up to 35 mm. long and 15 mm. in diameter.

Strontium titanate crystals have some unusual physical properties, such as very high dispersion and high index of refraction, which may indicate special uses in optics as well as other fields.

WORLD REVIEW

Deposits of strontium minerals are numerous and widespread throughout the world. High-grade ore was shipped to the United States in 1955 from deposits in Gloucestershire and Somerset in the United Kingdom and the Provinces of San Luis Potosi, Nueva Leon, and Coahuila in Mexico.

[5] Merker, Leon, Synthesis and Properties of Large Single Crystals of Strontium Titanate: Min. Eng., vol. 7, No. 7, July 1955, pp. 645–648.

Sulfur and Pyrites

By Leonard P. Larson [1] and Annie L. Marks [2]

HIGH industrial activity in the United States was reflected in expanding domestic sulfur requirements. Production of sulfur in all forms during 1955 increased 5 percent over 1954; approximately 82 percent was native sulfur; 6 percent was recovered sulfur; 6 percent was in pyrites; 5 percent, in smelter acid; and 1 percent, in other forms.

Production from most Frasch sulfur mines increased during the year; one new mine was opened, and another was closed. Development of Mexico as a major producer of Frasch sulfur was particularly noteworthy.

Several new plants to obtain sulfur other than by the Frasch process were opened. Sulfuric acid production at base-metal smelters and refineries and output from byproduct-sulfur projects, principally those recovering brimstone from natural- and refinery-gas purification, increased.

TABLE 1.—Salient statistics of the sulfur industry in the United States, 1946–50 (average) and 1951–55 (in long tons of sulfur content)

	1946–50 (average)	1951	1952	1953	1954	1955
Production (all forms)	5,292,340	6,196,859	6,284,191	6,247,971	6,675,200	7,020,528
Imports (pyrites and sulfur)	71,687	108,676	146,863	92,229	135,128	196,086
Producers' stocks (Frasch and recovered sulfur)	[1] 3,223,385	[1] 2,837,432	[2] 3,163,517	[2] 3,129,830	[2] 3,337,086	[2] 3,301,465
Exports (sulfur)	1,366,095	1,311,817	1,338,367	1,271,011	[3] 1,675,130	1,632,652
Apparent domestic consumption (all forms)	4,251,810	4,819,200	4,832,300	5,049,400	[3] 4,912,600	5,612,100

[1] Frasch sulfur only.
[2] Frasch and recovered sulfur.
[3] Revised figure.

DOMESTIC PRODUCTION

NATIVE SULFUR

In 1955, record tonnage of native sulfur was produced from Frasch process mines 4 percent greater than in 1954, the previous record year. Texas contributed 63 percent of native sulfur in the United States; Louisiana, almost 36 percent; small quantities came from California and Nevada. Production of Frasch sulfur, at an annual rate of 5.2

[1] Commodity specialist.
[2] Statistical assistant.

million tons during the first 6 months of 1955, increased to 6.3 million tons in the second half of the year, as a result of high production in October, November and December. During the last quarter 1,657,000 long tons were produced, which was at an annual rate of 6.6 million tons.

Texas Gulf Sulphur Co. produced an increased quantity of sulfur from Boling dome, Moss Bluff dome, and Spindletop in Texas. Exploration and development work was in progress at Lake Bullicamp near Houma, La., and Fannett dome near Beaumont, Tex.

Freeport Sulphur Co. produced Frasch sulfur at Grande Ecaille, Garden Island Bay, Bay Ste. Elaine, and Chacahoula domes in Louisiana; and Hoskins Mound and Nash dome in Texas.

TABLE 2.—Production of sulfur and sulfur-containing raw materials by producers in the United States, 1946–50 (average) and 1951–55, in long tons

	1946–50 (average)		1951		1952	
	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content
Native sulfur or sulfur ore:						
From Frasch-process mines	4,621,453	4,621,453	5,278,249	5,278,249	5,293,145	5,293,145
From other mines [1]	4,365	1,402	3,945	1,365	8,536	2,197
Total native sulfur		4,622,855		5,279,614		5,295,342
Recovered elemental sulfur:						
Brimstone	61,434	61,333	182,495	181,935	250,428	249,388
Paste	6,809	3,076	4,614	2,078	3,859	1,810
Total recovered elemental sulfur		64,409		184,013		251,198
Pyrites (including coal brasses)	900,421	377,952	1,017,769	432,819	994,342	418,139
Byproduct sulfuric acid (basis 100 percent) produced at Cu, Zn, and Pb plants	606,615	198,187	736,672	240,800	774,177	253,000
Other byproduct sulfur compounds [2]	32,222	28,937	70,257	59,613	77,307	66,512
Total equivalent sulfur		5,292,340		6,196,859		6,284,191

	1953		1954		1955	
	Gross weight	Sulfur content	Gross weight	Sulfur content	Gross weight	Sulfur content
Native sulfur or sulfur ore:						
From Frasch-process mines	5,155,342	5,155,342	5,514,640	5,514,640	5,738,978	5.738,978
From other mines [1]	151,819	38,257	214,157	64,333	199,899	60,902
Total native sulfur		5,193,599		5,578,973		5,799,880
Recovered elemental sulfur:						
Brimstone	342,297	340,827	361,107	359,135	400,754	398,601
Paste	1,723	833	284	136	380	179
Total recovered elemental sulfur		341,660		359,271		398,780
Pyrites (including coal brasses)	922,647	379,545	908,715	405,310	994,443	403,576
Byproduct sulfuric acid (basis 100 percent) produced at Cu, Zn, and Pb plants	775,069	253,000	791,049	258,600	992,903	324,580
Other byproduct sulfur compounds [2]	92,787	80,167	85,255	73,046	106,129	93,712
Total equivalent sulfur		6,247,971		6,675,200		7,020,528

[1] Sulfur content estimated for 1946–52.
[2] 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.

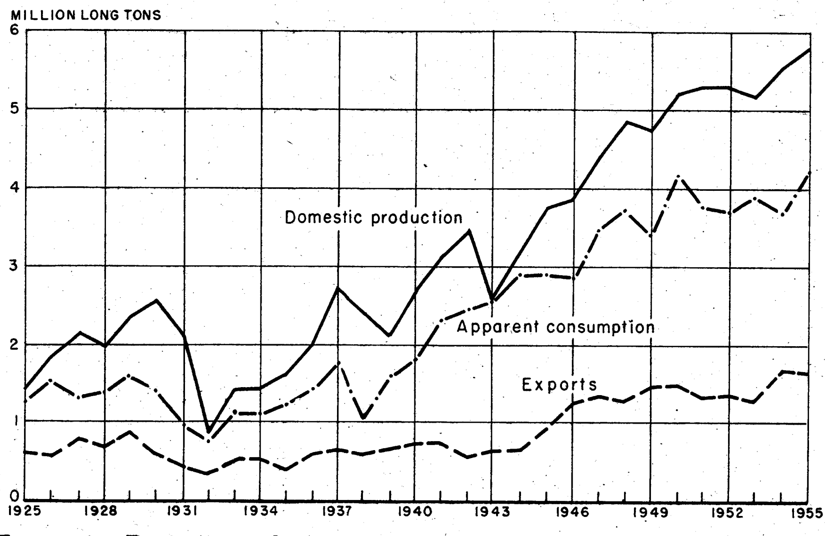

FIGURE 1.—Domestic production, apparent consumption, and exports of native sulfur, 1925–55.

The Freeport mine at Chacahoula dome, near Thibodaux, La., began work on February 25. Facilities included a powerplant to supply compressed air, electric power, and 3 million gallons of superheated water. Output from the mine was expected to total about 100,000 tons annually.[3] Grande Ecaille continued to be the company's largest producing mine followed by Garden Island Bay, Bay Ste. Elaine, and Nash dome. Freeport Sulphur Co. also was developing a salt dome deposit at Lake Pelto, 60 miles southwest of New Orleans. Detailed engineering studies and plant-site preparations were made. The dome is beneath 6–8 feet of water. No final decision had been made on the type of process water to be used; the company has successfully used both brackish and fresh water in the past.[4]

TABLE 3.—Sulfur produced and shipped from Frasch mines in the United States, 1946–50 (average) and 1951–55

Year	Produced (long tons)			Shipped	
	Texas	Louisiana	Total	Long tons	Approximate value
1946–50 (average)	3,592,845	1,028,608	4,621,453	4,845,850	$86,220,000
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
1953	3,514,771	1,640,571	5,155,342	5,224,202	141,054,000
1954	3,505,087	2,009,553	5,514,640	5,328,040	142,014,000
1955	3,657,717	2,081,261	5,738,978	5,839,300	163,156,000

[3] Wall Street Journal, Freeport Sulphur Ends 4-Year Expansion with an Engineering Victory over Swamp: Vol. 145, No. 18, Jan. 26, 1955, p. 6.
[4] Chemical Engineering, Underwater Sulfur Mining Planned: Vol. 62, No. 8, August 1956, p. 126.

Jefferson Lake Sulphur Co. produced sulfur at Long Point and Clemens domes in Texas and Starks dome in Louisiana. Exploratory drilling on some of its properties disclosed additional reserves.

Duval Sulphur & Potash Co. produced Frasch sulfur at the Orchard dome in Texas.

Standard Sulphur Co. expanded production at its mine at Damon mound. Exploration work on the Allen dome, Brazoria County, was continued.

In the first sale of offshore sulfur leases by Texas following the passage of The Federal Submerged Lands Act of 1953, Texas Gulf Sulphur Co. and Freeport Sulphur Co. leased nine tracts at a cost exceeding $8 million. Texas Gulf Sulphur Co., high bidder, offered $7.1 million for rights on 6 tracts containing 3,840 acres, 1½ to 3 miles off Galveston Island. Freeport Sulphur Co. leased 3 tracts of land, 4,320 acres farther offshore from Galveston for $1,175,202.[5]

Humble Oil & Refining Co. reported the discovery of a large sulfur dome in Grand Isle Block 18, 7½ miles off the Louisiana coast. The deposit in an offshore area claimed by the Federal Government covers several hundred acres and is 1,700 to 2,000 feet below the bottom of the Gulf.[6]

American Sulphur & Refining Co. continued to develop its solvent process for the recovery of purity sulfur at its refining plant at Sulphurdale, Utah. Ore processed by the plant was obtained from a brecciated tuff containing crystalline sulfur that occured in a banded structure of narrow, irregular veins. The company's Cove Creek deposits were said to contain 3.9 million tons of proved ore having an estimated total sulfur content of 730,000 long tons.[7]

Anaconda Co. produced sulfur at the Leviathan mine, Alpine County, Calif., for use at its copper plant, Yerington, Nev. Output also came from the D & B Sulphur Co., Inc., Gulch mine in the Last Chance Range, Calif., and the Sulphur Products, Inc., Vitallo mine, Sulphur, Nev.

TABLE 4.—Sulfur ore (10–70 percent S) produced and shipped in the United States, 1946–50 (average) and 1951–55, in long tons [1]

Year	Produced (long tons)	Shipped	
		Long tons	Value
1946–50 (average)	4,365	4,197	$70,596
1951	3,945	3,945	75,609
1952 (estimated)	8,536	4,686	91,310
1953	151,819	152,473	769,140
1954	214,157	185,085	1,507,429
1955	199,899	199,899	1,697,052

[1] California, Colorado (1948–49 only), Nevada (except 1954), Texas (1948 only), Utah (1952 only), and Wyoming (except 1948 and 1953–55).

[5] Chemical and Engineering News, Offshore Bids Roll In: Vol. 33, No. 46, Nov. 14, 1955, p. 4908.
[6] Chemical Engineering, vol. 62, No. 7, July 1955, p. 104.
[7] Pit and Quarry, American Sulfur Refining Co. Utah Plant Starts Production: Vol. 48, No. 3, September 1955, p. 42.

RECOVERED ELEMENTAL SULFUR

Production of recovered sulfur in 1955 totaled 400,754 long tons, 11 percent greater than the output in 1954. The production rate, which was consistently high during the year, increased as new facilities began producing and reached an annual rate of 427,000 tons during the last 3 months. The highest monthly total was reported in October, when 36,100 tons of brimstone was recovered as a byproduct from natural and oil-refinery gases. New installations for recovering sulfur from sour natural gas included the plants of Jefferson Lake Sulphur Co., Manderson, Wyo.; J. L. Parker Co., Penwell, Tex.; and Signal Oil & Gas Co. and J. L. Parker Co., 14 Mile Field, Wyo. New sulfur-recovery installations at oil refineries included Gulf Chemical Co., Girard Point, Pa.; Sun Oil Co., Marcus Hook, Pa.; and Union Oil Co., Santa Maria, Calif.

PYRITES

Output of pyrites in the United States increased 9 percent in 1955, exceeding the production in all years since 1948 except 1951, when the Nation was experiencing a sulfur shortage. Owing to the strong competition of native sulfur, only a small fraction of the output was sold on the open market. The producing companies converted most of the pyrites to sulfuric acid. In 1955, 821,000 long tons was consumed, and 155,000 tons was sold. Most of the pyrite was produced in the eastern portion of the United States, mainly in Tennessee. Tennessee Copper Co. remained the Nation's leading producer of pyrites at its mines at Copperhill, Tenn., for use in making sulfuric acid and other products. General Chemical Division of Allied Chemical & Dye Corp. produced pyrites at the Cliffsview mine for processing at its acid plant at Pulaski, Va. Appalachian Sulphides, Inc. sold pyrites from the South Strafford mine, Orange County, Vt. Bethlehem Steel Co. produced pyrites in Lebanon, Pa.

TABLE 5.—Pyrites (ore and concentrate) produced in the United States, 1946–50 (average) and 1951–55, in long tons

Year	Quantity		Value	Year	Quantity		Value
	Gross weight	Sulfur content			Gross weight	Sulfur content	
1946–50 (average)	900,421	377,834	$3,842,200	1953	922,647	379,545	$5,007,000
1951	1,017,769	432,819	4,656,000	1954	908,715	405,310	7,159,000
1952	994,342	418,139	4,947,000	1955	994,443	403,576	8,293,000

A number of Western States reported commercial recovery. Anaconda Co. recovered pyrites from copper-mill tailings at its base-metal plants. Rico Argentine Mining Co. and Climax Molybdenum Co. recovered pyrites in Colorado. Mountain Copper Co., Ltd., was a leading producer at the Hornet mine in California.

Tennessee was the principal producing State in 1955, followed by California, Virginia, Montana, Vermont, Pennsylvania, and Colorado.

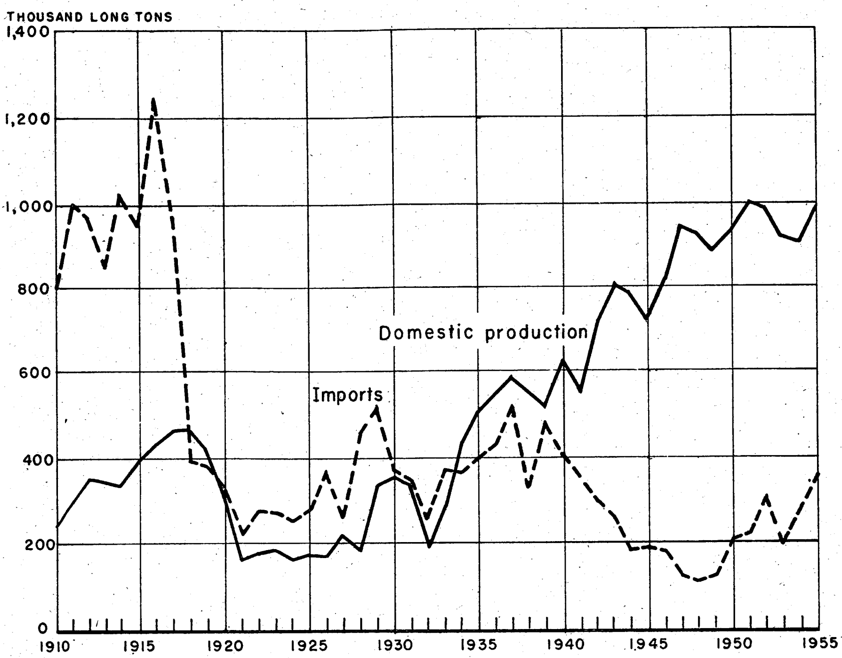

FIGURE 2.—Domestic production and imports of pyrites, 1910–55.

BYPRODUCT SULFURIC ACID

Output of byproduct sulfuric acid at copper and zinc plants increased 26 percent; at copper plants, 20 percent; and zinc plants, 28 percent. Expansion of capacity caused production from copper plants to increase without interruption from 1949 to 1955. An additional contact acid plant was completed by Anaconda Co. at its Anaconda, Mont., plant. Garfield Chemical Co., a joint affiliate of American Smelting & Refining Co. and Kennecott Copper Corp., began constructing a new $2.5 million, 250-ton per day, unit at its Garfield, Utah, plant to produce sulfuric acid for use in manufacturing fertilizers and treating uranium ore on the Colorado Plateau.

TABLE 6.—Byproduct sulfuric acid [1] (basis, 100 percent) produced at copper, zinc, and lead plants in the United States, 1946–50 (average) and 1951–55, in short tons

	1946–50 (average)	1951	1952	1953	1954	1955
Copper plants [2]	127,567	189,125	202,364	231,213	273,725	329,114
Zinc plants [3]	551,843	635,948	664,714	636,864	612,250	782,938
Total	679,410	825,073	867,078	868,077	885,975	1,112,052

[1] Includes acid from foreign materials.
[2] Includes acid produced at a lead smelter. Excludes acid made from pyrites concentrate in Montana and Tennessee.
[3] Excludes acid made from native sulfur.

In 1955 smelter acid was produced by 17 plants in the following States: California, Idaho, Illinois, Indiana, Kansas, Missouri, Montana, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Utah, and Washington.

OTHER BYPRODUCT SULFUR COMPOUNDS

In addition to the elemental sulfur recovered, a relatively small quantity of sulfur dioxide and hydrogen sulfide also was recovered from industrial gases. Output of this material, which has increased steadily from 21,000 tons of contained sulfur in 1947 to 94,000 tons in 1955, came from California, Louisiana, New Jersey, Pennsylvania, and Tennessee.

CONSUMPTION AND USES

Domestic consumption of sulfur in all forms reached a new high in 1955, when 5.6 million tons was used. The end uses of sulfur did not change greatly; sulfuric acid accounting for about 74 percent of consumption; and nonacid uses, 26 percent. The leading consumer of sulfuric acid was the fertilizer industry, followed by chemicals. Sulfuric acid use by the rayon industry was heavy, as production of rayon staple and yarn rose 28 percent over 1954. Large volumes of acid were consumed as pickling solution by the steel industry in this record-breaking year for steel production. Of new sulfuric acid produced, 75 percent was made from Frasch sulfur, 7 percent from pyrites, 8 percent from H_2S, 5 percent from smelter gas, and 5 percent from reconstituted refinery sludge.[8]

TABLE 7.—Apparent consumption of native sulfur in the United States, 1946–50 (average) and 1951–55, in long tons

	1946–50 (average)	1951	1952	1953	1954	1955
Apparent sales to consumers [1]	4,891,330	5,095,347	5,061,722	5,201,711	[2] 5,373,439	[2] 5,846,702
Imports	29	2,376	4,863	1,229	1,214	24,525
Total	4,891,359	5,097,723	5,066,585	5,202,940	5,374,653	5,871,227
Exports:						
Crude	1,324,591	1,287,773	1,304,154	1,241,536	[3] 1,645,000	1,597,951
Refined	41,503	24,044	34,213	29,475	30,130	34,701
Total	1,366,094	1,311,817	1,338,367	1,271,011	[3] 1,675,130	1,632,652
Apparent consumption	3,525,265	3,785,906	3,728,218	3,931,929	[3] 3,699,523	4,238,575

[1] Production adjusted for net change in stocks during the year.
[2] Includes native sulfur from mines that do not use the Frasch process. A small quantity was consumed before 1954; however, this tonnage was not included in the above figures.
[3] Revised figure.

[8] Forbath, T. Peter, Sulfur, H_2SO_4 Stack Records: Chem. Eng., vol. 63, No. 8, August 1956, p. 278, 280, 282.

TABLE 8.—Apparent consumption of sulfur in all forms in the United States, 1946–50 (average) and 1951–55 in long tons [1]

	1946–50 (average)	1951	1952	1953	1954	1955
Native sulfur [2]	3,525,271	3,785,900	3,728,200	3,931,900	[3] 3,699,500	4,238,600
Recovered sulfur shipments	49,861	193,800	224,500	313,800	[3] 342,300	380,100
Pyrites:						
Domestic production	377,973	432,800	418,100	379,500	405,300	403,600
Imports	71,667	106,300	142,000	91,000	133,900	171,500
Total pyrites	449,640	539,100	560,100	470,500	539,200	575,100
Smelter acid production	198,142	240,800	253,000	253,000	258,600	324,600
Other production [4]	28,896	59,600	66,500	80,200	73,000	93,700
Total	4,251,810	4,819,200	4,832,300	5,049,400	[3] 4,912,600	5,612,100

[1] Crude sulfur or sulfur content.
[2] In addition, a small quantity of native sulfur from mines that did not use the Frasch process was consumed; however, this tonnage was not included in the above figures prior to 1954.
[3] Revised figure.
[4] 1948–49, hydrogen sulfide; 1950–55, hydrogen sulfide and liquid sulfur dioxide. In addition, a quantity of acid sludge was converted to H_2SO_4 but was excluded from the above figures.

TABLE 9.—Production of new sulfuric acid (100 percent H_2SO_4) by geographic divisions and States, 1951–55, in short tons

[U. S. Department of Commerce]

Division and State	1951	1952	1953	1954 [1]	1955 [1]
New England [2]	210,324	172,157	190,456	169,880	183,698
Middle Atlantic:					
Pennsylvania	808,334	747,226	798,484	713,074	855,913
New York and New Jersey	1,348,451	1,343,165	1,504,408	1,441,943	1,547,113
Total Middle Atlantic	2,156,785	2,090,391	2,302,892	2,155,017	2,403,026
North Central:					
Illinois	1,073,223	1,059,602	1,131,632	1,257,759	1,305,576
Indiana	464,896	433,150	487,892	440,166	562,315
Michigan	(2)	196,120	226,254	217,888	261,493
Ohio	654,321	624,184	661,492	[3] 656,226	745,051
Other [4]	798,472	522,963	548,985	[3] 536,234	720,435
Total North Central	2,990,912	2,836,019	3,056,255	[3] 3,108,273	3,594,870
South:					
Alabama	298,404	290,139	306,565	[3] 269,576	243,024
Florida	535,719	741,630	900,099	[3] 1,185,883	1,233,281
Georgia	247,307	239,833	229,104	[3] 212,732	256,075
North Carolina	160,087	159,469	163,762	142,048	152,159
South Carolina	206,779	197,323	188,514	[3] 163,373	160,711
Virginia	549,918	550,742	532,003	[3] 463,897	537,095
Kentucky and Tennessee	835,310	841,555	857,874	944,404	974,827
Texas	947,916	1,086,957	996,601	1,212,530	1,477,179
Delaware and Maryland	1,340,009	1,221,445	1,210,674	[3] 1,203,399	1,353,567
Louisiana	435,335	505,768	602,858	730,021	788,311
Other [5]	489,988	459,972	437,816	[3] 467,898	459,035
Total South	6,046,772	6,294,833	6,425,870	[3] 6,995,761	7,635,264
West [6]	984,075	951,928	1,051,435	1,127,560	1,502,502
Total United States	12,388,868	12,345,328	13,026,908	[3] 13,556,491	15,319,360

[1] Includes information for Government-owned and privately operated plants.
[2] Includes data for plants located in Maine, Rhode Island, Massachusetts, and Connecticut.
[3] Revised figure.
[4] Includes data for plants located in Missouri, Wisconsin, Iowa, and Kansas. Michigan production shown separately in 1952–55.
[5] Includes data for plants located in West Virginia, Mississippi, Arkansas, and Oklahoma.
[6] Includes data for plants located in Arizona, California, Colorado, Idaho, Montana, Utah, Washington, and Wyoming.

TABLE 10.—Estimates of principal nonacid uses of sulfur and pyrites (sulfur equivalent) in the United States, 1953–55, in thousand long tons

[Chemical Engineering]

Use	1953	1954	1955
Wood pulp	[1] 390	[1] 400	[1] 425
Carbon bisulfide	220	[2] 215	300
Other chemicals, dyes	95	90	125
Insecticides, fungicides	100	100	125
Rubber	80	75	80
Other	135	135	195
Total	1,020	[2] 1,015	1,250

[1] Includes an estimated 10,000 tons of S equivalent in pyrites used in making sulfite liquor.
[2] Revised figure.

STOCKS

On December 31, 1955, producers' stocks of Frasch sulfur totaled 3,181,198 long tons. Of this, 2,836,931 tons was held at the mines and 344,267 tons were elsewhere. At the end of 1954, producers of Frasch sulfur held 3,236,067 tons; therefore, the inventories were reduced 2 percent during the year. Stocks of recovered sulfur in the hands of the producers increased from 109,066 tons in 1954 to 120,267 tons in 1955—a net gain of about 10 percent. Inventory statistics on pyrites were not available.

TABLE 11.—Estimates of United States use of sulfuric acid [1] (basis, 100 percent), 1953–55, in thousand short tons

[Chemical Engineering]

Industry	1953	1954	1955	Industry	1953	1954	1955
Fertilizers:				Iron and steel	1,010	850	1,160
Superphosphate	4,050	4,060	4,650	Other metallurgical	220	220	248
Ammonium sulfate	1,150	1,320	1,650	Industrial explosives	420	400	450
Chemicals	4,000	3,880	4,195	Textile finishing	30	30	30
Petroleum refining	1,780	1,770	1,800	Miscellaneous [2]	670	650	675
Inorganic pigments	1,300	1,300	1,400	Total	15,300	15,100	17,008
Rayon and film	670	620	750				

[1] Recycled acid, including reused, concentrated, fortified, and reconstituted acid is estimated at about 2,330,000 short tons in 1953, 1,900,000 tons in 1954, and 2,024,000 tons in 1955.
[2] Includes estimated total acid going into military explosives (in 1953 only). About ⅔ goes later into recycled acid.

PRICES

Throughout 1955, sulfur was quoted in E&MJ Metal and Mineral Markets at $25.50 to $27.50 f. o. b. Texas mines and Canadian pyrites at $9 to $11 delivered to consumer's plant. Oil, Paint and Drug Reporter quoted crude sulfur bulk, carlots, mines, contract, long tons at $26.50; export f. o. b. vessel, Gulf ports $31 to $33; domestic and Canadian, f. o. b. vessel, Gulf ports $28 to $29.50; Canadian pyrites (works) $3 to $5 per long ton.

FOREIGN TRADE[9]

Facing strong competition from the Mexican sulfur industry, producers of Frasch sulfur maintained a high volume of export trade and sought new markets. Foreign shipments of Frasch sulfur were 3 percent lower than in the preceding year, when the export trade took 25 percent of the domestic production. Imports of sulfur in all forms increased 45 percent owing primarily to a rise in the tonnage of Canadian pyrites and Mexican Frasch sulfur.

TABLE 12.—Sulfur imported into and exported from the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Imports				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
1946–50 (average)	1	$22	28	$8,296	1,324,591	$27,039,582	41,503	$2,130,093
1951	1,875	94,496	501	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
1953	525	18,456	704	32,658	1,241,536	34,553,709	29,475	2,091,670
1954	110	2,289	1,104	[1] 55,958	[2] 1,645,000	[2] 50,361,661	30,130	2,161,979
1955	24,152	595,485	373	16,657	1,597,951	48,614,725	34,701	2,453,756

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable with previous years.
[2] Revised figure.

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

TABLE 13.—Sulfur exported from the United States, 1954–55, by countries of destination

[U. S. Department of Commerce]

Country	Crude				Crushed, ground, refined, sublimed, and flowers			
	1954		1955		1954		1955	
	Long tons	Value	Long tons	Value	Pounds	Value	Pounds	Value
North America:								
Canada	292,435	$8,356,756	348,339	$9,956,607	8,863,915	$285,770	7,337,215	$310,461
Central America					534,807	19,427	440,126	19,079
Mexico	754	22,883	3,646	127,570	4,276,950	140,836	2,804,777	92,759
West Indies	27,589	834,700	19,200	572,931	280,868	11,857	273,064	8,499
Total	320,778	9,214,339	371,185	10,657,108	13,956,540	457,890	10,855,182	430,798
South America:								
Argentina	9,842	329,707	9,842	301,352	119,800	25,746	150,300	32,841
Brazil	82,126	2,760,638	75,502	2,303,390	4,182,375	229,969	1,124,907	102,600
Colombia			89	4,280	927,827	34,414	512,871	29,711
Ecuador					147,333	4,496		
Paraguay	191	6,466						
Peru	49	2,688			1,013,151	24,716	5,007,132	130,462
Uruguay	4,921	152,540	6,516	202,993	35,000	3,995		
Venezuela	1,069	39,015	1,380	49,574	349,778	26,101	198,956	20,910
Total	98,198	3,291,054	93,329	2,861,589	6,775,264	349,437	6,994,166	316,524
Europe:								
Austria	29,495	969,335	6,120	216,595				
Belgium-Luxembourg	48,500	1,497,950	73,199	2,356,967	133,200	3,673	145,650	9,327
France	176,430	5,455,098	127,360	4,000,510				
Germany, West	35,500	1,105,000	39,048	1,201,788	303,600	58,676	277,000	54,860
Greece					19,067,598	397,533	28,372,250	562,119
Netherlands			10,718	332,258	7,700	1,667	32,350	5,931
Norway					254,500	9,168	350,000	15,076
Portugal					71,200	10,475	72,900	11,993
Sweden					106,750	22,685	240,850	31,959
Switzerland	53,870	1,710,260	61,822	1,916,482	208,120	21,297	266,070	33,096
United Kingdom	409,208	12,502,434	294,715	8,989,985				
Yugoslavia	909	37,996			8,984,562	230,029	6,629,200	198,284
Other Europe	1,000	41,250	21,022	671,731	17,600	3,858	402,145	27,949
Total	754,912	23,319,323	634,004	19,686,316	29,154,830	759,061	36,788,415	950,594
Asia:								
India	69,825	2,195,763	75,215	2,335,515	7,371,702	215,377	13,245,954	370,546
Indonesia	6,310	195,610	8,190	253,495	405,890	17,488	348,150	17,224
Israel	1,000	31,000	400	12,400	43,220	4,887	179,545	6,231
Korea, Republic of					2,611,553	59,091	3,640,316	94,697
Lebanon					650,000	16,417	393,690	9,320
Pakistan	822	27,088	1,619	56,852			151,806	3,965
Philippines	3,600	167,550	3,600	152,556	272,355	11,221	226,129	9,210
Syria					500,808	11,330	850,310	19,205
Other Asia	1,673	54,123	4,417	157,219	235,110	7,145	650,515	19,941
Total	83,230	2,671,134	93,441	2,968,037	12,090,638	342,956	19,686,415	550,339
Africa:								
Algeria	11,419	344,989	12,000	372,000				
Egypt	246	8,781	787	26,378	3,749,955	96,190	1,501,091	29,462
French Morocco	7,000	217,000	7,500	232,500				
Tunisia	13,000	382,500	12,000	372,000				
Union of South Africa	67,000	2,028,400	78,500	2,363,770	902,174	95,100	971,759	108,516
Other Africa	1,969	69,300	2,000	62,000				
Total	100,634	3,050,970	112,787	3,428,648	4,652,129	191,290	2,472,850	137,978
Oceania:								
Australia	[1] 165,113	[1] 5,047,356	174,137	5,363,519	182,850	19,800	250,350	35,411
New Zealand	122,135	3,767,485	119,068	3,649,508	679,339	41,545	682,360	32,112
Total	[1] 287,248	[1] 8,814,841	293,205	9,013,027	862,189	61,345	932,710	67,523
Grand total	[1] 1,645,000	[1] 50,361,661	1,597,951	48,614,725	67,491,590	2,161,979	77,729,738	2,453,756

[1] Revised figure.

TABLE 14.—Pyrites, containing over 25 percent sulfur, imported for consumption in the United States 1946–50 (average) and 1951–55, by countries

[U. S. Department of Commerce]

Country	1946–50 (average)		1951		1952	
	Long tons	Value	Long tons	Value	Long tons	Value
North America:						
Canada	119,765	$266,508	221,487	$457,365	295,820	$865,547
Mexico						
Total	119,765	266,508	221,487	457,365	295,820	865,547
Europe:						
Germany, West						
Malta, Gozo, Cyprus	4	12				
Portugal	60	533			227	16,267
Spain	29,479	80,503				
Total	29,543	81,048			227	16,267
Oceania: Australia	4	48				
Grand total	149,312	347,604	221,487	457,365	296,047	881,814

Country	1953		1954		1955	
	Long tons	Value	Long tons	Value [1]	Long tons	Value [1]
North America:						
Canada	190,227	$662,566	[2] 46,649	[2] $292,025	[2] 80,305	[2] $519,756
Mexico	247	753				
Total	190,474	663,319	[2] 46,649	[2] 292,025	[2] 80,305	[2] 519,756
Europe:						
Germany, West	(3)	182				
Malta, Gozo, Cyprus						
Portugal						
Spain						
Total	(3)	182				
Oceania: Australia						
Grand total	190,474	663,501	[2] 46,649	[2] 292,025	[2] 80,305	[2] 519,756

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable with years before 1954.
[2] In addition to data shown an estimated 232,920 long tons ($627,620) in 1954; 277,860 long tons ($711,740) in 1955, all from Canada.
[3] Less than 1 ton.

TABLE 15.—Pyrites, containing over 25 percent sulfur, imported for consumption in the United States, 1946–50 (average) and 1951–55, by customs districts, in long tons

[U. S. Department of Commerce]

Customs district	1946–50 (average)	1951	1952	1953	1954	1955
Buffalo	108,047	221,391	295,626	172,375	[1] 30,594	[1] 38,954
Chicago	7					
Connecticut	14					
Duluth and Superior		46				
Michigan	1				260	24,348
New York	68		227	(2)		
Philadelphia	41,152					
Pittsburgh						682
Rochester		50				
St. Lawrence			194	2,656	7,115	8,973
Vermont	23			15,443	8,680	7,348
Total	149,312	221,487	296,047	190,474	[1] 46,649	[1] 80,305

[1] In addition to data shown, an estimated 232,920 long tons was imported through the Buffalo customs district in 1954; 277,020 long tons through Buffalo customs district and 840 long tons through Michigan customs district in 1955.
[2] Less than 1 ton.

TECHNOLOGY

Increased quantities of sulfur in a molten state were transported long distances from the mines to consumers. Originating in 1948 with experiments in the shipment of liquid sulfur from Grande Ecaille mine to Port Sulphur, a distance of 10 miles, the method was improved to the point where 1,000-mile movements have proved feasible. The "vacuum-bottle technique" has been improved by the addition of boilers in barges to keep the chemical hot. The hold of each barge consists of a huge tank within the barge hull, surrounded by airspace and lined with 4-inch-thick foam-glass insulation covered by a thin layer of asbestos board. Some barges are equipped with boilers and heating coils to maintain a minimum temperature of 260° F., 20° above the melting point of sulfur. The first shipment of liquid sulfur in the new insulated barges was made from Port Sulphur, La., on May 4 and ended at the National Lead Co. Titanium Division plant at St. Louis, Mo., a distance of 1,100 miles from the point of origin 8 days later.[10]

Kimberly Clark Corp. developed a new compact jet-type sulfur burner that requires only a fraction of the space normally occupied by conventional rotary- and combustion-chamber burners. The burner sprays a fine mist of molten sulfur into the chamber, with secondary air introduced in several stages. Operation was efficient for SO_2 gas concentrations between 12 and 18½ percent. Dark and light sulfur is burned efficiently at 2,100° F. with loads of 25 to 150 percent of rate capacity. Production of SO_3 gas is minimized by the rapid rise in temperature and shutdown is instantaneous.[11]

Laboratory Equipment Co. developed an induction furnace and automatic titrator for the rapid determination of sulfur in hydrocarbons by a high-frequency-combustion titration process. Depending on the type of material being tested, analysis time was reported to be 3 to 10 minutes. Results were in excellent agreement with conventional analysis procedures. Advantages claimed for the induction furnace included: Power consumed only during the combustion of the sample, ready for use within 45 seconds, cool in operation, and the furnace can be turned off immediately in case of dangerous hydrogen saturation of the atmosphere in a refinery. In addition to measuring sulfur in hydrocarbons, the furnace can be used to analyze sulfur or carbons in steel, iron ores, alloys, and slag by gravimetric, gasometric, and conductometric methods.[12]

Liquid sulfur dioxide and sulfuric acid were manufactured by Canadian Industries, Ltd., from high-quality furnace gas produced at the adjacent copper plant of International Nickel Co. of Canada at Copper Cliff, Ontario. High-quality sulfur dioxide gas, matte, and slag were produced by injecting finely divided copper concentrates, flux, and oxygen into a preheated smelting furnace. In this reaction the oxygen combines with a part of the sulfur and iron contained in the chalcopyrite ore to form sulfur dioxide and iron oxide. Residual copper-iron sulfide is melted by the heat of the reaction to form

---

[10] Wall Street Journal, Barge Carries Liquid Sulfur 1,000 Miles for First Time; Regular Shipments Start: Vol. 145, No. 96, May 17, 1955, p. 13.

[11] Chemical Engineering, Sulfur Burner: Vol. 62, No. 8, August 1955, pp. 236, 238.

[12] Chemical and Engineering News, Combustion-Titration for Fast Sulfur Analysis: Vol. 33, No. 33, Aug. 15, 1955, p. 3424.

matte; the iron combines with the siliceous flux to form a slag. Gas emitted from the furnace is water-scrubbed and treated in a wet Cottrell separator before conversion into liquid sulfur dioxide. The clean gas is dried with sulfuric acid, cooled, and compressed to condense the sulfur dioxide.[13]

Stauffer Chemical Co., New York, reported development of a process to produce new surface-conditioned sulfurs with free-flowing and blending characteristics. The company claims that the special surface treatment promotes more rapid blending during rubber compounding and greatly reduces "dusting" and attendant hazards from static-induced fires.[14]

Hercules Powder Co., Wilmington, Del., developed a new chemical (dicumyl peroxide) to substitute for sulfur in vulcanizing rubber. It is produced by hydrogenating cumene hydroperoxide to the corresponding alcohol and reacting the latter with more cumene hydroperoxide. It has been claimed that this material permits production of a vulcanized rubber of superior aging characteristics and that is less susceptible to degradation than rubbers vulcanized conventionally with sulfur and additives.[15]

Fluidized-solids reactors have been successfully adapted to oxidation reaction in recovering sulfur dioxide from low-grade sulfur ores. Oxidation with fluidized solids provides the effective solid-gas contact, temperature control, and rapid reaction rates necessary for efficiency.[16]

Olin Mathieson Chemical Corp., Pasadena, Tex., operated a scrubbing and stripping unit which eliminated objectional fumes, increased production rates 20 percent, and disposed of scrubber liquid in such a way as to avoid stream pollution. This process is a modification of the Cominco SO_2 recovery developed by the Consolidated Smelting & Refining Co. of Canada, Ltd. A new feature in the process was the use of a double scrubbing tower, two scrubbers built one above the other. Overall absorption efficiency of the unit, designed to handle SO_2 concentration up to 0.9 percent, was high, as tail gases contain less than 0.03 percent sulfur dioxide.[17]

WORLD REVIEW

NORTH AMERICA

Canada.—In 1955 the output of sulfur from all sources in Canada reached an alltime high of 654,237 short tons—an increase of about 19 percent over the 551,071 tons produced in 1954. This increase was attributed principally to the first full year of production at Noranda Mines, Ltd., sulfur-sulfur dioxide-iron-ore plant, Port Robinson, Ont. Pyrite shipments (sales) in Canada during 1955 contained 397,808 short tons of sulfur, an increase of about 28 percent over the 1954 production, which totaled 311,159 tons. Output of

---

[13] Chemical and Engineering News, Smelting Sulfides in Suspension: Vol. 33, No. 19, May 9, 1955, pp. 1966 and 1968. Chemical Engineering, Liquid Sulfur Dioxide: Vol. 62, No. 10, October 1955, pp. 320–324.

[14] Oil, Paint and Drug Reporter, Sulfur Development Told by Stauffer Chemical Co.: Vol. 168, No. 3, July 18, 1955, p. 37.

[15] Chemical Week, Gunning for Sulfur: Vol. 76, No. 24, June 11, 1955, p. 101.

[16] Chemical Engineering, Fluidized-Bed Technique Pays Off in New Sulfuric Acid Plant: Vol. 62, No. 8, August 1955, pp. 288–291.

[17] Chemical Engineering, SO_2 Absorber: Two Scrubs Better Than One: Vol. 62, No. 2, February 1955, pp. 132, 134.

smelter acid rose from 221,247 tons of contained sulfur in 1954 to 230,453 tons in 1955 and shipments of elemental sulfur recovered from natural gas increased 39 percent from the 1954 figure of 18,665 tons to 25,996 tons in 1955.

TABLE 16.—World production of native sulfur, by countries,[1] 1946–50 (average) and 1951–55, in long tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Mexico	5,260	11,375	11,784	5,900	52,407	475,487
United States	4,622,855	5,279,614	5,295,342	5,193,599	5,578,973	5,799,880
South America:						
Argentina	9,381	7,560	15,000	16,000	17,000	22,000
Bolivia (exports)	2,827	9,100	5,497	2,458	2,565	3,975
Chile	11,873	29,752	47,821	32,275	39,075	54,132
Colombia	[3] 569	2,479	2,974	2,657	5,118	5,413
Ecuador	27	1	2,353	100	64	1,550
Peru	1,520	2,251	5,066	4,916	----------	----------
Europe:						
France (content of ore)	5,586	10,905	17,692	10,710	----------	----------
Italy (crude) [4]	175,421	197,382	232,706	224,161	200,215	176,917
Spain [5]	4,400	6,700	4,800	5,100	5,400	6,500
Asia:						
Japan	48,617	140,181	176,652	186,556	184,244	199,219
Philippines	----------	----------	----------	1,089	761	[5] 3,700
Taiwan (Formosa)	1,077	2,732	5,001	3,423	5,873	4,854
Turkey	3,421	7,273	8,232	9,626	9,862	11,318
Total (estimates) [1]	5,000,000	5,900,000	6,000,000	5,800,000	6,300,000	7,000,000

[1] Native sulfur believed to be also produced in 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 and Pyrites chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[3] Average for 1948–50.
[4] In addition the following tonnages of ground sulfur rock (30 percent S) were produced and used as an insecticide: 1946–50 (average), 16,600 tons; 1950, 15,778 tons; 1951, 22,120 tons; 1952, 21,482 tons; 1953, 16,940 tons; 1954, 22,803 tons; 1955, 21,560 tons.
[5] Estimate.

A tremendous reserve of natural gas containing approximately 44.6 pounds of sulfur per million cubic feet of gas was reported in Alberta and the Peace River districts of British Columbia. Between 80 and 90 percent of the contained sulfur is estimated to be recoverable. Recovery of elemental sulfur from sour natural gases has increased since the Shell Oil Co. recovery plant at Jumping Pound began producing in May 1951. Capacity increased from 15 to 30 tons per day in 1952 and in 1955 rose further to 50 tons per day. Construction was begun on Canadian Gulf Oil Co. 40-million-dollar, 225-ton-per-day, sulfur-recovery plant near Lithbridge, Alberta, and the Imperial Oil, Ltd., new recovery plant, which will treat 9 million cubic feet of gas per day from the Redwater field.

Production was begun at the Indland Chemicals (Canada), Ltd., 100-ton sulfuric-acid plant adjoining the Sherrit Gordon refinery at Fort Saskatchewan, Alberta. The Shell Oil Co. Jumping Pound plant, Calgary, Alberta, was to supply the 25 tons of sulfur per day required for capacity production at the plant.[18] Shawinigan Chemicals, Ltd., began constructing a new 25,000 ton-per-year sulfuric acid plant at Shawinigan Falls, Quebec.[19]

[18] American Metal Market, vol. 62, No. 193, Oct. 5, 1955, p. 12.
[19] Chemical Age, vol. 73, No. 1896, Nov. 11, 1955, p. 1046.

TABLE 17.—World production of pyrites (including cupreous pyrites), by countries,[1] 1946–50 (average) and 1951–55, in long tons[2]

[Compiled by Helen L. Hunt]

Country[1]	1946–50 (average) gross weight	1951 Gross weight	1951 Sulfur content	1952 Gross weight	1952 Sulfur content	1953 Gross weight	1953 Sulfur content	1954 Gross weight	1954 Sulfur content	1955 Gross weight	1955 Sulfur content
North America:											
Canada (sales)	201,313	397,274	192,288	494,630	235,036	364,515	166,651	517,856	277,820	739,968	355,185
Cuba	-----	-----	-----	10,000	4,540	[3] 50,000	[3] 24,200	118,105	56,690	127,497	62,473
United States	900,421	1,017,769	432,819	994,342	418,139	922,647	379,545	908,715	405,310	994,443	396,576
South America: Brazil	[3] 3,600	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Europe:											
Austria	8,461	10,075	2,703	7,907	2,261	69	26	-----	-----	-----	-----
Czechoslovakia	4,959	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Finland	157,115	228,874	97,230	241,059	103,230	255,095	108,263	248,528	105,310	298,064	126,963
France	206,562	276,128	115,463	295,670	117,706	293,293	132,395	294,966	123,885	300,176	126,074
Germany, West	373,992	487,106	181,497	485,431	182,163	506,375	180,073	556,480	193,868	579,796	206,021
Greece	50,790	178,401	[3] 77,800	191,578	[3] 83,700	233,576	[3] 102,000	206,503	[3] 90,200	229,127	[3] 100,000
Italy	717,488	884,004	395,948	1,122,777	505,293	1,215,072	546,827	1,212,007	545,449	1,268,831	568,480
Norway	686,672	685,058	290,953	701,364	302,329	733,095	332,105	782,362	343,697	836,600	363,200
Poland	56,500	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Portugal	492,378	718,090	323,141	743,961	334,783	709,810	288,385	641,803	258,822	659,174	296,641
Rumania	[3] 4,900	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Spain	1,167,608	1,767,836	[3] 858,000	2,118,596	[3] 1,028,000	1,773,374	[3] 860,000	1,864,233	[3] 913,100	2,289,606	[3] 1,099,000
Sweden	362,726	400,509	199,603	407,055	201,770	382,848	189,178	392,896	193,563	387,852	190,823
United Kingdom	15,693	15,586	[3] 6,200	9,692	[3] 3,800	10,244	[3] 3,900	7,011	[3] 2,950	[3] 6,900	[3] 2,900
Yugoslavia	154,905	151,351	[3] 68,500	185,158	83,526	170,271	[3] 77,000	159,718	[3] 71,800	223,103	116,014
Asia:											
China	[3] 50,700	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)	(4)
Cyprus	643,343	944,682	453,447	1,056,026	506,893	994,345	477,342	1,103,367	[3] 529,500	1,318,363	[3] 632,800
India	-----	530	230	2,168	930	277	[3] 120	-----	-----	-----	-----
Japan	1,172,914	2,215,244	890,528	2,586,855	1,037,329	2,306,260	963,938	2,635,564	1,106,281	2,692,466	1,136,270
Korea, Republic of	-----	-----	-----	743	[3] 340	765	[3] 350	-----	-----	-----	-----
Philippines	-----	-----	-----	29	10	1,945	680	5,205	2,080	30,296	[3] 10,600
Taiwan (Formosa)	68	6,622	2,119	32,707	10,466	24,892	8,961	23,857	9,543	28,559	[3] 11,400
Turkey	-----	-----	-----	19,045	[3] 9,500	22,727	[3] 11,300	33,935	16,928	16,137	[3] 8,100
Africa:											
Algeria	33,332	30,953	13,619	23,631	10,397	29,290	12,893	33,020	14,517	21,328	9,380
French Morocco	[5] 343	1,918	863	1,993	857	2,005	799	1,537	575	4,007	600
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	17,039	27,823	11,964	18,752	8,064	36,086	15,517	36,387	15,283	21,268	8,933
Tunisia	3,158	-----	-----	-----	-----	-----	-----	-----	-----	-----	-----
Union of South Africa	35,512	32,851	14,245	30,649	13,198	92,362	36,259	225,534	86,809	351,650	137,882
Oceania: Australia	105,216	151,389	66,000	198,714	84,151	167,008	77,812	195,459	44,102	245,886	116,841
World total (estimate)[1]	9,400,000	12,800,000	5,350,000	14,100,000	5,900,000	13,500,000	5,650,000	14,400,000	6,000,000	16,000,000	6,700,000

[1] In addition to countries listed, East Germany, Kenya, North 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 Sulfur and Pyrites chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[3] Estimate. [4] Data not available; estimate by senior author of chapter included in total. [5] Average for 1948–50.

In 1955 the delivered price of Frasch sulfur to Canadian consuming plants, including transportation charges, ranged from $35 to $45 per long ton. Pyrite prices ranged from $4 to $5 per long ton f. o. b.

Since hydrogen sulfide and other impurities must be removed from sour natural gas before it is used, distribution of western gas by pipeline to the eastern Provinces was expected to result in increased production of elemental sulfur. It was estimated that by 1960 the output of sulfur in Canada may reach 1.2 million tons, double the 1955 consumption rate.[20]

Noranda Mines, Ltd., announced plans for constructing a multimillion-dollar sulfuric acid plant at Blind River, Ontario, to provide the large tonnage of acid required by the expanding uranium industry for the chemical leaching of uranium ore. Slightly larger than its Port Robinson plant, the plant will have an estimated production of 500 tons of acid, 70 tons of elemental sulfur, and about 350 tons of high-grade iron sinter daily.[21]

Mexico.—In 1955, the first year in which substantial tonnages of Frasch sulfur were produced outside the United States, Mexican sulfur producers became active competitors in world markets. Production of sulfur in all forms totaled 503,000 long tons; 475,487 tons was Frasch sulfur; and 28,000 tons, recovered. Pan American Sulfur Co. produced 391,111 tons from the Jaltipan dome, reaching 65,000 tons per month in the closing months of the first complete year of production. Exports totaled 130,000 tons. Output by the Mexican Gulf Sulphur Co., San Cristobal dome, totaled 83,675 tons and estimated sales to domestic and foreign markets 80,000 tons. The Gulf Sulfur Corp. developed its Las Salinas dome but reported no production.[22]

SOUTH AMERICA

Argentina.—Sociedad Minera Argentina was planning to install new mining equipment at its Volcan Overo mine and to increase sulfur production from 20,000 to 50,000 tons per year. At an elevation of 18,000 feet on the Volcan Overo, the mine is faced with severe weather conditions that restrict sulfur mining to three months of the year.[23]

Bolivia.—The Bolivian Government had undertaken a study of the prospects of increasing the Nation's output of sulfur. The Ministry of Mines, Corporcion de Minera, and Banco Minera formed a commission to investigate the possibilities of forming producers cooperatives and the feasibility of extending Government assistance to private mining companies.[24]

Chile.—Discovery of high-grade sulfur deposits have been reported in the Julia Segunda and Casualidad areas near the Bolivian and Argentine borders. The Chilean Department of Mines and Fuels has become increasingly interested in exploration and development of the country's large sulfur resources.[25] Chilean brimstone was the raw material to be used in a new 35-ton-per-day sulfuric acid plant

[20] Department of Mines and Technical Surveys, Ottawa, Sulfur and Pyrites in Canada, 1955 (prelim.): 6 pp.
[21] Skillings Mining Review, Noranda Mines Ltd., To Build Sulfuric Acid Plant at Blind River, Ont.: Vol. 44, No. 13, July 2, 1955, p. 21.
[22] British Sulphur Corp. (London), Sulfur in Mexico: Quart. Bull. 12, March 1956, p. 30.
[23] Mining World, vol. 17, No. 4, April 1955, p. 67.
[24] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 4, April 1955, p. 60.
[25] Mining World, vol. 17, No. 6, May 1955, p. 83.

being constructed at the port of Antofagasta for the leaching of copper oxide ores.[26]

Colombia.—Industria Purace S. A. produced sulfur by the autoclave process at a higher rate than in 1954. Since the domestic market was fully protected by high import duties on all but a few special grades of sulfur, world market prices have little effect on the price of sulfur in the country.[27]

Ecuador.—At the Tixan mine Ecuadorian Mining Corp. produced 1,550 long tons of sulfur at a rate of 4,000 tons/yr. during 1955. Rumors about the plant and mine reverting to the Government owing to marketing difficulties were said to be unfounded. Domestic and export shipments were to absorb the production.[28]

EUROPE

Austria.—Plans for reactivating and installing a new flotation plant at the Panzendorf mine, closed since 1953, were under consideration. Geological tests and drilling had not been completed, but it was thought that addition of a flotation plant would increase the annual production of pyrite concentrates containing 46 percent sulfur to 6,000 tons annually.[29]

France.—Société Nationale de Pétroles d'Aquitaine planned to construct a large-scale gas-treatment plant at Lacq. The vast reserve of natural gas discovered in the area contains approximately 17.06 percent H_2S, which was to provide the plant with enough raw material to produce 70,000 tons of sulfur annually. Output of clean gas and associated byproducts (sulfur, high-octane gasoline, butane, and propane) was expected to become available in 1957.[30] Antar-Pétroles de l'Atlantique planned to construct a plant for recovering sulfur from refinery gases similar to one built by cie de Raffinage Shell-Berre at the Berre-l 'Étang refinery.[31]

Italy.—Production of sulfur in Italy during 1955 was estimated at 890,000 metric tons; 66 percent was recovered from pyrites; 21 percent, from elemental sulfur; and 11 percent, from sulfur in blende, spent oxide, and sulfur ore.

Domestic consumption has increased steadily, totaling 823,000 metric tons in 1955, 75 percent greater than in 1930–40, and 50 percent more than in 1950. Elemental, used primarily for nonacid purposes in the agricultural and rayon industries, furnished about 14 percent of usage. During 1955 1.9 million tons (100 percent H_2SO_4) of sulfuric acid was produced, primarily from the roasting of pyrites from the Montecantini mines in central Italy augmented by a small tonnage of byproduct acid from nonferrous-metal smelters.

Competitive status in the export market was obtained in the latter part of 1955 with subsidies furnished by the Government. After an interval of nearly 3 years, 46,800 tons was exported to areas where freight advantages facilitated competition with Frasch sulfur. Subsidies, however, were not expected to provide a lasting solution to the problems confronting the industry. Only through the effective

---

[26] Engineering and Mining Journal, vol. 156, No. 7, July 1955, p. 174.
[27] British Sulphur Corp. (London), Quarterly Bull. 10, September 1955, p. 32.
[28] Mining World, vol. 17, No. 8, July 1955, p. 76.
[29] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 48.
[30] British Sulphur Corp. (London), Quart. Bull. 9, June 1955, p. 31.
[31] Work cited in footnote 27, p. 31.

use of capital provided by the Government for modernizing plants and mines can production cost be lowered enough to permit the industry to compete in world markets.[32]

Portugal.—According to the National Institute of Statistics, production of cuprous pyrites increased during 1954, compared with the previous year. Portugal's new steel industry was expected to provide a market for part of the pyrites produced. Exports declined sharply as a result of smaller demands in Germany.[33]

Spain.—Spain, the leading world exporter of pyrites, exported 700,000 metric tons of contained sulfur in 1954. Pyrite production was estimated at 1.9 million tons; 1.7 million tons was iron pyrites; and 0.2 million tons was cuprous pyrites. Output of sulfur in all forms totaled 940,000 tons; 890,000 tons was available for delivery. Available sulfur supplies consisted of 835,000 tons of sulfur in pyrites, 40,000 tons of elemental sulfur, 15,000 tons in byproduct sulfuric acid, and 210,000 tons in the form of washed pyrites. Domestic consumption, totaling 340,000 tons, increased, primarily owing to the expanding sulfuric acid and fertilizer industry and the diversification of elemental sulfur usage. Acid production increased to 780,000 tons and was expected to increase to 1.8 million tons of installed capacity in 1960, when new plant expansions totaling 800,000 tons are completed.

Pyrite reserves in Spain, estimated to contain 180 million tons of sulfur, consist primarily of massive iron pyrite containing approximately 48 to 49½ percent sulfur, 40 to 44 percent iron, 0.5 to 1 percent copper, 0.25 to 0.5 percent arsenic, and nonmetallic impurities. In addition to the iron pyrite, primary cuprous ores containing 38 to 48 percent sulfur and 1.0 to 2.5 percent copper were found in small deposits in numerous areas.[34]

ASIA

India.—Extensive deposits of sulfide ores, estimated to contain about 1.5 million tons, were discovered in the Chitaldrug district of Mysore. Because India's sulfur requirements have been imported, the Government was considering ways of utilizing these ores in manufacturing elemental sulfur, sulfuric acid, and fertilizers.[35]

Dharambi Chemical Co. of Bombay successfully treated 1,250 tons of sulfuric acid sludge from the Burmah Shell Refinerys, Ltd., and completed a new 25-ton-capacity sulfuric acid plant.[36]

Indonesia.—N. V. Abimanju Trading Co., Djakarta, undertook development of sulfur deposits in the Dieng Mountains and planned to build a 10-ton-per-day sulfuric acid plant at Wonosobo. The deposits were estimated by a recent survey to contain about 150,000 tons of sulfur.[37]

Iraq.—The Texas Gulf Sulphur Co. negotiations with the Iraq Government for exploration and development of the sulfur resources in that country were reported to be unsuccessful.[38]

---

[32] British Sulphur Corp. (London), Quart. Bull. 12, March 1956, pp. 15–20.
[33] Work cited in footnote 29, p. 49.
[34] Work cited in footnote 27, pp. 3–11.
[35] Mining World and Engineering Record (London), Ore Deposits in Mysore: Vol. 168, No. 4382, Mar. 26, 1955, p. 178.
[36] Chemical Age, Indian Newsletter: Vol. 73, No. 1890, Oct. 1, 1955, p. 729.
[37] Mining World, vol. 17, No. 10, September 1955, p. 94.
[38] Chemical and Engineering News: Vol. 33, No. 9, Feb. 28, 1955, p. 872.

Japan.—Production of pyrites in Japan during 1954 totaled 2,345,000 metric tons; over half was supplied by two companies, Matsua Co., Ltd., and Dowa Mining Co., Ltd. Output of elemental sulfur totaled 185,653 tons—2 percent less than in 1953. Owing to increased requirements for carbon disulfide by the Japanese rayon industry, consumption of elemental sulfur increased 4½ percent over the previous year to 180,068 tons. Exports declined from 13,000 tons in 1953 to 7,021 in 1954. Excessive production costs and the need to export at prevailing world prices compelled Japanese producers to subsidize their exports by about 40 percent. Serious consideration was given by the major producers to improvement of facilities to meet the rising domestic demand and to recapture a major part of the Far Eastern export market.[39]

Pakistan.—Sulfur-production capacity was increased in Pakistan by constructing a new sulfur-purification plant in Quetta. The new plant, first of its kind in Baluchistan, will meet the country's entire demand for purified sulfur.[40] Three new sulfuric acid plants also were under construction, one of which was to be under private management. Production from the 10-ton-a-day sulfuric acid plant at Karnafulli will be used by a local paper mill. A large percentage of the production from a 20-ton-per-day plant at Lyallpur will be used in manufacturing superphosphate.[41]

Philippines.—Atlas Consolidated Mining & Development Corp. planned to construct a sulfuric acid plant for utilizing byproduct pyrite obtained from milling copper ore at its Toledo mine in Cebu. Pyrites in excess of plant requirements were to be sold to fertilizer plants in the Philippines or to other countries in the Far East.[42]

Turkey.—The State Keciborlu mine near Isparta produced somewhat more sulfur than in 1954. Completion of a new flotation plant in 1954 increased productive capacity of the mine to 18,000 tons. Reserves of elemental sulfur held by the company at the Isparta mine site were estimated at 400,000 tons averaging 60 percent sulfur. Additional sulfur in the form of both elemental sulfur and sulfuric acid from stack gases was available. It was estimated that stack gases alone will provide 100,000 tons of sulfur a year.[43]

OCEANIA

Australia.—The effects of the bounty instituted by the Tariff Board to encourage the Australian sulfuric acid industry to convert its plants from imported brimstone to Australian pyrites have been limited. Because commitments for raw material were usually made a year in advance, the full effects of the bounty were not felt in 1955, even though suitable plant capacity was available. Output of sulfuric acid increased from 600,000 tons (mono) in 1949–50 to an estimated 800,000 tons in 1954–55. Commissioning of the 100,000-ton acid plant at Port Adelaide and other new plants and additions were

[39] Work cited in footnote 28, p. 20.
[40] Mining World, vol. 17, No. 12, November 1955, p. 76.
[41] Chemical Age, vol. 73, No. 1885 August 27, 1955, p. 431.
[42] Mining World, vol. 17, No. 4, April 1955, p. 63.
[43] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 4, October 1955, p. 50.

expected to increase the country's capacity to over 1 million tons. Approximately 80 percent of the acid produced was consumed in manufacturing superphosphate fertilizers. Approximately two-thirds of the sulfuric acid during 1954–55 was produced from brimstone; the remainder was obtained from sulfur ore concentrate.[44]

---

[44] Chemical Age, Sulphuric Acid Plant Opens: Vol. 73, No. 1883, August 13, 1955, p. 334.
Chemical Engineering and Mining Review, Review of Australia's Sulfuric Acid Industry: Vol. 47, No. 7, Apr. 11, 1955, pp. 252–255.
Fertilizer and Feeding Stuffs Journal, Sulphuric Acid in Australia: Vol. 43, No. 6 Sept. 14, 1955, pp. 237–238.

Talc, Soapstone, and Pyrophyllite

By Donald R. Irving[1] and Eleanor V. Blankenbaker[2]

REFLECTING the increase in domestic industrial activity, annual combined mine production and total sales of talc, soapstone,[3] and pyrophyllite during 1955 each exceeded 700,000 short tons for the first time. Mine production of these commodities in 1955 was 13 percent more than the previous alltime high recorded in 1951 and 17 percent above the 1954 total.

A decision in the District Court of the United States for the Middle District of North Carolina, Greensboro Division, on July 15, 1955, determined that sawing talc into crayons, packaging such crayons for sale, and pulverizing and bagging talc were the ususal and ordinary treatment processes normally applied by mine owners and operators to obtain commercially marketable talc. The Court concluded that, in determining the gross income from the sale of his products, the operator was entitled to a 15-percent-depletion deduction from the gross sales of talc powder and talc crayon produced, exclusive of royalties or lease.

DOMESTIC PRODUCTION AND SALES

Mine production of crude talc, soapstone, and pyrophyllite increased 17 percent in quantity in 1955, compared with 1954, and exceeded by 13 percent the previous alltime high attained in 1951, according to reports by producers. The value of production in 1955 was 30 percent greater than in 1954. Talc and soapstone production increased 15 percent in quantity; pyrophyllite production increased 25 percent.

In 1955, New York, California, and North Carolina again ranked first, second, and third, respectively, in the quantity of talc, soapstone, and pyrophyllite produced—an order maintained since 1951. California continued to lead in the value of crude ore produced. North Carolina remained the dominant pyrophyllite-producing State, followed by California. Production of talc was reported from Alabama for the first year since 1942.

---

[1] Assistant chief, Branch of Ceramic and Fertilizer Materials.
[2] Literature-research clerk.
[3] Excludes soapstone sold in slabs or blocks, which is part of the stone industry.

TABLE 1.—Salient statistics of the talc, soapstone, and pyrophyllite industries in the United States, 1954–55

	1954		1955	
	Short tons	Value	Short tons	Value
Mined	[1] 618,994	[1 2] $3,492,548	725,708	[2] $4,527,847
Sold by producers:				
Crude to consumers	19,052	190,685	47,032	340,243
Sawed and manufactured	1,012	290,697	1,311	397,476
Ground [3]	[1] 579,934	[1] 12,152,651	671,043	14,487,640
Total sales	[1] 599,998	[1] 12,634,033	719,386	15,225,359
Imports for consumption: [4]				
Crude and unground	36	6,230	125	20,300
Cut and sawed	45	18,149	72	29,363
Ground, washed, or pulverized	22,076	653,850	28,882	936,312
Total imports	22,157	678,229	29,079	985,975
Exports:				
Talc, steatite, soapstone, and pyrophyllite, crude and ground [5]	23,607	855,386	35,365	960,326
Powder—talcum (in packages, face and compact	(6)	1,075,592	(6)	1,245,993
Total exports		1,930,978		2,206,319

[1] Revised figure.
[2] Partly estimated.
[3] Includes some crushed material.
[4] Exclusive of "Manufactures, n. s. p. f. (not specially provided for), except toilet preparations," as follows: 1954: $11,508; 1955: None. Quantities not available.
[5] Includes manufactures, n. e. s. (not elsewhere specified)
[6] Figure not available.

Most of the talc, soapstone, and pyrophyllite is ground by producers before it enters 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. Table 2 shows the proportion of material that enters trade in crude, sawed and manufactured, and ground form rather than the proportion of each sold by the primary producers. In 1955 the quantity of crude ore sold to consumers increased 147 percent compared with 1954, mainly as a result of increased sales of ceramic-grade talc from Texas and refractory-grade pyrophyllite from North Carolina. The average value of crude ore sold to consumers decreased 28 percent during the same period. Total sales of crude, sawed and manufactured, and ground talc, soapstone, and pyrophyllite increased 20 percent in quantity and 21 percent in value.

TABLE 2.—Talc, soapstone, and pyrophyllite [1] sold by producers in the United States, 1946–50 (average), and 1951–55, by classes

Year	Crude			Sawed and manufactured		
	Short tons	Value at shipping point		Short tons	Value at shipping point	
		Total	Average		Total	Average
1946–50 (average)	14,944	$136,640	$9.14	828	$252,320	$283.86
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
1953	18,423	185,184	10.05	935	354,847	379.52
1954	19,052	190,685	10.01	1,012	290,697	287.25
1955	47,032	340,243	7.23	1,311	397,476	303.19

Year	Ground [2]			Total		
	Short tons	Value at shipping point		Short tons	Value at shipping point	
		Total	Average		Total	Average
1946–50 (average)	499,140	$7,718,522	$15.46	514,912	$8,107,482	$15.75
1951	614,805	10,736,448	17.46	636,068	11,322,830	17.80
1952	573,142	10,834,151	18.90	593,147	11,347,317	19.13
1953	589,516	10,840,283	18.39	608,874	11,380,314	18.69
1954	[3] 579,934	[3] 12,152,651	[3] 20.96	[3] 599,998	[3] 12,634,033	[3] 21.06
1955	671,043	14,487,640	21.59	719,386	15,225,359	21.16

[1] Includes pinite, 1947–48.
[2] Includes some crushed material.
[3] Revised figure.

TABLE 3.—Pyrophyllite [1] produced and sold by producers in the United States, 1946–50 (average), and 1951–55

Year	Production (short tons)	Sales					
		Crude		Ground		Total	
		Short tons	Value	Short tons	Value	Short tons	Value
1946–50 (average)	104,364	6,742	$39,980	96,115	$1,187,329	102,857	$1,227,309
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
1953 [2]	123,457	2,480	15,564	119,057	1,581,826	121,537	1,597,390
1954 [2]	126,702	3,015	18,552	114,998	1,644,337	118,013	1,662,889
1955 [2]	158,460	19,830	124,904	[3] 135,506	2,005,069	155,336	2,129,973

[1] Exclusive of pinite.
[2] Includes sericite schist.
[3] Includes a small quantity of sawed material

TABLE 4.—Crude talc, soapstone, and pyrophyllite produced in the United States, 1954–55, by States

State	1954		1955	
	Short tons	Value [1]	Short tons	Value [1]
Alabama			1,500	$8,000
California	133,474	$1,211,201	166,551	1,552,783
Georgia	50,536	176,876	53,828	117,656
Maryland and Virginia	37,611	133,253	36,603	135,823
Nevada	5,866	53,582	10,732	90,086
North Carolina	112,704	388,428	125,206	571,689
Pennsylvania [2]	1,898	8,541	(3)	(3)
Texas	19,362	127,855	35,064	213,366
Vermont	66,195	198,585	(3)	(3)
Other States [4]	[5] 191,348	[5] 1,194,227	296,224	1,838,444
Total	[5] 618,994	[5] 3,492,548	725,708	4,527,847

[1] Partly estimated.
[2] Sericite schist.
[3] Included with "Other States."
[4] Includes States indicated by footnote 3 and Arkansas, Montana, New York, and Washington.
[5] Revised figure.

TABLE 5.—Ground talc, soapstone, and pyrophyllite sold or used by grinders in the United States, 1954–55, by States

State	1954		1955	
	Short tons	Value	Short tons	Value
Alabama			1,500	$15,000
California	120,556	$3,221,396	152,483	3,732,164
Georgia	50,248	505,219	53,419	538,890
Maryland and Virginia	37,468	343,205	33,923	317,521
North Carolina	102,195	1,569,221	100,721	1,639,112
Pennsylvania	2,241	26,892	(1)	(1)
Texas	14,599	233,625	19,664	330,035
Vermont	61,605	849,698	(1)	(1)
Other States [2]	[3] 191,022	[3] 5,403,395	309,333	7,914,918
Total	[3] 579,934	[3] 12,152,651	671,043	14,487,640

[1] Included with "Other States."
[2] Includes States indicated by footnote 1 and Arkansas (1955 only), Montana, Nebraska, New York, Oregon, Utah, and Washington.
[3] Revised figure.

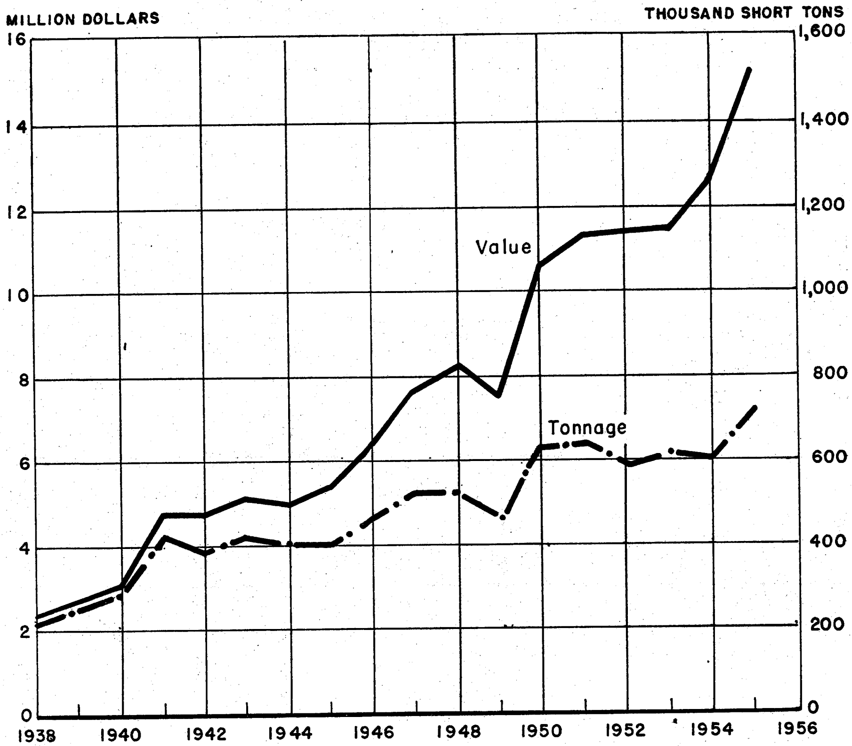

FIGURE 1.—Sales of domestic talc, soapstone, and pyrophyllite, 1938–55.

CONSUMPTION AND USES

Ceramics, paints, insecticides, roofing, rubber, asphalt filler, and paper consumed 87 percent of the talc and soapstone sold by producers in 1955, the same as in 1954 and 1953. Quantity increases over 1954, for specific uses, were reported as follows: Ceramics, 40 percent; insecticides, 32 percent; roofing, 15 percent; and asphalt filler, 15 percent. The quantity of talc reported sold for use in paper declined 16 percent in 1955, compared with 1954.

Insecticides, ceramics, refractories, paints, and rubber consumed 88 percent of the pyrophyllite sold by producers in 1955, compared with 92 percent in 1954 and 91 percent in 1953. Quantity increases over 1954, for specific uses, were reported as follows: Paints, 252 percent; refractories, 70 percent; ceramics, 59 percent; and insecticides, 33 percent. The quantity of pyrophyllite reported sold for use in rubber declined 80 percent in 1955, compared with 1954. No pyrophyllite was reported used for plaster products in 1955, although in 1954 and 1953 consumption for this use represented 6 percent of the total. In 1955 asphalt filler consumed 10 percent of the pyrophyllite sold by producers, compared with none in 1954.

TABLE 6.—Talc and soapstone sold or used by producers in the United States, 1953–55, by uses

Use	1953		1954		1955	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Ceramics	120,794	25	[1] 125,179	[1] 26	174,700	31
Paints	113,406	23	[1] 118,353	[1] 25	118,908	21
Insecticides	57,762	12	[1] 48,262	[1] 10	63,472	11
Roofing	53,858	11	[1] 52,431	[1] 11	60,537	11
Rubber	32,137	7	[1] 32,536	7	33,272	6
Asphalt filler	21,305	4	19,651	4	22,608	4
Paper	25,018	5	[1] 20,699	4	17,339	3
Toilet preparations	8,126	2	9,718	2	9,912	2
Foundry facings	7,502	1	[1] 6,332	1	9,131	2
Textiles	9,811	2	[1] 9,315	2	8,286	1
Rice polish	2,624	1	1,060	(2)	1,125	(2)
Crayons	660	(2)	612	(2)	766	(2)
Other	34,334	7	[1] 37,837	8	43,994	8
Total	487,337	100	[1] 481,985	100	564,050	100

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

TABLE 7.—Pyrophyllite sold by producers in the United States, 1953–55, by uses

Use	1953		1954		1955	
	Short tons	Percent of total	Short tons	Percent of total	Short tons	Percent of total
Insecticides	34,865	28	40,975	35	54,329	35
Ceramics	26,213	22	24,205	20	38,460	25
Refractories	15,565	13	13,798	12	23,400	15
Asphalt filler	------	------	------	------	15,752	10
Paints	4,977	4	4,204	3	14,778	10
Rubber	29,271	24	25,603	22	5,037	3
Plaster products	6,929	6	6,861	6	------	------
Roofing	1,500	1	------	------	------	------
Other	2,217	2	2,367	2	3,580	2
Total	121,537	100	118,013	100	155,336	100

PRICES

Table 8 shows the prices of ground talc and pyrophyllite at the beginning of 1954 and 1955 and at the end of the latter year, as quoted by the Oil, Paint and Drug Reporter. Prices quoted by E&MJ Metal and Mineral Markets for the same period are given in table 9. These price quotations merely indicate the range of prices; actual prices are negotiated between buyer and seller on the basis of a wide range of specifications.

TABLE 8.—Prices quoted on talc and pyrophyllite, carlots, 1954–55, per short ton

[Oil, Paint and Drug Reporter]

Mineral and grade	Jan. 4, 1954	Jan. 3, 1955	Dec. 26, 1955
GROUND TALC (BAGGED)			
Domestic, f. o. b. works:			
Ordinary:			
California	$32.00–$38.50	$32.00–$38.50	$32.00–$38.50
Vermont	14.00	14.00	[1] 18.40
Fibrous (New York):			
Off color	25.00–30.00	25.00–30.00	[1] 27.00–32.00
325-mesh:			
99.5 percent	27.00	27.00	[1] 30.00
99.95 percent, micronized	36.00	36.00	[1] 37.00
Imported (Canadian), f. o. b. mines	15.25–35.00	15.25–35.00	[1] 20.00–35.00
PYROPHYLLITE			
Standard, bulk, mines: [2]			
200-mesh	12.50	(3)	(3)
230-mesh	13.50	(3)	(3)
300-mesh	16.75	(3)	(3)
No. 3: 200-mesh, bulk, mines	11.00	(3)	(3)
Insecticide grade: 200-mesh, bags, mines	13.00–13.50	(3)	(3)
Rubber grade: 140-mesh, bags, mines	11.50–12.00	(3)	(3)

[1] Changed May 2, 1955.
[2] Standard and No. 3, in paper bags, $3 to $3.50 per ton extra.
[3] Not quoted.

TABLE 9.—Prices quoted on talc, carlots, 1954–55, per short ton, f. o. b. works

[E&MJ Metal & Mineral Markets]

Grade [1]	Jan. 7, 1954	Jan. 6, 1955	Dec. 15, 1955
Georgia: 98 percent minus 200-mesh:			
Gray, packed in paper bags	$10.50–$11.00	$10.50–$11.00	$10.50–$11.00
White, packed in paper bags	12.50–15.00	12.50–15.00	12.50–15.00
New Jersey: Mineral pulp, ground, bags extra	10.50–12.50	10.50–12.50	10.50–12.50
New York: Double air-floated, short fiber, 325-mesh	18.00–20.00	18.00–20.00	18.00–20.00
Vermont:			
100 percent through 200-mesh, extra white, bulk basis [2]	12.50	12.50	12.50
99½ percent through 200-mech, medium white, bulk basis [2]	11.50–12.50	11.50–12.50	11.50–12.50
Virginia:			
200-mesh	10.00–12.00	10.00–12.00	10.00–12.00
325-mesh	12.00–14.00	12.00–14.00	12.00–14.00
Crude	5.50	5.50	5.50

[1] Containers included unless otherwise specified.
[2] Packed in paper bags, $1.75 per ton extra.

FOREIGN TRADE [4]

Imports.—The quantity and value of unmanufactured "talc, steatite or soapstone, and French chalk" imported for consumption in the United States increased 31 and 45 percent, respectively, in 1955, compared with 1954. Italy was the chief supplier, with 70 percent of the quantity and 78 percent of the value. Most of the re-

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

mainder came from Canada, France, and India. No imports of manufactures n. s. p. f. (not specifically provided for), except toilet preparations, were reported in 1955.

Exports.—Crude and ground talc, steatite, soapstone, and pyrophyllite exports increased 51 percent in quantity and 15 percent in value in 1955 compared with 1954. Exports of manufactures, n. e. s. (not elsewhere specified) decreased 48 percent in quantity and 8 percent in value during the same period. The value of exports of "powders—talcum (in packages), face and compact" increased 16 percent in 1955 from the 1954 figure.

TABLE 10.—Talc, steatite or soapstone, and French chalk imported for consumption in the United States, by classes in 1946–50 (average) and 1951–53 (totals), and 1954–55 by classes and countries

[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	
1946–50 (average)	73	$4,472	19,187	$493,757	87	$24,332	19,347	$522,561	$12,114
1951	109	20,326	20,404	631,707	127	42,033	20,640	694,066	2,178
1952	284	57,991	19,954	649,955	64	18,900	20,302	726,846	1,922
1953	198	35,474	22,478	641,332	127	39,903	22,803	716,709	7,974
1954									
North America: Canada	-------	-------	2,960	44,669	-------	-------	2,960	44,669	-------
Europe:									
France	-------	-------	1,827	40,543	2	710	1,829	41,253	-------
Germany, West	-------	-------	-------	-------	-------	-------	-------	-------	6,432
Italy	-------	-------	16,713	554,123	8	2,780	16,721	556,903	-------
Norway	-------	-------	-------	-------	5	1,380	5	1,380	-------
Switzerland	-------	-------	-------	-------	-------	-------	-------	-------	5,076
Total	-------	-------	18,540	594,666	15	4,870	18,555	599,536	11,508
Asia:									
India	36	6,230	576	14,515	-------	-------	612	20,745	-------
Japan	-------	-------	-------	-------	30	13,279	30	13,279	-------
Total	36	6,230	576	14,515	30	13,279	642	34,024	-------
Grand total	36	6,230	22,076	[1]653,850	45	18,149	22,157	[1]678,229	11,508
1955									
North America: Canada	-------	-------	3,922	64,000	-------	-------	3,922	64,000	-------
Europe:									
France	-------	-------	3,795	80,570	-------	-------	3,795	80,570	-------
Italy	-------	-------	20,256	766,880	9	3,084	20,265	769,964	-------
Norway	-------	-------	-------	-------	12	3,301	12	3,301	-------
Total	-------	-------	24,051	847,450	21	6,385	24,072	853,835	-------
Asia:									
India	125	20,300	909	24,862	-------	-------	1,034	45,162	-------
Japan	-------	-------	-------	-------	51	22,978	51	22,978	-------
Total	125	20,300	909	24,862	51	22,978	1,085	68,140	-------
Grand total	125	20,300	28,882	[1]936,312	72	29,363	29,079	[1]985,975	-------

[1] Due to changes in tabulating procedures by the U. S. Department of Commerce data known not to be omparable to years prior to 1954.

TABLE 11.—Talc, pyrophyllite, and talcum powders exported from the United States, 1946–50 (average) and 1951–55

[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	
1946–50 (average)	[1] 17,338	[1] $451,443	(2)	(2)	$2,573,812
1951	22,903	645,217	106	$60,589	1,463,010
1952	22,958	615,160	265	142,356	1,244,801
1953	23,071	602,454	159	95,778	1,295,533
1954	23,348	744,828	259	110,558	1,075,592
1955	35,230	858,755	135	101,571	1,245,993

[1] Excludes shipments under the Army Civilian Supply Program during 1947.
[2] Beginning Jan. 1, 1949, manufactures, n. e. s., 1 ton ($455); 1950, 51 tons ($25,492).

TECHNOLOGY

The manufacturing operations of the Gouverneur Talc Co., Balmat, N. Y., and the pneumatic conveying system for handling finished talc products were described.[5] The chemical and physical properties of white-firing talc from an extensive commercial deposit in Hudspeth County, Tex., were reported.[6] Commercial talc ores from 12 California mines were studied, using the petrographic microscope, chemical and differential thermal analyses, and heavy-liquid-separation techniques.[7] Attempts to correlate the results with the shrinkage of high-talc wall-tile bodies were not successful, although microscopic examination was found to be of assistance in predicting firing behavior. A short account of the properties of a number of ceramic bodies containing talc (soapstone) was published.[8] As part of a general study of substitution of fluorine for hydroxyl in silicate structures, it was found that fluorine would partially substitute for hydroxyl in the talc structure.[9] Calculated quantities of fluorine were added to the batch in the form of MgF_2 to give varying ratios of F:OH. The reaction products were examined by microscope, X-ray, and differential thermal-analysis techniques, and the data were compared with those of natural talcs. Talc was the major phase observed in all experiments within the temperature range of 400° to 800° C. at 16,000 to 20,000 p. s. i.

Thermal conductivity, thermal diffusivity, and specific heat of pyrophyllite before and after heating to 1,200° C. were reported.[10]

Talc fractions of varying particle-size distribution were prepared from natural talc corresponding closely to the theoretical composition of talc, and their base-exchange capacities were determined.[11] Base-

[5] Rock Products, Pneumatic System Conveys Ground Talc Throughout Plant: Vol. 58, No. 6, June 1955, pp. 66–69.
[6] Pence, F. K., A Commercially Proved White-Firing Talc Occurring in West Texas: Bull. Am. Ceram. Soc., vol. 34, No. 4, April 1955, pp. 122–123.
[7] Lennon, J. W., Investigation of California Talc for Use in Wall Tile: Jour. Am. Ceram. Soc., vol. 38, No. 11, November 1955, pp. 418–422.
[8] Keramische Zeitschrift (Lubeck, Germany), [Soapstone Bodies]: Vol. 7, No. 5, May 1955, pp. 229–230.
[9] Van Valkenburg, Alvin, Jr., Synthesis of a Fluoro Talc and Attempted Synthesis of Fluoro Chrysotile and Fluoro Anthophyllite: Jour. Research, Nat. Bureau of Standards, vol. 55, No. 4, October 1955, pp. 215–217.
[10] Carte, A. E., Thermal Constants of Pyrophyllite and Their Change of Heating: British Jour. Appl. Phys. (London), vol. 6, No. 9, September 1955, pp. 326–328.
[11] Kingery, W. D., Halden, F. A., and Kurkjian, C. R., Base-Exchange Capacity of Talc: Jour. Phys. Chem., vol. 59, No. 4, April 1955, pp. 378–380.

exchange capacities were shown to be independent of the particle size. The viscosity of talc suspensions decreased markedly once the base-exchange capacity was exceeded, indicating that talc suspensions can be deflocculated in the same way as kaolin. Pyrophyllite, unlike talc, has a much greater base-exchange capacity, which increases markedly with grinding.

A number of patents were issued during 1955 covering the use of talc for various applications, including lubricants; [12] [13] coatings for ceramic bodies,[14] insulated conductors,[15] and metal surfaces to resist corrosion and marine organisms; [16] [17] [18] preservation of plants against fungus decay or mold deterioration; [19] abrasive products; [20] paste pigments; [21] detergents; [22] drawing paper; [23] gasket-insulation compounds; [24] and fire-resistant compositions for building materials.[25] [26] A patent was issued on the use of a slurry of a ceramic refractory for coating stainless-steel ingots before hot rolling. A mixture of pyrophyllite, bentonite, and plastic fire clay was reported to be satisfactory.[27]

WORLD REVIEW

The 1954 estimated world production of talc, soapstone, and pyrophyllite was revised downward from 1,840,000 short tons (reported as a new high in the 1954 chapter) to 1,600,000 short tons. Consequently, the 1955 total of 1,760,000 short tons is the alltime high, exceeding the 1951 figure by 2 percent.

Austria.—Talc exports for 1951–55, by countries of destination, are given in table 13. About 71 percent of the 1955 exports went to Poland and West Germany.

Canada.—According to the official preliminary estimates, Canada (table 14) produced 14,500 short tons of talc (value Can$192,000) in 1955 and 13,600 tons of soapstone (value Can$142,100), compared with final revised 1954 figures of 13,697 tons of talc (value Can$169,651) and 14,446 tons of soapstone (value Can$165,702).[28] Imports of talc

[12] Hugel, G. L., Lerer, M., and Courtel, R. J. M. (assigned to Institut Francais du Petrol des Carburantes et Lubrifants, Paris, France), Wire Drawing Composition: U. S. Patent 2,704,744, Mar. 22, 1955.
[13] Strange, C. H. (assigned to E. L. Strange, Jacksonville Beach, Fla.), Apparatus for Improvement in Thermostats or Heat Controls: U. S. Patent 2,705,746, Apr. 5, 1955.
[14] Barnard, R. M., and Buckley, S. E. (assigned to International Standard Electric Corp., New York, N. Y.), Metallizing Ceramic Bodies: U. S. Patent 2,706,682, Apr. 19, 1955.
[15] Dorst, S. O. (assigned to Sprague Electric Co., North Adams, Mass.), Heat-Stable Insulated Electrical Conductors: U. S. Patent 2,707,703, May 3, 1955.
[16] Evans, R. M. (assigned to The Master Mechanics Co., Cleveland, Ohio), Process for Forming Chemical Resistant Synthetic Resin Coatings on Metal: U. S. Patent 2,709,644, May 31, 1955.
[17] McBride, B. V. (assigned to Westinghouse Electric Corp., East Pittsburgh, Pa.), Rust Inhibitive Finishes for Ferrous Metals: U. S. Patent 2,725,310, Nov. 29, 1955.
[18] Christensen, J. C., and Fair, W. F., Jr. (assigned to Koppers Co., Inc., Pittsburgh, Pa.), Composite Coated Structural Articles: U. S. Patent 2,727,832, Dec. 20, 1955.
[19] Fischer, C. W. (assigned to Research Corp., New York, N. Y.), Preservation of Plants and Plant Parts: U. S. Patent 2,707,352, May 3, 1955.
[20] Price, J. E., and Groves, K. D. (assigned to American Viscose Corp., Wilmington, Del.), Abrasive Articles and Method of Making: U. S. Patent 2,711,365, June 21, 1955.
[21] Hunter, S. N. (assigned to Hunter Metallic Products Corp., East St. Louis, Ill.), Paste Pigments: U. S. Patent 2,713,006, July 12, 1955.
[22] Blumenthal, A., Method of Preparing Detergent Compositions: U. S. Patent 2,714,093, July 26, 1955.
[23] Eichorn, A. (assigned to Screen Engineering Co., Santa Monica, Calif.), Drawing Material: U. S. Patent 2,718,476, Sept. 20, 1955.
[24] Jelinek, U. (assigned to the M. W. Kellogg Co., Jersey City, N. J.), Gasket Composition and Method of Forming: U. S. Patents 2,717,024 and 2,717,025, Sept. 6, 1955.
[25] Ray, H. G., Artificial Lumber Products: U. S. Patent 2,717,420, Sept. 13, 1955.
[26] Gilchrist, A. E., Harrup, L. D., Hendrickson, R. C., and Rehor, D. T. (assigned to The Glidden Co., Cleveland, Ohio), Intumescent Coating Compositions: U. S. Patent 2,722,523, Nov. 1, 1955.
[27] Pakkala, M. H., and Scarry, J. L. (assigned to United States Steel Corp., Pittsburgh, Pa.), Method of Hot Rolling Stainless Steel: U. S. Patent 2,708,379, May 17, 1955.
[28] Canada, Department of Trade and Commerce, Dominion Bureau of Statistics, Preliminary Report on Mineral Production, 1955: P. 41. (Prepared in the Mineral Statistics Section of the Industry and Merchandising Division, Ottawa, Canada.)

and soapstone in 1955 were given as 11,382 tons (value Can$378,027) and exports of talc 4,428 tons (value Can$64,974). In 1954, the value of the Canadian dollar ranged from US$1.02 to US$1.03; in 1955, the value ranged from US$1.00 to US$1.03.

TABLE 12.—World production of talc, soapstone, and pyrophyllite, by countries,[1] 1946–50 (average) and 1951–55, in short tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada (shipments)	29,052	24,846	25,032	27,408	28,143	27,160
United States	514,910	640,456	600,908	631,518	618,994	725,708
Total	543,962	665,302	625,940	658,926	647,137	752,868
South America:						
Argentina	12,869	18,739	14,330	[3] 16,500	[3] 16,500	25,353
Brazil	11,901	12,461	21,464	23,466	21,967	[3] 22,000
Chile	495	28	----	----	----	----
Paraguay	----	----	----	99	132	[3] 110
Peru	----	144	137	----	----	3,708
Uruguay	1,944	1,057	748	982	1,167	[3] 1,100
Total	27,209	32,429	36,679	[3] 41,000	[3] 39,800	[3] 52,300
Europe:						
Austria	46,375	80,231	56,022	56,477	68,310	77,911
Finland	239	5,751	6,614	4,065	8,133	5,265
France	90,858	113,798	120,864	120,693	130,844	148,040
Germany, West	23,700	38,871	30,412	32,991	36,170	55,571
Greece	1,477	2,894	1,323	----	[3] 3,300	(4)
Italy	63,080	83,771	89,886	91,049	95,302	110,099
Norway	60,091	84,304	70,629	67,443	78,802	76,059
Portugal	[3] 10	1	7	18	6	11
Rumania	[3] 300	(4)	(4)	(4)	(4)	(4)
Spain	21,297	39,721	30,709	31,357	36,086	26,372
Sweden	13,572	14,696	9,686	9,806	14,689	13,695
United Kingdom	3,342	2,800	2,897	4,413	4,447	(4)
Yugoslavia	----	----	----	----	----	2,922
Total [1 3]	340,000	480,000	440,000	440,000	500,000	550,000
Asia:						
Afghanistan	[5] 97	926	882	661	717	[3] 800
India	40,314	37,685	23,264	32,632	47,405	[3] 44,000
Japan	239,075	441,614	350,960	362,193	246,197	246,273
Korea, Republic of	2,498	3,536	4,149	26,983	20,965	12,092
Taiwan (Formosa)	[5] 428	2,267	1,205	1,945	7,791	5,807
Total [1 3]	365,000	530,000	420,000	480,000	390,000	390,000
Africa:						
Egypt	5,338	4,138	5,405	2,423	2,822	6,878
Kenya	449	371	259	173	111	[3] 110
Union of South Africa	4,550	6,242	9,562	7,974	7,974	1,581
Total	10,337	10,751	15,226	10,570	10,907	8,569
Oceania: Australia	8,055	14,726	8,518	11,127	14,699	14,075
World total (estimate) [1]	1,300,000	1,730,000	1,550,000	1,640,000	1,600,000	1,760,000

[1] In addition to countries listed, talc or pyrophyllite is reported in China and U. S. S. R., but data are not available; estimates have been included in total.
[2] This table incorporates a number of revisions of data published in previous Talc, Soapstone, and Pyrophyllite chapters. Data do not add to totals shown due to rounding where estimated figures are included in detail.
[3] Estimate.
[4] Data not available; estimate by senior author of chapter included in total.
[5] Average for 1949–50.

TABLE 13.—Talc exported from Austria, 1951–55, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
Argentina	39				
Belgium-Luxembourg	1,034	728	1,079	1,258	1,425
Czechoslovakia	101				
Denmark		28	17	143	44
France	993	736	1,002	1,242	1,554
Germany:					
East	3,988	1,693	2,546	2,502	2,177
West	17,241	13,439	15,385	16,577	17,935
Hungary	4,043	3,412	2,183	3,508	5,563
Italy	23	53	295	627	1,275
Netherlands	1,597	2,198	715	666	1,109
Poland	7,624	9,714	10,558	19,914	21,074
Sweden	17		11	14	58
Switzerland	1,936	1,393	1,808	2,228	2,039
Trieste		26	17	44	
United Kingdom	444	581	864	582	505
Yugoslavia	102	95	17	95	62
Other countries			3	2	71
Total	39,182	34,096	36,500	49,402	54,891

[1] Compiled from Customs Returns of Austria.

The Canadian talc and soapstone industry in 1954 was described as follows: [29]

Producers of talc, soapstone, and pyrophyllite shipped 28,143 short tons valued at $335,353, in 1954, compared with 27,408 tons valued at $285,755 in the preceding year. Finely-ground pyrophyllite was shipped from Newfoundland. The output from Quebec included crayons, blocks, and ground soapstone. Most of the production in Ontario was high-grade milled talc. There was no production of talc or pyrophyllite in British Columbia during 1954.

The industry employed an average of 53 persons to whom $134,437 were distributed as salaries and wages. Fuel cost $13,008 and 1,366,049 kwh. of electricity were purchased for $22,537.

Imports of talc and soapstone in 1954 amounted to 12,392 tons valued at $397,985. Exported were 3,609 tons worth $48,753.

TABLE 14.—Consumption of ground talc and soapstone in Canada, by uses, 1951–53, in short tons [1]

Use	1951	1952	1953
Insecticides and miscellaneous chemicals	6,419	7,638	8,557
Roofing	8,861	8,255	8,050
Paints	6,921	7,264	7,838
Clay products	894	1,164	2,164
Rubber	1,684	1,617	1,620
Pulp and paper	1,974	2,568	1,510
Coal-tar distillation	305	133	694
Electrical apparatus	641	427	490
Toilet preparations	778	807	424
Medicinal preparations	(2)	(2)	321
Miscellaneous nonmetallic mineral products	97	47	82
Soaps and cleaning preparations	192	206	81
Polishes and dressings	12	16	11
Tanneries	8	20	5
Textiles and linoleum	520	533	1
Asbestos products		1	1
Total	29,306	30,696	31,849

[1] Source: Canada, Department of Trade and Commerce, Dominion Bureau of Statistics.
[2] Included in toilet preparations, 1951–52.

[29] Canada, Department of Trade and Commerce, Dominion Bureau of Statistics, The Talc and Soapstone Industry, 1954: Ind. Merchandising Div., Mineral Statistics Section, Ottawa, Canada, 1955, 4 pp.

Finland.—In 1954 sales of ground talc totaled 10,337 short tons (9,378 metric tons). The entire quantity, which was produced by Suomen Mineraali Oy, at Maljasalmi and Jormua, a few kilometers north of Kajaani, was sold to roofing-felt manufacturers.[30] Domestic talc is not white enough for use in Finland's paper mills, which rely on imports mainly from Norway and France. The output of soapstone reached a new high of 3,950 cubic meters in 1954, compared with 3,050 cubic meters in 1953. Virtually all of the soapstone output was consumed locally in the sulfate cellulose mills, which use soapstone blocks to line soda furnaces and to produce electrical instrument panels, ornamental stone plates, and ornamental fireplaces.

France.—Exports of talc and soapstone, 1950–54, by countries of destination, are given in table 15. Almost all of the material exported was ground talc.[31]

TABLE 15.—Talc and soapstone exported from France, 1950–54, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1950	1951	1952	1953	1954
Belgium-Luxembourg	3,783	4,450	3,071	3,133	3,206
Finland	654	1,256		893	874
Germany, West	3,041	3,416	2,222	2,020	4,011
Netherlands	1,613	1,706	1,206	1,842	1,643
Sweden		1,166	856	5,163	
Switzerland	7,045	9,277	5,909	276	6,064
United Kingdom	6,731	9,707	6,126	6,023	7,395
United States	2,181	1,775	1,579	2,413	2,066
Other countries	6,355	2,424	4,058	1,304	2,124
French Overseas Territories	2,326	4,114	862	4,125	4,699
Total	33,729	39,291	25,889	27,192	32,082

[1] Compiled from Customs Returns of France.

Italy.—In 1955 the United States received 46 percent of the talc exported from Italy, as shown in table 16. The United Kingdom received 20 percent; West Germany, 12 percent; and other countries 22 percent. Exports from Italy increased 35 percent over 1954.

TABLE 16.—Talc exported from Italy, 1951–55, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
Belgium-Luxembourg	374	292			
Canada	743	780			
France	1,291	416			
Germany:					
East	389	138			
West	4,874	3,930	3,590	4,251	5,507
Netherlands	230	405			
Portugal	147	175			
Switzerland	228	374			
Union of South Africa	1,290	375			
United Kingdom	7,754	6,172	9,150	7,486	9,246
United States	13,989	12,932	15,607	13,686	21,117
Other countries	4,567	3,270	8,190	8,418	9,982
Total	35,876	29,259	36,537	33,841	45,852

[1] Compiled from Customs Returns of Italy.

[30] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 3, March 1956, pp. 34–35.
[31] Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 4, April 1956, p. 39.

Japan.—Production of pyrophyllite in 1955 was 226,207 short tons (205,211 metric tons); and production of talc was 20,066 short tons (18,204 metric tons).[32]

Norway.—Exports of talc and soapstone, 1950–54, by countries of destination, are given in table 17. Exports in 1954 increased 26 percent over 1953.

TABLE 17.—Talc and soapstone exported from Norway, 1950–54, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1950	1951	1952	1953	1954
Belgium-Luxembourg	1,603	2,973	3,694	3,277	3,086
Denmark	5,365	6,216	4,902	5,733	7,882
Finland	3,661	4,218	2,744	393	2,432
France	274	699	668	423	536
Germany:					
East				168	83
West	5,534	4,489	4,561	4,326	6,599
Indonesia		2,061	2,142	1,499	1,335
Netherlands	9,319	8,132	6,099	7,662	7,454
Poland	219		226	510	328
Sweden	8,986	9,204	5,342	6,816	8,604
Switzerland		204	148	98	79
United Kingdom	12,434	16,961	12,263	12,607	15,764
Other countries	2,191	1,474	1,653	1,170	2,021
Total	49,586	56,631	44,442	44,682	56,203

[1] Compiled from Customs Returns of Norway.

Peru.—Production of pyrophyllite was reported for the first time in 1955 and totaled 3,041 short tons (2,759 metric tons). Talc production was 667 short tons (605 metric tons) in 1955, compared with previous production of 144 short tons in 1951 and 137 short tons in 1952.[33] These commodities were consumed by local ceramic industries, including a new refractory brick plant.[34]

Union of South Africa.—Production of "wonderstone," a massive pyrophyllite, totaled 377 short tons in 1954 compared with 408 tons in 1953. The 1952 production was 4,183 tons. Local sales in 1954 were 1,158 tons valued at US$10,660, compared with 116 tons valued at US$8,290 in 1953. Exports were 174 tons in 1954, compared with 272 tons in 1953. The United States received 87 percent of the exports in 1954, compared with 99 percent in 1953.

[32] United States Embassy, Tokyo, Japan, State Department Dispatch 910: Apr. 6, 1956, p. 6.
[33] United States Embassy, Lima, Peru, State Department Dispatch 9: July 5, 1956, p. 3.
[34] United States Embassy, Lima, Peru, State Department Dispatch 42: July 18, 1956, p. 13.

Thorium

By John E. Crawford[1]

THE MAJOR INTEREST in thorium during 1955 was centered upon its use in nuclear-powered generating systems, as a fertile source for fissionable material. The first full-size power reactor proposed by industry was described as a breeder type, requiring approximately 10 tons of thorium annually.

Of more immediate concern was the growing application of a thorium-bearing magnesium alloy to fabrication of guided-missile and jet-aircraft-engine components. Optimism was expressed in 1955 concerning the growtb and outlook for this end use.

Commercial recovery of thorium-bearing monazite in South Carolina was begun in 1955; and exploration for workable concentrations of thorium in monazite, thorite, and other appropriate minerals continued with some fervor.

Operations at domestic processing plants were uninterrupted. Several companies were investigating the possibilities for economic production of thorium metal.

India, Brazil, and Union of South Africa were the major foreign producers of thorium-bearing raw materials. Only Union of South Africa exported significant tonnages of ore during 1955. India and Brazil continued to enforce embargoes on thorium exports.

The International Conference on the Peaceful Uses of Atomic Energy was held in Geneva, Switzerland, August 8–20, 1955. Many aspects of thorium exploration, production, and use in nuclear reactors were described. (See footnotes 11–13, 19–22, 24, 25.)

DOMESTIC PRODUCTION

Exploration and Mine Production.—Marine Minerals, Inc., commenced dredging operations near Aiken, S. C.; ilmenite, rutile, monazite, and associated heavy minerals were recovered. On the southeastern coast of Florida, some monazite was mined with heavy black sands by the Humphreys Gold Corp., Jacksonville, Fla., and the Florida Ore Processing Co., Sharonville, Ohio.

In the Big Creek area near Cascade, Valley County, Idaho, two companies maintained dredging equipment for producing monazite-bearing black-sand concentrate—the Idaho-Canadian Dredging Co. and Baumhoff-Marshall, Inc. Operations were curtailed in mid-1955 because of competition from imported ore. Also in Valley County, the Porter Bros. Corp. continued preparations for mining a euxenite-bearing placer deposit that contained some recoverable thorium.

[1] Commodity specialist.

Thorite-vein deposits of the Powder-Horn district, Gunnison County, Colo., and the Wet Mountains, Custer and Freemont Counties, Colo., were investigated by mining interests in 1956. American Mineral Development Corp. announced plans to construct a thorium mill at Canon City, Colo., to treat Colorado ore,[2] but no material was reported to have been mined commercially. Colonial Uranium Co. also indicated its intention to erect milling facilities in Colorado to treat thorium ore produced in Colorado, Wyoming, and New Mexico.

Exploration techniques for economic deposits of monazite were described.[3]

Refinery Production.—Inasmuch as thorium is a source material, as defined by the Atomic Energy Act, refinery-production data concerning the element is security-classified by the AEC and cannot be published.

Monazite was treated chemically, and thorium compounds were produced therefrom by the following firms:

Lindsay Chemical Co., West Chicago, Ill.
Maywood Chemical Works, Maywood, N. J.
Rare Earths, Inc. Davison Chemical Co., Pompton Plains, N. J.

Small quantities of thorium metal were produced by the Westinghouse Electric Corp. (Lamp Division), Bloomfield, N. J., and Metal Hydrides, Inc., Beverly, Mass., from refined salts. The AEC Feed Materials Production Center at Fernald, Ohio, produced reactor-grade thorium metal from refined salts purchased under contract. The center was operated by the National Lead Co. of Ohio.

High-purity, thorium-metal-production techniques were investigated by the Bureau of Mines on behalf of the AEC. Horizons, Inc., Princeton, N. J., and Cooper Metallurgical Associates, Cleveland, Ohio, also were reported to have conducted research on processes for recovering pure thorium.

CONSUMPTION AND USES

Nonenergy Uses.—The use of thorium for gas mantles in 1955 was nearly five times greater than in 1954. It is believed that the statistics representing authorizations to purchase thorium compounds for gas-mantle manufacture include material exported.

TABLE 1.—Allocations of thorium compounds to industry by Atomic Energy Commission for nonenergy purposes in the United States, 1951–55, in pounds of contained ThO_2.

Industry	1951	1952	1953	1954	1955
Magnesium alloys			3,600	4,647	23,944
Gas-mantle manufacture	31,132	25,427	8,707	9,765	44,566
Refractories and polishing compounds	3,382	1,157	236	24	105
Chemical and medical	6,246	11,064	5,179	3,738	3,898
Electrical	1,457	277	1,222	2,016	926
Total	42,217	37,925	18,944	20,190	73,439

Magnesium alloys consumed about five times as much thorium in 1955 as in 1954. The HK–31 magnesium alloy developed by the Dow

[2] Mining Congress Journal, vol. 41, No. 4, April 1955, p. 129.
[3] Griffith, Robert F., Development of Monazite Exploration Techniques Improves U. S. Rare Earth and Thorium Supply: Min. Eng., vol. 7, No. 10, October 1955, pp. 930–932.

Chemical Co. was found suitable for jet-engine and guided-missile components. The alloy, containing 96.3 percent magnesium, about 3 percent thorium, and 0.5–0.7 percent zirconium, has good resistance to creep and maintains strength within the temperature range of 300° to 700° F. Brooks & Perkins, Inc., Detroit, Mich., magnesium fabricators, published an informative technical bulletin on the alloy.[4]

Authorizations permitting thorium salts to be employed for refractory and polishing compounds, chemical and medical uses, and electrical-equipment parts remained relatively insignificant, composing less than 7 percent of the total.

Energy Uses.—Research progressed on nuclear applications of high-purity thorium metal and thorium oxide. According to AEC reports, work continued at the Oak Ridge National Laboratory, Oak Ridge, Tenn., on Homogeneous Reactor Experiment 2. The HRE–2, if later modified for higher power, will be provided with a blanket of thorium oxide in heavy water, surrounding a core of uranyl sulfate-heavy-water fuel. With the modified design, the fertile thorium should prove to be a source of as much or more fissionable material than is consumed in the core of the reactor. The objectives of HRE–2 are: (1) To demonstrate that a homogeneous reactor of moderate size can be operated with the continuity required of a powerplant; (2) to establish the reliability of engineering materials and components of a size that can be adapted to full-scall powerplants; (3) to evaluate equipment modifications leading to simplifications and economy; (4) to test simplified maintenance procedures; and (5) to develop and test methods for the continuous removal of fission and corrosion contaminates.[5]

The Consolidated Edison Co. applied to the AEC for a license to build a power reactor at Indian Point, N. Y. The 236,000-kilowatt reactor would require aproximately 20.8 tons of thorium for the first year of operation and 10.3 tons for each succeeding year as a breeder material. The license application indicated the AEC as the source of the thorium.

The Foster Wheeler Corp., New York, N. Y., announced in 1955 that it was ready to design and build for industry the first large-scale nuclear powerplant of the aqueous-homogeneous power-breeded concept. It was stated that the plant would produce 100,000 kilowatts of electricity at an estimated capital cost of $21 million. The reactor was similar in design to the HRE–2 at Oak Ridge, Tenn.

A conceptual, heterogeneous, breeder-reactor design was presented by Babcock & Wilcox Co. The thermal-breeder reactor consisted of a pressurized, heavy-water coolant and moderator system and a core of uranium–235 fuel rods surrounded by thorium elements. It was estimated that a 140,000-kilowatt powerplant of this design would require an investment of $240 per kilowatt of capacity.[6]

The Brookhaven National Laboratory, Upton, N. Y., investigated uranium-bismuth and thorium-bismuth liquid-metal fuel and breeder systems.

---

[4] Brooks & Perkins, Inc. (Detroit, Mich.), Preliminary Data, HK–31, New Magnesium-Thorium Alloy: 1955, 34 pp.

[5] Atomic Energy Commission, Major Activities in the Atomic Energy Programs: January 1956, pp. 44–45.

[6] Kallman, D., Edlund, M. C., Thorium Thermal Breeder Reactor: Address before a meeting of the Atomic Industrial Forum, Washington, D. C., Sept. 27, 1955, 26 pp.

PRICES

Massive monazite containing 55 percent total rare-earth oxides, including thorium, was quoted by the E&MJ Metal and Mineral Markets, December 15, 1955, at 13 cents per pound, c. i. f. United States ports; sand containing 55 percent total rare-earth oxides, including thorium, 15 cents per pound, c. i. f. United States ports; sand containing 68 percent total rare-earth oxides, including thorium, 20 cents per pound, c. i. f. United States ports; nominal.

Thorite, the thorium silicate mineral, was not mined in sufficient tonnages to establish a market price, but processors inferred a value of about $1 per pound of contained ThO_2 for thorite concentrate assaying at least 10 percent ThO_2, f. o. b. Colorado in carlots.

Prices of the principal refined-thorium compounds or salts were quoted by a leading producer in 1955, in 100-pound lots or more, as follows:

Thorium compound:	*ThO_2, percent*	*ThO_2, price per pound*
Carbonate	80–85	[1] $7.25–8.80
Chloride	50	7.00
Fluoride	80	6.50
Nitrate (mantle grade)	47	3.00
Oxide	97–99	[1] 8.25–9.35

[1] Variable, depending on rare-earth content.

Thorium metal was available in 1955 from one producer, in gram lots, f. o. b. plant, at the following prices:

Thorium metal: [1]	*Price per gram for less than 200 grams*	*Price per gram for 200 grams or more*
Powder	$0.45	$0.35
Unsintered bars	.50	.40
Sintered bars	.65	.50
Sheet, 0.005 inch or more	.75	.60
Sheet, 0.002 to 0.0049 inch	.85	.85

[1] Chief impurities; Calcium, 0.05%; iron, 0.05%; and ThO_2, 1.0–1.5%.

FOREIGN TRADE

Import-export statistics on thorium ore and concentrate, thorium compounds, and thorium metal were not available for publication. Union of South Africa was the most likely source of nearly all the thorium imported during 1955. India placed an embargo on thorium exports in 1946, and in 1950 Brazil limited monazite exports to Government-to-Government transactions. Exports of mantle-grade thorium nitrate probably were greater in 1955 than in 1954.

WORLD REVIEW

NORTH AMERICA

Canada.—Dominion Magnesium Ltd. of Toronto, Ontario, produced thorium metal 97–99 percent pure and magnesium alloys containing 1.8 or 3.0 percent of thorium.

The Molybdenum Corp. of America and Kennecott Copper Corp. announced joint development of columbium-tantalum-uranium-thorium property in the Oka district of Quebec, about 25 miles southwest of Montreal. Exploration and metallurgical research were conducted in 1955.[7]

Euxenite, assaying 0.35–0.54 percent uranium, 2.5–4.0 percent thorium, 4.0–6.0 percent columbium, and 0.8–2.0 percent tantalum, was being developed in the Parry Sound area of Ontario by Ascot Metals Corp., Ltd.[8]

In the Bancroft-Haliburton area, Ontario, about 150 miles northeast of Toronto, the Rare Earth Mining Corp. and the Blue Rock Cerium Mines developed adjoining uranium properties which also showed promise as a source of thorium. Pilot-plant investigations indicated that an acceptable thorium concentrate could be produced, and it was reported that a large United States chemical company was willing to purchase it.[9]

It was indicated that the Lindsay Chemical Co. of West Chicago, Ill., had taken a 2-year option on a monazite-bearing vein deposit in the Lake Athabaska district, Saskatchewan. The vein was purported to be 12 feet wide and to assay about 15 percent monazite.[10]

The Blind River uranium deposits in Ontario were considered a potential source of byproduct thorium. Low-grade thorium in the uranium-bearing conglomerate is discarded in mill tailing under the current processing scheme; however, it could prove worth recovering if nuclear-power demands for thorium become substantial.

SOUTH AMERICA

Brazil.—Thorium occurrences in Brazil (many of them in pegmatites) were described by Brazilian delegates to the International Conference. The monazite beach sands of Espírito Santo, Rio de Janeiro, and Bahia were the only occurrences considered of economic importance in 1955.[11] Thorium and rare-earth compounds continued to be produced by Orquima (Industrias Quimieas Reunidas S. A.) at Sao Paulo.

EUROPE

Austria.—Treibacher chemische Werke, Treibach, Austria, was reported to have recovered thorium from monazite ores.

France.—Société de produits chimiques des terres rares, La Rochelle, France, probably produced some thorium salts as well as rare-earth compounds in 1955.

Italy.—The National Committee for Nuclear Research and the Mineralogical Institute of Pisa University investigated Tyrrhenian coastal sands for radioactive minerals. Beach deposits between Nettuno and La Banca contained significant quantities of thorium in the minerals perrierite, monazite, and uranothorite. The average ThO_2 content of the sands was 60 grams per ton, and it was estimated that 27 tons of ThO_2 was present, along with 44,000 tons of titaniferous magnetite, 10,000 tons of garnet, and 4,000 tons of zircon. It was assumed

[7] Mining World, vol. 17, No. 9, August 1955, pp. 71, 73.
[8] Engineering and Mining Journal, vol. 156, No. 6, June 1955, p. 168.
[9] Northern Miner, vol. 41, No. 23, Sept. 1, 1955, pp. 1, 5.
[10] Atomic Energy Newsletter, vol. 14, No. 9, Dec. 13, 1955; Mining World, vol. 17, No. 13, December 1955, p. 55.
[11] de Moraes, Luciano Jacques, Known Occurrences of Uranium and Thorium in Brazil; Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 134–139.

that submerged sands would contain as least double the quantities in sand above the tideline.[12]

Spain.—Beach deposits of monazite in the coastal regions of Southern Galicia were mentioned by the Spanish representative to the Geneva Conference. In the Province of Salamanca thorium is found in pegmatites associated with tantalum and in vein deposits with cassiterite, rutile, and wolframite. Monazite mineralization in the Province of Cardoba also was described.[13]

ASIA

Ceylon.—It was proposed by Government personnel that a pilot plant be erected in Ceylon to treat thorianite deposits in that country. Thorianite consists of thorium-uranium oxide, and it was suggested that a 100-ton stockpile of this mineral be established.[14]

In addition to the thorianite deposits Ceylon has monazite placer occurrences which have been worked intermittently.

India.—A thorium-uranium extraction plant at Trombay, on the outskirts of Bombay, began operations in 1955. The refinery treated the crude-thorium cake produced at the monazite-concentrating facilities operated by Indian Rare Earths, Ltd., at Alwaye. It is estimated that the plant would produce a few hundred tons of thorium and a few tons of uranium per year.[15]

The Indian Atomic Energy Commission asked the Andhra University to survey the reserves of monazite and other radioactive minerals in beach sands of Godavari in the Sisakhapantam and Srikakulam districts. Deposits of monazite in sands on the beaches of Bimlipatnam near Visakhapatnam were reported previously.[16]

The Indian Government visualized an electric-power program utilizing thorium as a source of fissionable uranium–233.[17]

Monazite deposits in the Travancore-Cochin area were worked during 1955. The occurrences were said to contain reserves having 150,000 to 180,000 tons of ThO_2,[18] in 2 million tons of monazite.[19]

Indonesia.—A small tonnage of monazite may have been mined from monazite placers during 1955, but no reports of production were published.

Malaya.—Commercial-grade monazite occurred in residual deposits, but the quantity recovered, if any, is unknown.

Taiwan (Formosa).—The Taiwan Monazite Prospecting Bureau established by the Ministry of Economic Affairs explored the island and determined that heavy sands containing monazite were present in (1) beach and dune deposits primarily in northern and northwestern

---

[12] Ippolito, Felice, Present State of Uranium Surveys in Italy; Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 167–173.

[13] Alia, Manuel, Radioactive Deposits and Possibilities in Spain; Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 196–197.

[14] Engineering and Mining Journal, vol. 156, No. 12, December 1955, p. 180.

[15] American Embassy, New Delhi, India, State Department Despatch No. 1031, Mar. 21, 1956, 1 p.

[16] Mining World, vol. 17, No. 1, January 1955, p. 65.

[17] Chemical and Engineering News, vol. 33, No. 3, Jan. 17, 1955, p. 236.

[18] Franklin, James W., Eigo, Daniel P., Thorium: Eng. and Min. Jour.; vol. 156, No. 11, November 1955, pp. 75–81.

[19] Wadia, D. N., Natural Occurrences of Uranium and Thorium in India; Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 163–166.

Taiwan; (2) offshore barriers of southwestern Taiwan; and (3) fluvial deposits of northwestern and southwestern Taiwan. The total reserves of heavy sands in western Taiwan were estimated at 200,000 tons, containing 4.4 percent monazite, with an average ThO_2 content of 5 percent.[20]

South Korea.—The monthly production of monazite was reported to be in excess of 100 tons per month and could be expanded readily if the demand for thorium increased. Important occurrences of monazite were in the (1) Chonan alluvial zone, Chungchong-Namdo; (2) Bonyong-gun coastal area, Chungchong-Namdo; (3) Chong-won-gun placer zone, Chungchong-Pukto; (4) Kumchae-gun alluvial zone, Cholla-Pukto; (5) Kuregun placer zone, Chollā-Namdo; (6) Kosung coastal area, Kangwon-Do; (7) Pyongwon-gun placer zone, Pyongan-Namdo.[21]

Thailand.—Monazite occurs in tailing of Thailand tin-mining operations. It could be recovered from such residue if the price for monazite were high enough to justify its removal.[22]

AFRICA

Kenya.—At Mrima Hill, near Mombasa, investigations proved the presence of significant mineralization, of which thorium-bearing monazite was a part.[23]

Nigeria.—At Kaffo, in the Liruei-n-Kano Hills, pyrochlore mineralization with 41.1 percent columbium-tantalum oxide, 3.1 percent uranium oxide, and 3.3 percent thorium oxide may have economic significance as a source of thorium if the thorium can be recovered as a byproduct of columbium-tantalum production.[24]

Madagascar.—Urano-thorianite in pyroxenite was of continued interest near Fort Dauphin and to the north in the basin of the Mandraré River. Prospecting and development work to determine tonnages was in progress.[25]

Union of South Africa.—Massive monazite was mined in the Van Rhynsdorp district of Namaqualand, Cape Province, by the Anglo-American Corp. of South Africa, Ltd. Concentrate was exported to the United States and England.

OCEANIA

Australia.—Heavy black sands with monazite were stripped from beach deposits on the east coast of Australia between Stradbroke Island in Queensland and the mouth of the Clarence River in New South Wales.

---

[20] Shen, J. T., Exploration of Monazite and Associated Minerals in the Province of Taiwan, China; Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 147–151.

[21] Yun, Tong Suk, Occurrence of Uranium and Thorium in South Korea; Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 176–177.

[22] Delegation of Thailand, Natural Occurrence of Uranium and Thorium in Thailand; Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 201–203.

[23] Chemical and Engineering News, vol. 33, No. 33, Aug. 15, 1955, p. 3402.

[24] Davidson, C. F., Radioactive Minerals in the British Colonies; Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, p. 210.

[25] Roubault, Marcel, The Uranium Deposits of France and French Overseas Territories; Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 159–161.

Heavy-mineral reserves in coastal deposits were determined by the Australian Bureau of Minerals Resources, the Queensland Mines Department and The Zinc Corp.

TABLE 2.—Reserves of beach-sand heavy minerals, Australia

(Tons of contained minerals)

Locality	Zircon	Rutile	Ilmenite	Monazite	Total
Frazer Island to Moreton Island	39, 200	28, 500	102, 900	1, 200	173, 000
North Stradbroke Island	1, 848, 800	1, 790, 700	2, 876, 400	20, 500	6, 642, 000
South Stradbroke Island	18, 450	19, 300	16, 700	270	55, 000
Southport to Mouth of Clarence River	936, 700	685, 200	460, 000	11, 700	2, 185, 000
Other areas	18, 600	17, 050	8, 200	405	45, 000

Titanium & Zirconium Industries Pty., Ltd., a subsidiary of The Zinc Corp., worked the important North Stradbroke Island deposits and operated a separation plant at Dunwich, Queensland, with a capacity of 720 tons of heavy minerals per month.

Rutile Sands Pty., Ltd., Mineral Deposits Syndicate, Titanium Alloy Manufacturing Div., National Lead Co., Tweed Rutile Syndicate, Cudgen R. Z., and Metal Recoveries Pty., Ltd., also mined heavy-sand deposits in Australia.[26]

[26] Gardner, D. E., Beach-Sand Heavy Mineral Deposits of Eastern Australia: Commonwealth of Australia, Dept of Nat. Development, Bureau of Miner. Res., Geol. and Geophysics, Bull. 28, 1955, 103 pp.

Tin

By Abbott Renick[1] and John B. Umhau[2]

THE WORLD tin supply and demand were almost in balance in 1955, and ample supplies were available to meet requirements of industry and stockpiling. World consumption, the highest since 1941, increased about 12,000 long tons and compensated for the most part for the decreased demand for strategic stockpiling by the United States Government. World mine production increased only slightly. The Texas City tin smelter continued operation but on a reduced scale. At the close of 1955 the proposed International Tin Agreement was awaiting ratification by Indonesia before steps could be taken to bring it into operation.

The price of Straits tin for prompt delivery in New York averaged 94.73 cents a pound in 1955, compared with 91.81 cents a pound in 1954. The price was relatively stable, but temporary conditions affecting the market resulted in unusual fluctuations during the latter part of 1955.

President Eisenhower's Budget Message to the Congress on January 17, 1955, covering the fiscal year 1956, stated:

> Gross expenditures for promotion of defense production are expected to decline from 1,061 million dollars in 1955 to 638 million dollars in 1956. Most of this reduction is in the synthetic rubber and tin programs. In accordance with the terms of the Rubber Producing Facilities Disposal Act, the estimates assume that these plants will be sold or leased before June 30, 1955. Most of these facilities have already been sold, subject to congressional approval. Moreover, since purchases of tin for the national stockpile have now been completed and world supplies are ample to meet current needs, no provision is made for continued operation of the government tin smelter.

The Congress reviewed the tin program and by unanimous consent passed Senate Concurrent Resolution 26 for continuation of the Texas City tin smelter until June 30, 1956. The resolution also requested the President to conduct a study and investigation for the Congress before March 31, 1956, on the feasibility of maintaining a permanent tin-smelting industry in the United States and authorized the Federal Facilities Corporation to enter into negotiations for disposal of the plant. It was announced that the plant was available, and the FFC prepared and distributed a brochure describing the plant to over 100 prospects, but it received no concrete proposal.

World mine production of tin increased 1,400 long tons to 180,200 tons in 1955. Production in Malaya and Thailand established new postwar records. Exports of tin from Bolivia decreased to the lowest level since 1939. World-smelter production declined 3 percent. Free

[1] Commodity-specialist.
[2] Commodity-industry analyst.

World consumption reached a postwar high. World industrial stocks of tin increased from 62,360 tons at the beginning to 62,900 tons at the end of 1955.

The United States mine output of tin in 1955 continued to be negligible, with Alaska the principal producer. Mining at Lost River, Alaska, by the United States Tin Corp. was discontinued late in 1955.

Tin consumption in the United States was 9 percent more than in 1954; use of primary tin increased 10 percent and secondary, 8 percent. Tinplate, the principal use of primary tin, took about 60 percent of the total for 1955, 1954, and 1953. Tinplate production established a new record at 5,400,000 short tons, an increase of 8 percent above 1954 and 7 percent more than the previous high in 1953. Domestic smelter output from the Government-owned plant at Texas City, Tex., decreased 5,000 long tons and continued on a reduced scale, pending decision as to its continuance. Secondary tin production was larger than in 1954. Detinning plants treated the largest tonnage of tinplate clippings on record and increased their recovery of tin as metal and chemical compounds 5 percent.

Metal imports of tin decreased 1 percent and represented 76 percent of the total tin imported. Receipts of tin in concentrate decreased 9 percent. Imports of metal and concentrate were augmented by 6,100 long tons (gross weight—chief value, tin) of tin alloys, mainly from Denmark in the form of 94-percent-tin alloys. The tonnage of tinplate exported in 1955 was the highest recorded.

At the end of 1955 tin stocks held by the Government and industry—comprising pig tin, tin in ore, raw materials in process, and other (but excluding the National Strategic Stockpile)—totaled 44,300 long tons, a 9-percent increase compared with 40,800 tons on hand December 31, 1954. The Office of Defense Mobilization (ODM) reported [3] to the Congress that the minimum stockpile objective has been achieved.

TABLE 1.—Salient statistics of tin in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Production:						
From domestic mines [1]----long tons--	33.7	88.0	98.7	56.0	204.68	99.24
From domestic smelters [2]--------do----	36,491	31,852	22,805	37,562	27,407	22,329
From secondary sources--------do----	24,662	30,745	28,800	27,600	26,190	28,340
Consumption:						
Primary--------do----	58,402	56,884	45,323	53,959	54,427	59,828
Secondary--------do----	28,938	31,285	33,095	31,681	28,464	30,655
Imports for consumption:						
Metal--------do----	46,543	28,255	80,543	74,570	[3] 65,599	64,718
Ore (tin content)--------do----	33,849	29,621	26,491	35,973	22,140	20,112
Exports (domestic and foreign)-----do----	469	1,513	380	203	822	1,107
Monthly price of Straits tin at New York:						
Highest------------cents per pound--	106.70	184.00	121.50	121.50	101.00	110.00
Lowest--------do----	73.53	103.00	103.00	78.25	84.25	85.75
Average--------do----	85.33	128.31	120.44	95.77	91.81	94.73
World mine production--------long tons--	137,300	169,400	174,100	179,600	178,800	180,200
World smelter production----------do----	146,000	170,900	171,200	183,900	187,000	182,100
World consumption--------do----	127,000	140,000	132,500	135,300	144,200	156,000

[1] Includes Alaska.
[2] Including tin content of alloys made directly from ores.
[3] Revised figure.

[3] Office of Defense Mobilization, Stockpile Report to the Congress, January–June 1955: September 1955, p. 9.

GOVERNMENT CONTROLS

In 1955 there were no controls over the use and inventories of tin or tin alloys and no restrictions on the quantity of tin exported. Shipments by destinations, however, were governed by the Export Control Act of 1949 and extended to June 30, 1956.

The Internal Revenue Code of 1954 provides for accelerated tax amortization to expand production capacity to provide for defense needs. On September 29, 1955, ODM closed the list of expansion goals, which included electrolytic tinplate and metal cans.

DOMESTIC PRODUCTION

MINE OUTPUT

Domestic mine production of tin was again insignificant. Production dropped to 100 long tons valued at $210,000 in 1955, compared with 200 tons valued at $421,000 in 1954. Alaska was the principal producer. The lode deposit of United States Tin Corp., Lost River, Port Clarence District, western Seward Peninsula, furnished most of the tin mined. Part of the 1955 production was derived from upgrading concentrate produced in 1954. The United States Tin Corp. discontinued mining at Lost River in October, and the property was put in standby condition. Operation of this mine had been supported by a Government-guaranteed loan and advances on a $3 million Defense Materials Procurement Agency (DMPA) purchase contract.

Tin concentrate was derived as a byproduct from molybdenum ores at the Climax mine, Lake County, Colo., and shipped to the Texas City tin smelter. A published article [4] gives information on cassiterite occurrence and recovery in the Climax ore.

At the end of 1955, projects of the Defense Minerals Exploration Administration (DMEA) included three tin contracts totaling $498,831, in which Government participation was 90 percent. The exploration contracts in effect at the end of 1955 follow: United States Tin Corp., Lost River, Alaska, $290,600; Zenda Gold Mining Co., Cape Mountain, Alaska, $159,300; and Keenan Properties, Lawrence County, S. Dak., $48,931. The Alaska Tin Corp. project was terminated without certification May 20, 1955, as no significant quantity of ore of commercial value was discovered. Foote Mineral Co. did no exploration work in 1955 on the Kings Mountain prospect in Cleveland County, N. C.

Tin occurrences in Custer County and southern Pennington County, S. Dak., were discussed in a publication.[5]

A Federal tin-purchase program for Alaska was proposed, and hearings were held on May 20,[6] July 20,[7] and November 1 and November 4.[8] H. R. 7145, introduced July 1, 1955 (S. 2648 of July 27) set a floor or base price of $1.25 per pound on metallic tin in concentrates to be delivered from domestic sources to purchasing depots, including one at Seattle, Wash. H. R. 7749, introduced July 30,

[4] Mining Engineering, Molybdenum Mining, Climax, Colo., Crushing and Concentrating: Vol. 7, No. 8, August 1955, p. 744.

[5] Bureau of Mines, Black Hills Mineral Atlas, South Dakota: Inf. Circ. 7707, 1955, 208 pp.

[6] House of Representatives, Subcommittee on Mines and Mining of the Committee on Interior and Insular Affairs, Alaska Tin: Serial No. 10, on Federal Tin Purchase Program in Alaska, 84th Cong., 1st sess.; hearings on May 20, 1955, 37 pp.

[7] American Metal Market, vol. 62, No. 140, July 21, 1955, p. 6.

[8] United States Senate, Subcommittee on Minerals, Materials, and Fuels of the Committee on Interior and Insular Affairs, Domestic Tin Production: 84th Cong., 1st sess., hearings on November 1 and 4, 1955, 63 pp.

and an amendment intended to be proposed to S. 2648, set the base price at $1.35 per pound for tin in concentrates produced from lode mining and $1.20 per pound for tin in concentrates from placer operations. It was proposed that delivery be accepted of not more than 10,000 long tons of metallic tin in concentrate or that delivered during a period of not more than 10 years, whichever was completed sooner; this concentrate was to have been produced in the United States, its Territories, or possessions. The bills were pending in committees at the close of 1955.

SMELTER OUTPUT

Domestic tin-smelter production was 22,329 long tons, compared with 27,407 tons in 1954. The entire output came from the Government-owned Longhorn smelter at Texas City. No Copan alloy was produced in 1955. In 1954, in addition to Longhorn tin, the smelter produced 477 long tons, gross weight of Copan (405 tons, tin content). The plant was idle for almost 3 weeks beginning June 21 due to a labor strike.

According to the 1956 Federal budget: [9]

> * * * Since purchases of tin for the national stockpile have now been completed and world supplies are ample to meet current needs, no provision is made for continued operation of the Government tin smelter.
>
> * * * The budget provides for operation of the Government-owned tin smelter only until June 30, 1955. Meanwhile the Congress has undertaken to review this program with a report expected by March 15, 1955.

On April 25 the Senate, acting on the report of the Committees on Armed Services and Banking and Currency,[10] passed without dissent and cleared for action by the House of Representatives Senate Concurrent Resolution 26, providing for continued operation of the Texas City tin smelter until June 30, 1956. The House concurred in the resolution unanimously on June 7, 1955. The resolution also requested the President to conduct a study and investigation for the purpose of recommending the most feasible methods of maintaining a permanent domestic tin-smelting industry. The President's report and recommendations thereon were to be made to the Congress before March 31, 1956.

On August 31, 1955, the ODM, after consultation with the Defense Mobilization Board and in accord with Senate Concurrent Resolution 26, authorized the Federal Facilities Corporation to enter into negotiations for disposal of the tin smelter. The final decision on the disposal of the plant was to be subject to approval of the Congress. Thereupon the Federal Facilities Corporation, as a step toward disposal of the plant to private industry, prepared and distributed a brochure on the smelter.[11] However, no firm offer to buy the plant had developed by year end.

According to the semiannual progress report by the ODM on the National Stockpiling Program: [12]

> The fulfillment of stockpile objectives brings to an end any defense justification for the continued operation of the Texas City Tin Smelter by the Government. It is unlikely that the United States will again be required for defense reasons to

[9] Bureau of the Budget, The Budget of the United States Government for the Fiscal Year Ending June 30, 1956: Jan. 17, 1955, p. M77, 947.

[10] Providing for the Continued Operation of the Government Tin Smelters at Texas City, Tex.: U. S. Senate, S. Rept. 215 (to accompany S. Con. Res. 26), 84th Cong., 1st sess., Apr. 21, 1955, 4 pp.

[11] Federal Facilities Corporation, Longhorn Tin Smelter Texas City, Tex.: Sept. 6, 1955, 25 pp.

[12] Work cited in footnote 3.

build and operate a tin smelter. However, should this condition arise, the present stockpile will provide for our national defense needs and leave adequate time to permit the building of a smelter more suited to our needs than the present facility.

There exists in the world today, exclusive of the Texas City Tin Smelter, adequate smelter capacity to meet the world's requirements for tin consumption. These smelters can process all of the tin ores and concentrates now being produced throughout the world with a surplus of capacity over demand. Since no single country controls either the ore production or the major smelters, there will be continuing competition among smelters for the ores and among the producers for the world markets. Under the circumstances, neither a world nor a United States shortage of tin appears likely.

Concentrate was procured on a reduced scale, and inventories of concentrate continued to be maintained at a minimum, pending decision as to continuance of smelting operations. Receipts were the smallest since inception of the smelter. In 1955 the smelter received 39,100 long tons of concentrate containing 20,100 tons of tin compared with 45,900 tons containing 21,800 tons of tin in 1954. Bolivia continued to be the main source of supply, but the receipts therefrom (tin content) decreased from 12,000 tons in 1954 to only 9,390 tons in 1955. In 1955 concentrate was also received from Indonesia, Thailand, Belgian Congo, and miscellaneous sources.

Contracts for Bolivian, Indonesian, and Belgian Congo tin concentrates were in effect. In addition, spot purchases of concentrate were made under an agreement with the Government of Thailand. As of December 31, 1955, outstanding commitments and the Thailand agreement indicated 7,018 long tons of tin contained in concentrate remained to be delivered. Provision was made for terminating purchases of concentrate from Indonesia, Belgian Congo, and Thailand in March 1956, and from Bolivia in April 1956 to provide enough time for transporting and smelting well in advance of June 30, when authority to operate the smelter expires.

TABLE 2.—Production of Longhorn tin at the Texas City, Tex., smelter, by months, 1946–50 (average) and 1951–55, in long tons

Month	1946–50 (average)	1951	1952	1953	1954	1955
January	3,178	3,211	1,802	3,960	2,750	2,402
February	3,011	3,096	1,800	3,391	3,009	2,505
March	3,038	3,123	1,800	3,850	3,559	2,353
April	2,990	3,058	1,800	3,750	3,006	2,103
May	3,237	3,059	1,800	3,060	2,054	1,604
June	3,086	2,655	----------	3,000	1,205	851
July	3,009	2,406	----------	3,000	----------	952
August	2,964	2,505	50	2,600	2,002	1,749
September	2,850	2,155	2,450	2,700	2,404	1,751
October	2,925	2,055	3,364	2,751	2,404	1,803
November	2,997	1,806	4,020	2,750	2,205	1,803
December	3,040	1,805	3,706	2,750	2,404	2,453
Total	36,325	30,934	22,592	37,562	27,002	22,329

During fiscal year 1955 the Longhorn smelter treated 53,499 long tons of material comprising 47,196 tons of concentrate and 6,303 tons of slimes and cleanup material. Of the concentrate, 32,539 tons was Bolivian-type with an average grade of 38.6 percent, and 14,657 was alluvial with an average grade of 72.7 percent. The slimes and cleanup material, containing roughly 15 percent tin, were accumulated during the early days of wartime smelting operations and virtually all were derived from Bolivian concentrate. In fiscal year 1955 the smelter produced 23,237 long tons of refined tin, of which

23,188 tons was for Government account and 49 tons was treated on a toll or fee basis for the account of others. In addition, 105 long tons of Copan was produced in fiscal year 1955 in cleaning up an accumulation of impurities in the circuit. The tin metal and Copan produced in fiscal year 1955 cost $47,840,921, of which $43,609,398 represented the cost of concentrates and slimes and $4,231,523 processing costs. In fiscal year 1954 the cost of producing 32,507 tons of tin metal was $77,659,576, of which $71,319,580 was the cost of ore and $6,339,996 the cost of processing. Results during fiscal year 1955 showed a net loss of $294,765 after all costs and expenses, as compared with a net loss of $1,330,000 for the preceding fiscal year 1954. 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 $13,153,000 less accumulated depreciation of $6,723,000, or $6,430,000 as of June 30, 1955.

During the latter half of 1955 the Texas City smelter treated the remaining tonnage of slimes and cleanup material heretofore carried as inactive inventory. These materials were accumulated during the early days of wartime smelting operations and virtually all were derived from Bolivian concentrate.

Since its inception, the Texas City smelter has been operated by Tin Processing Corp. (a Delaware corporation and a subsidiary of N. V. Billiton Maatschappij) as an independent contractor under an operating agreement with Reconstruction Finance Corporation (RFC) and Federal Facilities Corporation (FFC). In conjunction with this arrangement, FFC purchases all concentrates, pays all operating costs, and disposes of the resulting tin. The agreement has been extended to June 30, 1956.

According to the 1955 annual report of N. V. Billiton Maatschappij:

The Tin Processing Corporation, the issued capital of which is entirely held by us, continued in charge of the management of the Longhorn Tin Smelter in Texas, U. S. A., which smelter is the property of Federal Facilities Corporation, a Government Agency of the United States of America. The mandate granted to this Government Agency for the exploitation of the smelter expired at the end of July 1955 but it was continued for another year. The U. S. Government meanwhile has invited offers for continuing its exploitation by private parties interested and for their own account. For a variety of reasons, among other things, the high level of wages in the U. S. A., this smelter cannot compete with other tin smelters. At the time of writing this report nothing is known about the future of this enterprise.

TABLE 3.—Tin concentrate received at Longhorn smelter, 1954–55 [1]

Country	1954				1955			
	Concentrate received (long tons)	Content: Long tons	Content: Tin (percent)	Percent of tin content of receipts	Concentrate received (long tons)	Content: Long tons	Content: Tin (percent)	Percent of tin content of receipts
Bolivia	32,325	11,996	37.11	55	23,953	9,386	39.19	47
Indonesia	9,895	7,266	73.43	33	9,702	6,996	72.11	35
Thailand	1,521	1,056	69.43	5	3,102	2,234	72.02	11
Belgian Congo	1,119	821	73.37	4	974	728	74.74	3
Mexico	178	73	41.01		403	159	39.45	1
Miscellaneous	843	556	65.95	3	965	583	60.41	3
Total	45,881	21,768	47.44	100	39,099	20,086	51.37	100

[1] Source—Reconstruction Finance Corporation and Federal Facilities Corporation.

SECONDARY TIN

The total recovery of secondary tin increased 8 percent in quantity and 12 percent in value in 1955 compared with 1954. Most of the tin recovered was contained in copper-, lead-, and tin-base alloys and chemical compounds. Only 11 percent of the total was recovered in the form of unalloyed metallic tin, and most of this was accomplished at detinning plants. Secondary tin recovered in chemicals in 1955 increased 16 percent and was the highest since 1941. The tonnage of metallic tin recovered in 1955 was 1 percent more than in 1954. The total production increased for the first time since 1950, with gains in the recovery of tin from old copper- and lead-base scrap. The tonnage of tin in solder scrap reached an alltime high, whereas tin recovered from old tin scrap was the lowest recorded.

Tonnagewise, the largest gains among white metals shipped in 1955 were in the secondary tin content of type metal and solder. The tin content of "genuine" babbitt from scrap increased 140 long tons and totaled 370 tons in 1955. In 1955 the tonnage of high-tin babbitt scrap consumed declined to a new low.

Detinning plants treated 572,420 long tons of tinplate clippings in 1955, the largest on record and 6,040 tons more than the previous peak of 566,380 tons in 1954. In addition, old cans processed decreased from 6,350 tons in 1954 to only 5,900 in 1955; these were small figures compared with the record use of 175,870 tons in 1943. Tin recovered from tinplate clippings in 1955 was 3,160 tons and from old cans 40 tons; about the same as in 1954. Recovery of tin from the billions of old cans discarded annually is metallurgically feasible, but, largely owing to the collection and cleaning problems, it has seldom proved profitable. A public document pointing out methods for the recovery and disposal of scrap at military activities gives some information on the uses of tin-can scrap.[13]

For additional data concerning the secondary tin industry, see the Secondary Metals, Nonferrous, chapter of this volume.

TABLE 4.—Secondary tin recovered in the United States, 1946–50 (average) and 1951–55, 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
1946–50 (average)	2,856	403	3,259	3,077	23,385	26,462	$50,824,098
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
1953	2,650	450	3,100	2,850	24,750	27,600	59,212,676
1954	2,660	530	3,190	2,930	23,260	26,190	53,863,091
1955	2,580	620	3,200	2,970	25,370	28,340	60,140,288

[13] Departments of the Army, the Navy, and the Air Force, Scrap Yard Handbook: TM 754-200-NAVSANDA PUB 283-AFM 68-3NAVMC 1111-SD, October 1955, pp. 85-86, 92-93, 113.

CONSUMPTION BY USES

The total consumption of tin in the United States was 9 percent more in 1955 than in 1954. The use of primary tin increased 10 percent and secondary 8 percent. Consumption (tin content of manufactured products) was 91,000 long tons in 1955 (60,000 primary and 31,000 secondary) compared with 83,000 tons in 1954 (54,000 primary and 29,000 secondary). The figures on secondary tin include 2,800 tons in 1955 and 3,300 tons in 1954 contained in imported tin-base alloys. Use of tin by the tinplate industry increased 2 percent and by all other industries 14 percent.

TABLE 5.—Consumption of primary and secondary tin in the United States 1946–50 (average) and 1951–55, in long tons

	1946–50 (average)	1951	1952	1953	1954	1955
Stocks on hand Jan. 1 [1]	26,065	31,856	20,764	23,105	24,525	23,326
Net receipts during year:						
Primary	61,276	48,298	48,657	57,969	52,673	64,544
Secondary	2,811	3,273	2,338	2,582	2,351	2,191
Terne	564	594	622	604	[2] 226	
Scrap	27,105	28,974	32,917	29,754	28,601	30,262
Total receipts	91,756	81,139	84,534	90,909	83,851	96,997
Available	117,821	112,995	105,298	114,014	108,376	120,323
Stocks on hand Dec. 31 [1]	27,278	20,764	23,105	24,525	23,326	27,757
Total processed during year	90,543	92,231	82,193	89,489	85,050	92,566
Intercompany transactions in scrap	2,184	2,726	2,397	2,566	2,159	2,083
Total consumed in manufacturing	88,359	89,505	79,796	86,923	82,891	90,483
Plant losses	1,019	1,336	1,378	1,283	(3)	(3)
Tin content of manufactured products	87,340	88,169	78,418	85,640	82,891	90,483
Primary	58,402	56,884	45,323	53,959	54,427	59,828
Secondary	28,938	31,285	33,095	31,681	28,464	30,655

[1] Stocks shown exclude tin in transit or in other warehouses on Jan. 1, as follows: 1951, 1,355 tons; 1952, 971 tons; 1953, 525 tons; 1954, 240 tons; 1955, 1,340 tons and 1956, 2,005 tons.
[2] January–June only, earlier reported as tin content of terne metal consumed in terneplate manufacturing. Beginning July 1954 reported as tin consumed in making terne metal.
[3] No longer reported separately.

Five items—tinplate, solder, bronze and brass, babbitt, and tinning—consumed most of the tin in 1955 and 1954. Tinplate, the largest use of primary tin, took about 60 percent of the total for 1955, 1954, and 1953. Solder, next in rank, accounted for the largest increase in tonnage (2,800) among all items using primary tin. Consumption in bronze increased the most—3,100 tons (900 primary and 2,200 secondary)—mainly for general purposes, bearings, and bushings. The total for babbitt increased 100 tons; primary increased 330, whereas secondary decreased 230 tons. The tonnage of secondary tin used for babbitt was the smallest since 1939. Tinning increased slightly. Usage in miscellaneous alloys remained virtually unchanged, excluding Copan alloy, the manufacture of which was discontinued at the Texas City tin smelter after November 1954. Usage of tin for white metal almost doubled with larger tonnages going into jewelers and britannia metals. Tin consumption in chemicals increased 20 percent. A significant tonnage of tin compounds was used by the plastics industry as a stablizer. Tin powder used 940 tons of tin in 1955.

TABLE 6.—Consumer receipts of primary tin, by brands, 1946–50 (average) and 1951–55, in long tons

	Banka	Chinese	English	Katanga	Longhorn	Straits	Others	Total
1946–50 (average)	2,219	1,482	(1)	5,082	25,869	20,421	6,203	61,276
1951	6,159	352	1,406	4,602	20,263	12,163	3,353	48,298
1952	4,208	(1)	3,279	1,573	14,694	23,010	1,893	48,657
1953	1,731	------	6,798	2,826	927	42,886	2,801	57,969
1954	1,216	------	4,727	5,112	255	38,784	2,579	52,673
1955	3,268	------	3,873	6,744	30	47,844	2,785	64,544

[1] Included with "Others" not separately reported.

Tinplate production (excluding waste-waste) rose to a new peak in 1955—4 percent above the previous record year 1954. The United States was the largest producer and consumer of tinplate in the world requiring about 55 percent of the world consumption of tin for tinplate. In 1955, 60 percent of the tin used to make tinplate was for electrolytic and 40 percent for hot-dipped, whereas in 1953 and 1954 total tin utilized was equally divided between both varieties. Of the total output of tinplate in 1955, electrolytic supplied 79 percent (72 percent in 1954) and the hot-dipped type, only 21 percent (28 percent in 1954). Production of tinplate by electrolytic lines was 13 percent above the previous high record established for this product in 1954. Hot-dipped tinplate, however, decreased 21 percent in 1955, to the

TABLE 7.—Tin content of tinplate and terneplate produced in the United States, 1946–50 (average) and 1951–55

Year	Total tinplate (all forms)			Tinplate (hot-dipped)			Tinplate (electrolytic)			Tinplate waste-waste, strips, cobbles, etc.		
	Gross weight (short tons)	Tin content (long tons)	Tin per short ton of plate (pounds)	Gross weight (short tons)	Tin content (long tons)	Tin per short ton of plate (pounds)	Gross weight (short tons)	Tin content (long tons)	Tin per short ton of plate (pounds)	Gross weight (short tons)	Tin content (long tons)	Tin per short ton of plate (pounds)
1946–50 (av.)	3,790,531	30,721	18.5	1,786,025	21,289	26.7	1,852,025	8,425	10.4	152,481	1,007	15.4
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
1953	5,067,010	[1] 31,327	13.9	1,375,606	14,807	24.1	3,331,386	14,605	9.8	360,018	1,915	11.9
1954	5,017,227	[1] 33,026	14.7	1,339,611	15,906	26.6	3,526,982	16,115	10.2	[2] 150,634	[3] 1,005	------
1955	5,422,444	[1] 33,549	13.9	1,062,850	13,395	28.2	4,002,068	20,154	11.3	357,526	------	------
	Total terneplate			Short ternes			Long ternes			Terneplate waste-waste		
1946–50 (av.)	258,949	639	5.5	97,264	230	5.5	156,429	398	5.5	5,256	11	4.6
1951	273,244	767	6.3	52,614	201	8.6	216,069	555	5.8	4,561	11	5.1
1952	225,679	580	5.8	56,961	225	8.8	165,260	347	4.7	3,458	8	5.5
1953	278,242	643	5.2	59,429	241	9.1	215,360	392	4.1	3,453	10	6.0
1954 January–June [4]	93,264	225	5.4	23,786	80	7.5	69,478	145	4.7	------	------	------

[1] Includes small tonnage of secondary pig tin and tin acquired in chemicals.
[2] Not reported during January–June 1954; figures shown are for period July–December only.
[3] For period January–June only; thereafter not separately reported, but included in above figures on tinplate.
[4] Not separately reported after June 1954.

smallest tonnage since 1921. Nearly 90 percent of the tinplate used was for making cans, of which about 60 percent was for the food pack and 40 percent for nonfood products. Shipments of tinplate to canmakers increased 10 percent in 1955. The total tonnage of cans shipped increased 8 percent; cans for packing food increased 8 percent and for nonfood products 9 percent. Among products packed in 1955, fruits and vegetables made the largest gain, whereas cans for soft drinks showed the largest decrease.

TABLE 8.—Consumption of tin in the United States, 1953–55, by finished products, in long tons of contained tin

Product	1953			1954			1955		
	Primary	Secondary [1]	Total	Primary	Secondary [1]	Total	Primary	Secondary [1]	Total
Tinplate	[2] 31,327	--------	[2] 31,327	[2] 33,026	--------	[2] 33,026	[2] 33,549	--------	[2] 33,549
Terne metal	333	310	643	190	204	394	149	174	323
Solder	10,110	10,063	20,173	9,303	10,086	19,389	12,063	10,167	22,230
Babbitt	2,492	2,191	4,683	2,279	1,997	4,276	2,611	1,760	4,371
Bronze and brass	3,777	15,738	19,515	3,278	13,336	16,614	4,204	15,508	19,712
Collapsible tubes and foil	917	127	1,044	860	107	967	845	78	923
Tinning	2,473	179	2,652	2,447	130	2,577	2,568	45	2,613
Pipe and tubing	97	80	177	96	92	188	82	74	156
Type metal	171	1,619	1,790	132	1,325	1,457	175	1,312	1,487
Bar tin	835	71	906	824	74	898	1,439	140	1,579
Miscellaneous alloys	294	279	573	[3] 651	198	[3] 849	254	232	486
White metal	516	150	666	573	35	608	1,088	91	1,179
Chemicals including tin oxide	481	828	1,309	590	820	1,410	645	1,047	1,692
Miscellaneous	136	46	182	178	60	238	156	27	183
Total	53,959	31,681	85,640	54,427	28,464	82,891	59,828	30,655	90,483

[1] Includes 3,530 long tons of tin contained in imported tin-base alloys in 1953; 3,340 in 1954 and 2,765 in 1955.
[2] Includes small tonnage of secondary pig tin and tin acquired in chemicals.
[3] Includes 405 tons of tin in Copan produced in 1954.

According to statistics published by the American Iron and Steel Institute, 5.6 million short tons of tinplate (including short ternes and waste-waste) was shipped in 1955. The tonnage shipped in 1955 increased for the third successive year and was the largest on record, being 12 percent more than in 1954, the previous peak year. Of the total shipped in 1955, 80 percent was for cans and closures, 14 percent for export, and 6 percent for other classifications. In 1955 the portion for cans and closures was smaller than in 1954 but larger for export and other markets. However, the largest increase in tonnage was for sanitary cans for the food pack. Electrolytic tinplate shipped to categories under "Other markets" gained in virtually all items, mainly for automotive vehicles and parts (assemblies), for which there has been a rapid growth since 1953, reaching nearly 36,000 short tons in 1955. Shipments of electrolytic tinplate for export, the highest recorded for this product, were 342,000 short tons in 1955, whereas hot-dipped tinplate shipped for export was 430,000 short tons, the highest since 1948. Table 9 shows a breakdown of tinplate shipments by market classifications from 1946–55, inclusive. In addition, in 1955 shipments of black plate were 798,000 short tons (673,000 in 1954), of which 398,000 (356,000 in 1954) was for cans. Hot-dipped terneplate (short ternes—shipments thereof included above) production was 34,258 short tons in 1955) 30,476 in 1954). Shipments of long-terne sheets (long ternes) are not reported separately, but production was 217,320 short tons in 1955 (146,554 in 1954), the highest recorded.

TABLE 9.—Tinplate shipments by market classifications, 1946–50 (average) and 1951–55, in thousand short tons

[American Iron and Steel Institute Annual Report on Shipments of Steel Products, by Market Classifications, AIS 16]

Market classifications	1946–50 (average)	1951	1952	1953	1954	1955
Sanitary cans:						
Hot dip	1, 228	1, 067	875	798	716	500
Electrolytic	853	1, 429	1, 362	1, 446	1, 530	1, 978
Total	2, 081	2, 496	2, 237	2, 244	2, 246	2, 478
General line cans:						
Hot dip	185	104	92	82	118	82
Electrolytic	667	812	854	1, 280	1, 424	1, 606
Total	852	916	946	1, 362	1, 542	1, 688
Total	2, 933	3, 412	3, 183	3, 606	3, 788	4, 166
Closures—crown caps and other:						
Hot dip	26	20	4	12	6	8
Electrolytic	167	289	250	297	298	326
Total	193	309	254	309	304	334
Total cans and closures	3, 126	3, 721	3, 437	3, 915	4, 092	4, 500
Other use:						
Hot dip	87	91	96	105	80	81
Electrolytic	63	122	116	137	164	251
Total	150	213	212	242	244	332
Export:						
Hot dip	433	346	299	321	387	430
Electrolytic	79	235	235	183	265	342
Total	512	581	534	504	652	772
Total:						
Hot dip	1, 959	1, 628	1, 366	1, 318	1, 307	1, 101
Electrolytic	1, 829	2, 887	2, 817	3, 343	3, 681	4, 503
Grand total	3, 788	4, 515	4, 183	4, 661	4, 988	5, 604

Finding a substitute for tinplate in the canning industry has been under detailed study for over a quarter century. Developments during 1955 included: [14]

* * * A new type of aluminum coated steel produced in sheet and coil form in widths up to 48 in. This material is applicable for exterior use. Molten aluminum is applied to cold rolled sheet through a continuous pretreatment and immersion process. Several steel companies are also making plastic coated sheets on an experimental basis. * * * A new food can has been developed which has an aluminum coating instead of tin, and side seams that are welded instead of soldered. This entirely tinless can was developed as part of a program to eliminate tin and other hard-to-get raw materials from metal containers. The welded side seams not only eliminate the use of tin-and-lead solder, but provide a stronger can than conventional soldered types.

Industrial receipts of tin in 1955 were 97,000 long tons (16 percent more than in 1954), of which 67 percent was primary pig tin. Receipts of primary tin increased 23 percent and other raw materials 4 percent. "Straits," the principal brand of tin acquired, composed nearly three-fourths of the primary receipts in 1953, 1954, and 1955. Other brands received in 1955 included Katanga, 11 percent; English, 6 percent; Banka, 5 percent; and the remaining, 4 percent.

[14] Madsen, I. E., Developments in the Iron and Steel Industry During 1955: Iron and Steel Eng., vol. 33, No. 1, January 1956, p. 146.

STOCKS

Tin stocks held by the Government and industry—comprising pig tin, tin in ore, raw materials in process, and other, but excluding the National Strategic Stockpile—increased in 1955 from 40,800 long tons to 44,300. Industrial stocks of pig tin in the United States at the end of 1955 were 3,700 tons more than at the beginning of the year. Tinplate mills, which held about 80 percent of total plant stocks of pig tin in the United States, had 4,200 tons more at the end than at the beginning of 1955. These stocks were the highest since the end of February 1951. Tin in process at tin mills on December 31, 1955, was the highest recorded. End-of-year pig-tin stocks at other industrial plants declined to the lowest point recorded. Tin metal afloat to the United States on December 31, 1955, was 5,340 long tons.

According to a semiannual progress report by the Office of Defense Mobilization on the National Stockpiling program: [15]

> * * * Recently the minimum objective has been achieved and by the end of fiscal year 1956 the stockpile will contain or have available sufficient tin metal to meet the long-term objective—enough to meet any foreseeable defense emergency.

TABLE 10.—Tin stocks in the United States, Dec. 31, 1951–55, in long tons [1]

	1951	1952	1953	1954	1955
Industry:					
Pig tin—virgin	10,043	11,819	13,680	12,162	16,205
In process [2]	10,721	11,286	10,845	11,164	11,552
Total at plants	20,764	23,105	24,525	23,326	27,757
Other pig tin:					
In transit in United States	971	525	240	1,340	2,005
Jobbers—Importers	82	531	260	1,200	260
Afloat to United States	895	5,300	2,700	5,200	5,340
Total—other pig tin	1,948	6,356	3,200	7,740	7,605
Total industry	22,712	29,461	27,725	31,066	35,362
Government (RFC-FFC):					
Pig tin [1] total	6,753	13,265	18,467	1,352	2,284
Concentrates—ores:					
In foreign ports or afloat	1,107	11,868	4,600	2,817	3,600
In United States	10,771	13,341	11,318	5,558	3,082
Total concentrates—ores	11,878	25,209	15,918	8,375	6,682
Total Government	18,631	38,474	34,385	9,727	8,966
Grand total	41,343	67,935	62,110	40,793	44,328

[1] Excludes Copan (gross weight, long tons) at end of year as follows: 1951, 260; 1952, 191; 1953, 60; and 1954, 105.
[2] Includes secondary pig tin (long tons) as follows: 1951, 341; 1952, 306; 1953, 326; 1954, 277; and 1955, 246.

PRICES

The tin market was comparatively steady during most of 1955. The average quoted price of Straits tin for prompt delivery in New York was 94.73 cents per pound in 1955 compared with 91.81 cents in 1954. The lowest price for 1955 was 85.75 cents on January 6. The price was steady at about 91 cents until June 6 when a noteworthy upward movement began which brought the price to 98.75 cents by

[15] Work cited in footnote 3.

July 21. A slight downward trend developed until November 15, when the market began to show strength. The price advanced sharply in December and reached 110.00 cents on December 13, 15, and 16—the high for 1955—and the highest since April 8, 1953. By the close of the year the price had gradually receded to 108.00 cents.

On the London market the average price for standard tin was £740.7 per long ton in 1955 compared with £720.3 in 1954. The monthly average price fluctuated from the low of £693.5 in January to the high of £824.8 in December. The lowest price for the year was £679.5 on January 7, and the highest £845 on December 13.

TABLE 11.—Monthly prices of Straits tin for prompt delivery in New York, 1954–55, in cents per pound [1]

Month	1954			1955		
	High	Low	Average	High	Low	Average
January	85.250	84.250	84.83	90.250	85.750	87.27
February	85.750	84.500	85.04	91.625	89.625	90.77
March	95.750	86.750	91.88	91.375	90.625	91.04
April	101.000	94.250	96.12	92.125	90.625	91.39
May	94.500	92.500	93.52	91.750	90.750	91.37
June	96.500	93.375	94.20	95.250	91.625	93.64
July	97.750	95.500	96.54	98.750	95.000	96.83
August	95.500	92.500	93.37	97.625	95.625	96.46
September	94.125	92.625	93.54	97.250	92.250	96.26
October	94.625	92.250	93.04	96.625	95.875	96.09
November	92.250	89.875	91.10	100.000	96.125	97.87
December	90.250	85.625	88.57	110.000	101.250	107.76
Total	101.000	84.250	91.81	110.000	85.750	94.73

[1] Compiled from quotations published in the American Metal Market.

The Singapore market was firmer, with the average monthly price of Straits tin ex-works at £721 per long ton for 1955, compared with £694.5 for 1954. The lowest price for the year was £661.8 on January 7. The price ranged between £692 and £708 from February to May. Thereafter the price moved steadily upward to £739.5 on July 26, then downward within narrow limits until the middle of October; from then on it advanced until December 9, when the price reached £806.5, the high for the year.

FOREIGN TRADE [16]

Tin has been one of the principal imports of the United States and ranked ninth in value among all commodities in 1955. In value, among metals and minerals imported (net imports) in 1955, tin was exceeded only by petroleum and copper. The principal tin items in the foreign trade of the United States in 1955 were imports of metallic tin, concentrate, and 94-percent tin alloys and exports of tinplate and tin cans. Of minor importance were the import and export trade in tin scrap, including tinplate scrap; exports of tinplate circles, strips, cobbles, etc.; and exports of waste-waste tinplate (not separately reported but included with tinplate). There was also an appreciable export of miscellaneous tin manufactures and tin compounds. Tin contained in babbitt, solder, type metal, and bronze imported and exported is accounted for in the Lead and Copper chapters of this volume.

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

457676—58——73

Imports of metallic tin in 1955 decreased 1 percent, or 900 long tons. Of the total imports, Malaya, the principal source, furnished 73 percent; the quantity of tin received from Malaya in 1955 increased 10 percent compared with 1954. Other important sources of metal in 1955 include: Belgium-Belgian Congo, 11 percent (receipts increased 5 percent); Netherlands, 9 percent (receipts declined 45 percent); and United Kingdom, 6 percent (receipts declined 9 percent). A dock strike from May 23 to July 4 in the United Kingdom resulted in temporary dislocation in the flow of tin from England to the United States. The tonnage imported has declined each year from 1952 to 1955—the longest period of downward movement in metallic tin imports since 1929–32. Imports of tin concentrate were consigned to the Government-owned tin smelter at Texas City, Tex. Receipts of concentrate, in terms of metal, were 9 percent less than in 1954 and the lowest since 1940. Bolivia continued to be the main source of tin in concentrate imported. Imports of tin in concentrate from Bolivia in 1954 and 1955 were the lowest since shipments for treatment by the Texas City tin smelter began arriving in 1941. Imports of metal and concentrate were augmented by 6,070 long tons (5,830 in 1954)—gross weight, chief value, tin—of alloys (including alloy scrap) brought into the United States in 1955, mainly from Denmark in the form of 94-percent tin alloys. Exports of metallic tin in 1955 were 1,100 long tons (800 in 1954), with Canada the principal destination. (Beginning with 1954 this export class has included tin in concentrates and ores.) The United Kingdom imported 46 long tons of tin in concentrate from the United States in July 1955, according to the Statistical Bulletin of the International Tin Study Group. This probably represented Bolivian tinny-tungsten ore which had been beneficiated in the United States and shipped to England for smelting. A significant tonnage of tin of foreign origin moves through the United States annually to foreign destinations via the Netherlands, West Germany, and Belgium in the nature of transit trade. According to the Statistical Bulletin of the International Tin Study Group, the quantity totaled 1,250 long tons of tin metal in 1955 compared with 2,300 tons in 1954 and went mostly to Switzerland.

Cargo shipments through the Panama Canal during the fiscal year 1955 included 88,321 long tons (gross weight) of tin ore—44,110 tons to the United States (of which 37,124 was from South America and 6,986 from Asia) and 44,211 to Europe from South America. Corresponding figures for the fiscal year 1954 totaled 90,748 long tons (gross weight) of tin ore—41,288 tons to the United States (37,052 was from South America and 4,236 from Asia) and 49,460 to Europe from South America. Most of the tin coming to the United States, however, has arrived from the Far East, shipped through the Suez Canal and the Mediterranean. The combined gross weight of the metallic tin and tin-ore traffic through the Suez Canal from south to north (country of origin or destination not indicated) was 102,357 long tons in 1955 compared with 105,310 tons in 1954. In terms of tin, this approximates half the world production and would include about 85 percent of the output of the Straits smelters. In 1955 and 1954, 75 and 84 percent, respectively, of the total quantity of metallic tin imported entered the United States through eastern seaboard customs districts, and nearly all the tin concentrate entered through the Galveston, Tex., customs district.

The major tin-export item of the United States, as usual, was tinplate; moreover, since 1947 tinplate has been the most valuable (and since 1950 the largest tonnagewise) iron and steel product exported from the United States. Tinplate exports reached a new high in 1955—18 percent more in tonnage and 17 percent in value compared with 1954, the previous record year. The tin content of the tinplate exported in 1955 has been estimated at 5,300 long tons.

Tinplate was exported in 1955 and 1954 to Europe, Latin America, Asia, Africa, and Oceania. By country of destination, shipments to the United Kingdom, India, Argentina, Mexico, and Indonesia showed the largest increases, whereas those to Brazil, Australia, and Union of South Africa showed the greatest losses. From November 29, 1954, to September 18, 1955, the United Kingdom suspended the 25-percent duty on tinplate to permit importation of 50,000 tons from the United States to supply demands of food packers that could not be met by British producers.

TABLE 12.—Foreign trade of the United States in tin concentrate and tin, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Imports				Exports			
	Concentrate (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
1946–50 (average)	33,849	$58,270,677	46,543	$90,244,403	343	$547,782	126	$240,979
1951	29,621	82,462,215	28,255	74,556,994	264	762,662	1,249	3,978,852
1952	26,491	65,286,937	80,543	215,603,146	301	580,855	79	209,539
1953	35,973	82,713,269	74,570	175,950,269	128	297,695	75	141,901
1954	22,140	41,724,776	[1] 65,599	133,185,565	271	467,029	551	1,125,003
1955	20,112	[2] 36,773,366	64,718	131,397,074	254	503,892	853	1,748,367

[1] Revised figure.
[2] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not comparable with earlier years.

Hot-dipped-tinplate exports totaled 294,790 long tons valued at $62,906,400, a 3-percent increase in quantity and 2 percent in value compared with 286,850 tons valued at $61,513,900 in 1954. The principal countries of destination were Argentina, Netherlands, United Kingdom, and Union of South Africa. Exports of electrolytic tinplate were 271,170 tons valued at $53,324,700, or 25 percent more in tonnage and value than in 1954 (216,250 tons, valued at $42,500,000). The leading destinations were Brazil, United Kingdom, Netherlands, Union of South Africa, and India. Italy provided the largest export market for secondary tinplate in 1955. Exports of short ternes, shipped mainly to Canada, were 4,000 long tons in 1955 compared with 3,830 in 1954. Beginning with 1952 the quantity and value of long ternes exported have been included in the item "Steel sheets, black, ungalvanized" in the Iron and Steel chapter of this volume. Exports of tin cans were mainly to Canada, Venezuela, and Mexico.

According to the American Iron and Steel Institute producers in 1955 shipped for export 772,600 short tons (652,000 in 1954) of tinplate, of which 430,000 tons was hot dipped (387,000 in 1954) and 342,600 electrolytic (265,000 in 1954).

With reference to preparations for the trade-agreement conference in Geneva in January 1956, the United States Tariff Commission and the United States Department of State announced on September 21, 1955, hearings to be held October 31 and intention to negotiate on the President's list of import items, including tinplate and collapsible tubes. (The hearings were held October 31 to November 10, 1955.)

TABLE 13.—Tin concentrate (tin content) imported for consumption in the United States, 1954–55, by countries

[U. S. Department of Commerce]

Country	1954		1955	
	Long tons	Value	Long tons	Value
North America:				
Canada	97	$199,079	168	$341,032
Mexico	72	69,008	254	348,572
Total	169	268,087	422	689,604
South America: Bolivia	12,575	20,939,378	9,765	16,883,721
Europe:				
Netherlands	1	1,509		
Portugal	162	313,279	30	64,705
Total	163	314,788	30	64,705
Asia:				
Burma	59	90,237		
Hong Kong	4	5,258		
Indonesia	7,228	15,827,484	6,969	13,466,397
Thailand	1,062	2,153,670	2,208	4,176,200
Total	8,353	18,076,649	9,177	17,642,597
Africa:				
Belgian Congo	880	2,125,874	713	1,489,339
Egypt			5	3,400
Total	880	2,125,874	718	1,492,739
Grand total	22,140	41,724,776	20,112	[1] 36,773,366

[1] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not comparable with earlier years.

TABLE 14.—Tin [1] imported for consumption in the United States, 1954–55, by countries

[U. S. Department of Commerce]

Country	1954		1955	
	Long tons	Value	Long tons	Value
Europe:				
Belgium-Luxembourg	6,505	$14,082,962	7,064	$14,732,173
Denmark	19	34,392	5	10,668
France	8	15,516		
Germany, West	264	515,422	94	192,221
Italy			10	21,100
Netherlands	10,601	23,438,690	5,869	12,082,266
Portugal	216	437,456	49	92,149
Spain			5	9,983
Switzerland			75	151,072
United Kingdom	4,498	9,183,853	4,071	8,433,557
Total	22,111	47,708,291	17,242	35,725,189
Asia:				
Japan			30	61,228
Malaya	[2] 42,943	84,282,240	47,126	94,955,293
Total	[2] 42,943	84,282,240	47,156	95,016,521
Africa: Belgian Congo	545	1,195,034	320	655,364
Grand total	[2] 65,599	133,185,565	64,718	131,397,074

[1] Bars, blocks, pigs, grain, or granulated.
[2] Revised figure.

TABLE 15.—Foreign trade of the United States in tinplate, taggers tin, and terneplate in various forms, 1946–50 (average) and 1951–55, in long tons

[U. S. Department of Commerce]

Year	Tinplate, taggers tin, and ternplate		Tinplate circles, strips, cobbles, etc. (exports)	Waste—waste tinplate (exports)	Terneplate clippings and scrap (exports)	Tinplate scrap	
	Imports	Exports				Imports	Exports
1946–50 (average)	3,423	479,757	4,523	30,501	250	35,967	151
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
1953	374	[1] 459,639	11,445	(2)		37,582	5,195
1954	127	[1] 635,969	[3] 11,831	(2)		[3] 29,214	944
1955	40	[1] 747,561	14,798	(2)		28,721	960

[1] Owing to changes in classifications, data not strictly comparable with earlier years.
[2] Beginning January 1, 1952, not separately classified; included with "tinplate."
[3] Revised figure.

TABLE 16.—Tinplate and terneplate exported from the United States, 1954–55, by countries of destination

[U. S. Department of Commerce]

Destination	1954		1955	
	Long tons	Value	Long tons	Value
North America:				
Canada	4,445	$858,013	9,707	$1,797,169
Cuba	17,715	3,771,255	23,126	4,908,901
Mexico	12,392	2,319,248	25,469	5,269,306
Other	2,476	525,690	3,195	643,513
Total	37,028	7,474,206	61,497	12,618,889
South America:				
Argentina	42,123	8,805,187	65,027	14,016,682
Brazil	90,381	17,684,164	48,529	8,595,481
Colombia	11,426	2,234,396	16,841	3,393,355
Peru	8,098	1,704,796	7,437	1,547,704
Uruguay	4,018	870,514	3,394	734,629
Venezuela	10,798	2,667,440	11,338	2,911,057
Other	1,326	257,493	1,674	326,039
Total	168,170	34,223,990	154,240	31,524,947
Europe:				
Austria	1,748	331,490	2,627	491,107
Belgium-Luxembourg	20,034	3,787,345	21,478	4,222,146
Denmark	12,140	2,444,715	14,452	3,120,547
Finland	1,018	199,383	805	167,644
Germany, West	2,777	456,504	4,494	776,006
Greece	7,383	1,051,895	4,386	636,873
Ireland	2,000	380,950	1,563	274,764
Italy	50,204	8,354,955	57,894	9,523,515
Netherlands	61,735	13,007,928	63,954	13,453,909
Norway	25,525	5,282,759	24,034	4,921,467
Portugal	13,992	2,645,651	14,089	2,804,499
Spain	496	97,489	628	126,781
Sweden	10,299	2,108,341	11,788	2,277,603
Switzerland	16,132	3,370,626	15,532	3,210,717
Turkey	20,370	3,545,317	16,772	3,101,074
United Kingdom	4,186	817,838	53,094	10,758,007
Yugoslavia	1,201	250,678	895	186,702
Other	331	63,514	477	91,751
Total	251,571	48,197,378	308,962	60,145,112
Asia:				
Hong Kong	3,220	333,788	4,546	548,639
India	6,720	961,449	43,536	7,036,529
Indonesia	10,242	[1] 1,835,769	23,160	3,751,914
Iran	4,539	727,556	7,209	1,334,074
Israel	4,757	809,706	5,176	964,982
Japan	[1] 9,697	[1] 1,066,389	14,541	1,820,460
Lebanon	3,146	471,457	2,941	473,357
Malaya	7,994	932,419	8,664	1,174,768
Pakistan			3,833	758,137
Philippines	20,414	3,704,636	25,718	4,668,908
Taiwan	2,259	319,413	5,755	975,949
Thailand	1,622	181,642	4,717	628,483
Other	1,792	247,014	5,849	1,051,119
Total	[1] 76,402	[1] 11,591,238	155,645	25,187,319
Africa:				
Anglo-Egyptian Sudan	645	124,666	662	60,653
Belgian Congo	447	92,674	468	109,551
British East Africa	18	3,281	550	103,722
Egypt	3,874	557,698	4,158	593,377
French Morocco	372	67,005		
Nigeria			884	167,899
Union of South Africa	48,538	10,107,598	40,770	8,342,527
Other	1,391	287,662	762	161,306
Total	55,285	11,240,584	48,254	9,539,035
Oceania:				
Australia	46,950	10,056,160	7,688	3,898,408
New Zealand	526	104,065	1,196	235,826
Other	37	7,425	79	20,078
Total	47,513	10,167,650	18,963	4,154,312
Grand total	[1] 635,969	[1] 122,895,046	747,561	143,169,614

[1] Revised figure.

TABLE 17.—Foreign trade of the United States in miscellaneous tin, tin manufactures, and tin compounds, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Miscellaneous tin and manufactures						Tin compounds	
	Imports			Exports				
	Tin foil, tin powder, flitters, metallics, tin and tinplate manufactures, n. s. p. f. (value)	Dross, skimmings, scrap, residues, and tin alloys, n. s. p. f.		Tin cans, finished or unfinished		Tin scrap and other tin-bearing material except tinplate scrap (value)	Imports (pounds)	Exports (pounds)
		Pounds	Value	Long tons	Value			
1946–50 (average)	$165,618	1,874,339	$651,726	27,272	$8,774,554	$1,222,228	23,758	(1)
1951	365,741	2,566,000	1,897,991	33,171	14,048,409	2,403,354	102,212	136,179
1952	447,925	18,351,019	17,454,460	41,624	16,842,755	[2] 2,086,612	1,358	73,131
1953	605,609	15,924,059	11,894,770	29,841	12,916,664	[2] 2,418,061	5,115	183,328
1954	[3] 784,511	[4] 13,165,707	[4] 9,358,134	23,878	11,022,214	[2] 3,340,533	2,703	342,146
1955	[3] 558,964	13,764,531	[3] 10,435,455	26,490	11,516,846	[2] 2,440,829	11,350	311,005

[1] Not separately classified 1946–48; 1949: 41,004 pounds, 1950: 122,716 pounds.
[2] Owing to changes in classifications data not strictly comparable with earlier years.
[3] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known to be not comparable with years before 1954.
[4] Revised figure.

TABLE 18.—Tin concentrate (tin content) and tin imported into the United States, 1954 and 1955, by customs districts, in long tons

[U. S. Department of Commerce]

Customs districts	1954	1955	Customs districts	1954	1955
Tin concentrate (tin content):			Tin—Continued		
Galveston, Tex	21,563	19,432	Michigan	10	-------
Laredo, Tex	72	254	Mobile, Ala	1,615	3,220
New York	444	426	New Orleans, La	4,500	8,410
Maryland	61	-------	New York	40,072	41,808
			Ohio	101	39
Total	22,140	20,112	Oregon	10	10
			Philadelphia, Pa	934	1,082
Tin:[1]			Sabine, Tex	50	-------
Chicago, Ill	138	-------	San Francisco, Calif	2,326	2,824
Galveston, Tex	295	505	Virginia	100	-------
Los Angeles, Calif	1,571	1,365	Washington	-------	37
Maine and New Hampshire	652	-------			
Maryland	12,872	4,913	Total	65,599	64,718
Massachusetts	353	505			

[1] Bars, blocks, pigs, grain, or granulated.

TECHNOLOGY

The Tin Research Institute, Inc., Greenford, England, maintained its office at Columbus, Ohio, and offered free service for technical inquiries and general information on tin. The institute maintains a technical library on tin and has a number of publications for free distribution. Among those made available in 1955 were: Tin and Its Uses, Nos. 31 and 32; Electroplated Tin-Nickel Alloy; Corrosion Tests of Tin-Cadmium Coatings on Steel; A Rust-Resistance Test for Tinplate; Determining the Thickness of Tin Coatings; The Casting of Tin-Base Alloys; and Report of the Tin Research Institute in 1955.

Another activity of the institute was the holding of conferences on tin research in various countries. During 1955 four conferences were organized: In Paris, Utrecht, Milan, and Hannover, respectively.

In an article describing the Sullivan concentrator (Consolidated Mining & Smelting Co. of Canada, Ltd.) the author stated [17] as follows:

* * * Tin content of the feed approximated 0.04 percent in the form of cassiterite; the balance consists of residual amounts of lead, zinc and other minor metallic minerals with a predominance of pyrrhotite and varying proportions of pyrite and siliceous gangue. The fineness of this product presented a concentration problem. The use of shaking tables was not economical due to the amount of floor space needed for this type of equipment. Desliming and elimination of the sulphides by flotation, followed by gravity concentration was adopted.

* * * The final product normally grades 61 percent Sn, 3.3 percent Fe. The ratio of concentration is 5,000 to 1.

Developments in improved technique for testing alluvial tin deposits in northern Tasmania were described.[18]

The Commonwealth Minister for National Development recently announced that the Bureau of Mineral Resources is using a Werf-Conrad machine for testing alluvial tin deposits in northern Tasmania.

The Werf-Conrad machine is a mechanical pit-digger developed by a Dutch company with extensive experience in testing alluvial deposits in Indonesia. The pit is dug by a rotating steel tube 16 in. in diameter, and having a sharp cutting shoe at the lower end. The tube sinks in the alluvium under its own weight to a depth of up to 80 ft. The material inside the tube (1.4 cu. ft. per foot depth) is excavated by a cable operated digger, using a clam-sheel grab or tip bucket, and is washed and treated in a portable treatment unit. The principal advantage of the machine is that it yields a more representative sample, and testing of alluvial ground is consequently more accurate. Testing is also more rapid, and operation of the machine is not affected by water-logged ground.

The machine being used by the Bureau was imported at a cost of £ 7,500 and has given satisfactory results at the Dorset tin-dredging project, where new reserves were discovered sufficient to extend the life of the project by five years. It is now to be used to test tin resources of the Great Northern Plain near Boobyalla, Tas.

An article describing the recent modernization and underground working methods currently employed at the Geevor Tin Mines, Ltd., 1 of the 2 remaining tin mines still operating in Cornwall, was published;[19] among other things it stated:

Present production from Geevor is approximately 55 tons of cassiterite concentrate (black tin 65 percent Sn) per month, these being sold and shipped to Williams, Harvey and Co., Ltd., Bootle, Lancashire, for smelting. During the financial year ending March, 1954, 57,445 tons of ore were hoisted from the mine yielding an average recovery of 27.82 lb. black tin per ton milled.

A brochure describing the Longhorn tin smelter at Texas City, Tex., was issued [20] by the Federal Facilities Corporation. During the year July 1, 1954–July 30, 1955, the average monthly cost per long ton [21] of new ore treated follows:

	Per ton
Ore storage	$6.77
Roasting	9.71
Leaching	26.17
Smelting ores and slag	23.89
Refining and casting	3.99
General expenses	18.16
Management	1.59
Gross operating cost	90.28
Less credits	21.79
Net operating cost per ton new ore	68.49

[17] Deco Trefoil, The Sullivan Concentrator: March–April 1955, pp. 9–16.
[18] Chemical Engineering and Mining Review (Melbourne), Improved Technique for Alluvial Testing: Vol. 47, No. 7, Apr. 11, 1955, p. 260.
[19] Mine and Quarry Engineering (London), Geevor Mine: Vol. 21, No. 7, July 1955, pp. 282–290.
[20] Federal Facilities Corporation, Longhorn Tin Smelter: Sept. 6, 1955, 18 pp.
[21] Average monthly costs reflect the smelter operation only. It does not include cost of operating the waste acid plant and capital expenditures. The purchase and transportation of tin concentrate to the plant and tin metal from the plant are also not included.

The conclusions of a technical paper dealing with electrolytic plating of a lead-base alloy containing tin follow:[22]

A solution has been developed from which an alloy with a nominal composition of 11 per cent tin, 7 per cent antimony, and remainder lead can be simultaneously electrodeposited. The effects of variation of individual constituents of the solution on the plated alloy composition have been investigated and determined. The effects of variations of current density, temperature and agitation have also been investigated and determined. Equipment and a procedure have been developed for plating bearings and have been shown adaptable for production use with excellent control of the plated alloy.

An article discussed the important developments relating to tin, including: Tin-alloy plating, tin coatings, new aluminum-tin bearing alloys, soldering practice, and miscellaneous uses for tin.[23]

The abstract of a technical report on the mechanical properties of antimonial bronze bearing-metal exhibitor, Berry Metal Co., follows:[24]

This is the second report on the evaluation of "Berry Metal," a tin-free antimonial bronze, as a substitute for high-leaded tin bronze in journal bearing applications. The first report compared the friction and wear behavior of the two bronzes. In this report, the tensile and compressive properties of Berry metal and high-leaded tin bronze are compared at 80°, 212°, and 300° F. Also, variations in the microstructure caused by the addition of nickel and/or phosphorous to the antimonial bronze are presented and discussed. A few sea water corrosion-erosion tests were conducted but the results were inconclusive. The discussion of the report includes service and laboratory test information furnished by the exhibitor.

In an article describing the detinning of tinplate, older processes, the alkali chemical process, and economic aspects, the authors concluded[25] as follows:

The United States, since it has virtually no domestic sources of tin ore and is the world's largest consumer of tin, is dependent on imports and on secondary recovery. Since the largest single use of tin is in the manufacture of tin cans, this presents the greatest potential source for secondary recovery. Detinning plants already do an efficient job in processing the scrap incident to can manufacture, but the cans themselves, except for a very small fraction sent to detinners, generally end up on the dump with a total loss of the associated tin. Under sufficient incentive, as was demonstrated during World War II, much of this could be salvaged. Obstacles to large-scale detinning of used cans are economic rather than technical and depend chiefly on the cost of collecting the cans.

An article[26] described dredging for tin in Malaya. It stated:

For many years the greater part of the Tin-ore produced in Malaya and neighbouring countries has been won by bucket dredging methods. At the present time there are about 80 dredges operating in Malaya alone. The size and capacity of these plants vary considerably. There are the small dredges, each handling about 200 tons of spoil per hour and digging to a depth of 30 feet below water level, whilst the biggest dredges excavate more than 1,000 tons per hour and can dig to a depth of around 135 feet below the surface of the paddock in which they float. In between these extremes there are others, and all are "tailored" to suit the particular property on which they operate.

* * * Present-day mining operations call for big yardages with efficient digging and treatment plants. At the present time the large bucket dredge is the only proved plant that can meet all requirements and give an overall operating cost of approximately 7d. per cubic yard.

An excellent review on tinplate technology was published.[27]

---

[22] Putnam, R. T. and Roser, E. J., Lead-Tin-Antimony Plating: American Electroplaters Society Tech. Proc., 1955, 42d Ann. Convention, Cleveland, Ohio, July 20–23, 1955, pp. 38–41.

[23] Nekervis, Robert J., Tin and Its Alloys: Ind. Eng. Chem., vol. 47, No. 9, September 1955, pp. 2036–2040.

[24] U. S. Naval Engineering Experiment Station, Evaluation Report 040037F(4)-NS-013-118: Feb. 14, 1955, 17 pp.

[25] Swanson, L. E., and Taylor, R. H., Detinning: Encyclopedia Chem. Tech., vol. 14, 1955, pp. 151–156.

[26] Tin (London), Dredging for Tin in Malaya: July 1955, pp. 140–147.

[27] Tin (London), Recent Advances in Tinplate Technology: September 1955, pp. 183–184.

An article [28] described ore-dressing methods in Nigeria.

As part of the Bureau of Mines activities, a progress report was issued presenting the results of experiments on the recovery of tin from low-grade Bolivian tin ores.[29]

Another Bureau of Mines report discussed the oxidation rates of molten metals.[30]

The abstract of a technical paper on the recovery of tin from tin-plate scrap stated: [31]

> The Sn was dissolved from the scrap by dry Cl. It was pptd. as the metal with pure Zn. The ppt. was melted under a cover of NH_4Cl. Analysis of the melt showed 99.8% Sn. The recovery from the scrap was 83%. Electrochem. deposition of Sn by Fe was extremely slow.

Low-temperature-research studies by the National Bureau of Standards under the sponsorship of the Air Research and Development Command during the fiscal year 1955 [32] on superconductivity:

> * * * Dealt largely with an unusual class of tin crystals called "whiskers." The interest in tin whiskers stems primarily from their size—about 1 micron in diameter. As the surface-to-volume ratio of a super-conductive wire becomes large, as in the case of tin whiskers, size effects occur. A study of these effects provides information about the surface tension between superconducting and normal domains and about the penetration of a magnetic field at the surface of a superconductor. Recent results indicate that domain segmentation is not possible in tin whiskers under certain conditions which ordinarily favor such a structure. This has been explained in terms of a prohibitively high interdomain surface energy in filaments of this size. The Bureau is now seeking a more precise expression of these results and is investigating the effects of magnetic field penetration on the phase transition in tin whiskers.

United States patents relative to tin, issued during 1955, include the following: [33]

WORLD REVIEW

INTERNATIONAL TIN AGREEMENT

At the close of 1955 the proposed International Tin Agreement (drafted at Geneva in 1953) was not yet ratified by Indonesia. To enable the agreement to enter into force approval is required of producing countries holding 900 out of 1,000 producing votes and 9 consuming countries holding 333 out of the 1,000 consuming votes.

After enough instruments of ratification have been formally deposited with the United Kingdom Government a meeting of the ratifying countries will be convened in London for fixing the date of

[28] Mining Magazine (London), Dressing Tin-Columbite Concentrates: Vol. 92, No. 2, February 1955, pp. 86–89.

[29] Spendlove, M. J., and Wilson, D. A., Experiments on the Recovery of Tin From Low-Grade Bolivian Tin Ores by Sulfide Volatilization: Bureau of Mines Report of Investigations 5161, 1955, 40 pp.

[30] Bilbrey, J. H., Jr., Wilson, D. A., and Spendlove, M. J., Oxidation Rates of Molten Metals as Determined by a Recording Thermobalance; Part 1. Tin: Bureau of Mines Rept. of Investigations 5181, 1955, 24 pp.

[31] Chemical Abstracts, Recovery of Tin From Tin-Plate Scrap: Vol. 49, No. 8, Apr. 25, 1955, Item 5167 p. 49.

[32] National Bureau of Standards, Annual Report, 1955: Miscellaneous Pub. 217, p. 27.

[33] Robertson, Delbert P. (assigned to National Steel Corp.), Determination of Tin on Tinplate: United States Patent 2,716,596, Aug. 30, 1955.

Bauch, Frederick (assigned to General Motors Corp.), Stripping Tin From Copper: United States Patent 2,721,119, Oct. 18, 1955.

Nelson, John Walter (assigned to Sinclair Refining Co.), Art of Tin Plating: United States Patent 2,721,149, Oct. 18, 1955.

Heymann, Erich, and Schmerling, Grigory, Electrodeposition of Alloys Containing Copper and Tin: United States Patent 2,722,508, Nov. 1, 1955.

entry into force of the agreement; and the first meeting will be called of the International Tin Council, which will administer the agreement. The council will have its seat at London. The various participating countries will be represented on the council, and there will be an appointed independent staff comprising a chairman, secretary, buffer-stock manager, and subordinates. Duration of the agreement will be 5 years. A buffer stock aggregating 25,000 tons of tin (or cash equivalent) will be established as the principal stabilizing instrument. No tin may be procured for this above 90 cents a pound, although metallic tin may be deposited by members when market prices are above that level. There is to be no restriction of output until the buffer stock accumulates 15,000 tons of tin. When the buffer stock holds 10,000 tons of tin metal or more, exports can be restricted. The initial contribution by producing countries will be equivalent in the aggregate to 15,000 tons of tin metal, and this may be in cash at £640 a ton (80 cents a pound) or in metal. Once metal has been deposited it can not be sold by the manager until the price has gone up to £800 a ton (or $1.00 a pound). After the initial contribution producers would be liable for 2 subsequent contributions, each of which shall be equivalent in the aggregate to 5,000 tons of tin metal, the first being due as soon as the buffer stock holds 10,000 tons of tin metal and the second when it holds 15,000 tons of tin metal.

Under the terms of the agreement the floor and ceiling prices of tin on which the buffer-stock manager will base his market transactions are 80 cents and $1.10 a pound, respectively. At the floor price (when the price on the London Metal Exchange is below £640 a long ton) the buffer-stock manager must buy tin if he has cash, and he must sell at the ceiling price (above £880 a ton) if he has tin. In the upper third of the range between floor and ceiling ($1.00 to $1.10) he may sell tin, and in the lower third (80 to 90 cents) he may buy if he considers it necessary. In the middle range between the floor and ceiling prices ($0.90 to $1.00) the manager can neither buy nor sell unless the council decides otherwise.

Tables 19 and 20 list the countries which were parties to the agreement.

TABLE 19.—Producing countries [1]

Country	Percentage of production	Number of votes allocated	Signed [2]	Ratified	Date of ratification
Belgian Congo and Ruanda Urundi	8.72	90	90	90	Apr. 6, 1955
Bolivia	21.50	213	213	213	Dec. 31, 1954
Indonesia	21.50	213	213	213	May 16, 1956
Malaya	36.61	360	360	360	Dec. 15, 1954
Nigeria	5.38	58	58	58	Dec. 15, 1954
Thailand	6.29	66	66	------------	
Total	100.00	1,000	1,000	934	

[1] Required: Ratification by producing countries holding together at least 900 votes.
[2] By June 30, 1954, the agreement had been signed by or on behalf of producing countries listed.

TABLE 20.—Consuming countries [1]

Country	Tonnage	Number of votes	Signed [2]	Ratified	Date of ratification
Australia	1,580	16	16	16	Nov. 11, 1954
Brazil	1,800	17			
Belgium	1,260	14	14	14	Apr. 6, 1955
Canada	4,720	37	37	37	Sept. 17, 1954
Denmark	780	10	10	10	Oct. 1, 1954
Ecuador	3	5	5	5	Mar. 24, 1955
France	7,230	55	55	55	Aug. 10, 1955
Germany, West	7,280	55			
India	3,430	29	29	29	Jan. 28, 1955
Italy	3,380	28	28		
Japan	3,050	26	26		
Lebanon	50	5	5		
Netherlands	4,570	36	36	36	July 26, 1955
Switzerland	870	11			
Spain	680	10	10	10	June 7, 1955
Turkey	830	11	11		
United Kingdom	20,360	145	145	145	Dec. 15, 1954
United States	74,310	490			
Total	136,183	1,000	427	357	

[1] Required: Ratification by at least 9 consuming countries holding at least 333 votes.
[2] By June 30, 1954, the agreement had been signed by or on behalf of consuming countries as indicated.

WORLD MINE PRODUCTION

World mine production of tin increased 1,400 tons in 1955. The tinfields of Malaya furnished 34 percent of the total, Indonesia 19 percent, Bolivia 16 percent, Belgian Congo 9 percent, Thailand 6 percent, Nigeria 4 percent and all the remaining sources 12 percent. Output increased in Belgian Congo, Malaya, and Thailand and dropped in Bolivia, Indonesia, and Nigeria. Production in Malaya and Thailand reached new post-World War II records. Bolivian production was the lowest since 1939. World mine production of tin was 25,000 to 26,000 long tons over world industrial consumption in 1955, compared with 37,000 to 38,000 tons in 1954 (excluding National Strategic Stockpile accumulations). Ore receipts by the Texas City tin smelter contained 20,100 long tons of tin in 1955.

TABLE 21.—World mine production of tin (content of ore), by countries, 1946–50 (average) and 1951–55, in long tons [1]

[Compiled by Augusta W. Jann]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	330	155	95	488	174	177
Mexico	283	366	413	476	349	605
United States	34	88	99	56	205	99
Total	647	609	607	1,020	728	881
South America:						
Argentina	386	237	261	153	94	89
Bolivia (exports)	34,710	33,132	31,959	34,825	28,824	27,921
Brazil	246	197	229	209	[2] 180	[2] 300
Peru [3]	47	86	31			
Total	35,389	33,652	32,480	35,187	29,098	28,310
Europe:						
France	57	93	285	493	531	483
Germany, East	70	257	395	563	669	669
Italy	30					
Portugal [4]	579	933	1,146	1,168	993	1,033
Spain	514	940	733	795	654	678
United Kingdom	952	841	903	1,103	940	1,034
Total [5]	2,202	3,064	3,462	4,122	3,787	3,897
Africa:						
Belgian Congo [6]	13,845	13,669	13,795	15,293	15,084	15,303
French Cameroon	94	72	87	86	82	85
French Morocco	1	13	15	9	5	15
French West Africa	16	65	110	118	72	46
Mozambique	1	8	3			
Nigeria	9,157	8,529	8,318	8,228	7,926	8,158
Rhodesia and Nyasaland, Fed. of:						
Northern Rhodesia	4	2	11	7	1	
Southern Rhodesia	92	40	30	30	14	208
South-West Africa	131	76	106	210	446	377
Swaziland	30	32	36	36	34	27
Tanganyika (exports)	105	67	47	45	39	41
Uganda (exports)	173	118	110	92	86	58
Union of South Africa	508	761	935	1,360	1,315	1,283
Total	24,157	23,452	23,603	25,514	25,104	25,601
Asia:						
Burma	1,316	1,400	1,600	1,400	950	1,127
China [2]	5,080	7,500	8,600	9,600	10,000	11,500
Indochina	24	92	156	264	110	253
Indonesia	22,775	30,986	35,003	33,822	35,861	33,368
Japan	159	426	638	732	715	897
Malaya	38,544	57,167	56,838	56,254	60,690	61,244
Thailand	4,975	9,502	9,479	10,126	9,776	11,067
Total	72,873	107,073	112,314	112,198	118,102	119,456
Oceania: Australia	2,044	1,559	1,611	1,553	1,979	2,077
Total (estimate) [5]	137,300	169,400	174,100	179,600	178,800	180,200

[1] The table incorporates a number of revisions of data published in previous Tin chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[2] Estimated by authors of the chapter and in a few instances from the Statistical Bulletin of the International Tin Study Group, The Hague, Netherlands.
[3] Minor constituent of other base-metal ores.
[4] Excludes mixed concentrates.
[5] Excludes production of U. S. S. R.
[6] Includes Ruanda-Urundi.

WORLD SMELTER PRODUCTION

World smelter production of tin in 1955 exclusive of U. S. S. R. decreased 3 percent compared with 1954. Excluding United States production, which was for Government stockpiling, world smelter production was only 4,000 tons over world industrial consumption. The Malayan tin-smelting plants (the world's most important sources of pig tin) decreased their output 500 tons but supplied 39 percent

(38 percent in 1954) of the total. On October 1 the new smelting works at Butterworth, Province Wellesley, Malaya, were brought into production. Next in rank in the Free World were the United Kingdom, Netherlands, United States, and Belgium. Smelters in these 5 countries supplied 86 percent of the world's tin in 1955. About 46 percent of the world smelter output in 1955 was for the United States.

TABLE 22.—World smelter production of tin, by countries, 1946–50 (average) and 1951–55, in long tons [1]

[Compiled by Augusta W. Jann]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	330	155	95	—	—	—
Mexico	251	366	140	209	224	357
United States	36, 491	31, 852	22, 805	37, 562	27, 407	22, 329
Total	37, 072	32, 373	23, 040	37, 771	27, 631	22, 686
South America:						
Argentina	402	206	185	130	60	99
Bolivia (exports)	185	39	257	174	196	107
Brazil	172	133	116	553	1, 850	[2] 1, 800
Peru [3]	41	86	31	—	—	—
Total	800	464	589	857	2, 106	[2] 2, 000
Europe:						
Belgium	8, 488	8, 360	10, 585	9, 039	11, 377	10, 432
Germany:						
East	70	316	563	[2] 480	600	605
West	143	581	758	694	—	280
Italy	24	—	—	—	—	—
Netherlands	13, 320	20, 977	27, 913	26, 950	28, 442	26, 566
Portugal	254	313	340	471	664	945
Spain	1, 005	766	687	935	676	608
United Kingdom [4]	29, 018	27, 650	29, 521	28, 860	27, 475	27, 241
Total [5]	52, 322	58, 963	70, 367	67, 429	69, 234	66, 677
Africa:						
Belgian Congo	3, 394	3, 011	2, 765	2, 715	2, 459	3, 034
French Morocco	—	—	15	—	8	[2] 12
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	97	63	37	27	19	132
Union of South Africa	665	829	960	828	752	779
Total	4, 156	3, 903	3, 777	3, 570	3, 238	3, 957
Asia:						
China [2]	4, 740	7, 000	8, 000	9, 000	9, 400	11, 500
Indochina	7	—	—	—	—	—
Indonesia	133	217	224	644	1, 351	1, 572
Japan	184	575	637	805	813	1, 030
Malaya	44, 408	65, 914	62, 829	62, 410	71, 166	70, 631
Thailand	106	—	17	—	—	—
Total	49, 578	73, 706	71, 707	72, 859	82, 730	84, 733
Oceania: Australia	2, 090	1, 460	1, 700	1, 443	2, 063	2, 004
World total (estimate) [5]	146, 000	17 , 900	171, 200	183, 900	187, 000	182, 100

[1] This table incorporates a number of data published in previous Tin chapters. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[2] Estimated by authors of the chapter and in a few instances from Statistical Bulletin of the International Tin Study Group, The Hague, Netherlands.
[3] Tin content of dross.
[4] Beginning January 1948 includes production from imported scrap and residues refined on toll.
[5] Excluding production of U. S. S. R.

WORLD CONSUMPTION

World consumption of tin increased 8 percent in 1955 compared with 1954 and was the highest since 1941. In 1955 and 1954, 8 countries consumed 78 and 77 percent, respectively, of the world totals; these were the United States, United Kingdom, France and Saar, West Germany, Japan, Denmark, India, and Canada. Each of these countries increased its consumption of tin, as follows: United States, 10 percent; United Kingdom, 5 percent; France and Saar, 16 percent; West Germany, 24 percent; Japan, 6 percent; Denmark, 20 percent; India, 5 percent; and Canada, 11 percent. Tonnagewise, the largest increase in tin consumed in 1955 by any country was 5,400 tons by the United States. The United States consumed 41 percent in 1955 and 40 percent in 1954 of the Free World total. The largest decrease in usage of tin in 1955 by any country was 935 tons by the Netherlands. Omitting figures on Government stocks and production by the Texas City smelter, in 1955 the Free World available supplies of metallic tin and commercial demand was virtually in balance.

TABLE 23.—World consumption of tin, by countries, 1946–50 (average) and 1951–55, in long tons [1]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	4,045	4,731	4,190	3,904	3,604	4,018
United States	58,402	56,884	45,323	53,959	54,427	59,828
Others	458	600	590	730	810	760
Total	62,905	62,215	50,103	58,593	58,841	64,606
South America:						
Argentina	1,281	1,350	1,400	1,500	1,600	1,600
Brazil	1,184	1,750	1,700	1,650	1,750	1,750
Others	406	624	706	720	795	795
Total	2,871	3,724	3,806	3,870	4,145	4,145
Europe:						
Belgium-Luxembourg	1,414	1,770	1,224	1,164	1,807	2,022
Czechoslovakia	948	1,500	1,600	1,700	1,700	1,700
Denmark	511	880	1,140	2,650	4,000	4,800
Finland	398	400	375	375	375	420
France	7,100	7,900	7,550	8,000	9,000	9,700
Germany, West	2,334	7,506	7,270	5,814	6,567	8,165
Italy	1,720	2,900	2,500	2,800	3,000	3,100
Netherlands	2,787	2,400	8,700	4,330	3,450	2,515
Poland	1,521	2,000	1,900	1,800	1,700	1,700
Spain	917	1,020	900	840	840	840
Sweden	910	950	850	800	800	900
Switzerland	710	800	750	750	750	750
United Kingdom	24,660	23,892	22,554	18,882	21,712	22,873
Others	2,083	4,034	3,869	3,809	3,871	4,034
Total [2]	48,013	57,952	61,182	53,714	59,572	63,519
Africa	2,011	2,351	2,552	2,539	2,431	2,402
Asia:						
India	3,160	3,900	3,900	3,700	4,000	4,200
Japan [3]	3,253	4,067	4,591	6,350	7,480	7,963
Turkey	504	800	800	800	800	800
Others	1,571	2,229	2,709	3,148	4,155	5,531
Total	8,488	10,996	12,000	13,998	16,435	18,494
Australia and New Zealand	2,580	2,760	2,620	2,560	2,820	2,900
World total	127,000	140,000	132,500	135,300	144,200	156,000

[1] Statistical Bulletin of the International Tin Study Group, October 1956, p. 26.
[2] Excludes U. S. S. R.
[3] Figures for 1951–55 from Ministry of International Trade and Industry, Japanese Mining Industry 1955, p. 77.

REVIEW BY COUNTRIES

Australia.—Production of tin-in-concentrate in Australia was 2,077 long tons and represented a 5-percent increase over the previous year. Domestic smelter production declined 3 percent to 2,004 tons. Consumption of tin in Australia was 2,500 tons during 1955, unchanged from the previous year.

According to a report: [34]

> A £2 million development scheme for Shaw River tin deposits, near Marble Bar in Western Australia, will be undertaken soon. Development plans include working two plants, one at each end of the field which extends about 26 miles along the eastern side of the Shaw River. The field would employ between 60 to 80 men and a township would be built. The field is believed to be capable of becoming one of the biggest producers of tin in the Commonwealth, with an output of 400 to 600 tons of tin oxide a year.

Belgian Congo.—Production of tin-in-concentrate in the Belgian Congo, including Ruanda-Urundi, totaled 15,303 long tons, virtually unchanged from 1954. This output represented 60 percent of 1955 African total tin production. Domestic-smelter production totaled 3,034 tons, a 23-percent increase from the previous year. Tin contained in exports of concentrate totaled 12,391 tons, of which Belgium received 10,674 tons, United States 912, Brazil 637, and other countries 168 tons. Exports of tin metal from Belgian Congo totaled 2,582 tons, of which Belgium received 2,047 tons, United States 460, and Union of South Africa 75 tons.

Stocks of tin metal increased from 35 tons at the beginning of 1955 to 123 tons at the end of the year. Stocks of tin-in-concentrates increased from 534 tons at the beginning of 1955 to 554 at the end of the year.

Bolivia.—In 1955 declining output of tin and inadequate exploration of tin resources characterized the Bolivian tin industry. The production of tin contained in concentrate totaled 27,200 long tons, a 4-percent decrease from 1954. The total tin contained in exports of concentrate and metal in 1955 was 27,921 tons. This represented 16 percent of world production of tin. Nearly 57 percent of the Bolivian exports was consigned to the United Kingdom and approximately 41 percent to the United States, leaving 2 percent to Germany, Argentina, and Chile. The distribution of exports of tin from Bolivia, by groups, in 1953–55, follows: [35]

Group:	*Long tons* 1953	1954	1955
Corporacion Minera de Bolivia	29, 500	24, 744	23, 417
Banco Minero:			
Medium mines	2, 390	1, 718	1, 957
Small mines	2, 761	2, 166	2, 440
Total tin-in-concentrates	34, 651	28, 628	27, 814
Oruro smelter (tin metal)	174	196	107
Total tin exports	34, 825	28, 824	27, 921

[34] Canadian Foreign Trade, vol. 103, No. 7, Apr. 2, 1955, p. 25.
[35] International Tin Study Group, Statistical Bulletin: June 1956, p. 9.

A recent State Department Dispatch commented on the Bolivian Government efforts to stimulate mineral production (particularly tin) as follows:[36]

The Bolivian Cabinet issued a decree in late November amending certain of the provisions of the principal decree governing small and medium private miners. * * * *

The miners will hereafter be granted 20 percent of the foreign exchange derived from the sale of their mineral production instead of the present 16 percent. The additional 4 percent which the government has conceded the private miners will be applied principally on the purchase of basic foods for the mine commissaries. The Minister of National Economy will continue to supervise the purchase of articles for the commissaries, fixing quotas for the distribution of foodstuffs and other items for all of the private mines.

The bonus payments for increased production in the private mines may now be used on a somewhat more flexible basis. In conformance with Article 13 of the government decree of November 3, these bonuses may be used as follows: no less than 60 percent of the bonus may be applied to the purchase of capital goods and equipment such as machinery, motors, implements, trucks, tractors, construction materials and sanitary and electrical installations; and up to 40 percent may be applied on the purchase of general merchandise. This latter percentage may also be exchanged for bolivianos at the free market exchange rate.

The new decree, which involves but a few modifications of the March 23 decree, nevertheless indicates the trend in current government thinking in regard to private miners; i. e., to offer more and more incentives to encourage increased mineral production.

In November 1955 the Bolivian Government, under a contract financed by the International Cooperation Administration, an agency of the United States Government, engaged the services of Ford, Bacon, and Davis, a New York engineering firm, to make a study of all phases of the industry, including mining, milling, smelting, and refining, research operations, management, capital requirements and the like. The firm plans to prepare its report, according to ICA Press Release 56 of November 8, 1955, so that they will:

(1) Serve as a guide to the Bolivian Government in taking measures to place the mining industry in a position to make its maximum contribution to the Country's economy, and

(2) Serve as a basis for attracting the capital and management required for the development of the industry.

Receipts of Bolivian tin concentrate at the Texas City smelter during the calendar year 1955 were:

TABLE 24.—Receipts of Bolivian ore (concentrate) at the Texas City, Tex., smelter in 1955, in long tons

Grade	Concentrate (tons)	Tin (percent)	Tin (tons)	Total content (percent)
High	6,946	57.59	4,000	42
Medium	7,188	46.70	3,357	36
Low	9,819	20.66	2,029	22
Total	23,953	39.19	9,386	100

On November 28, 1955, representatives of the Corporacion Minera and of Williams, Harvey & Co., Ltd., signed a contract for smelting deliveries of tin concentrates from the former Patino Mines & Enterprises Consolidated, Inc., for an additional 5-year period. The contract became effective January 1, 1956, and continues until December 31, 1960.

[36] U. S. Embassy, La Paz, Bolivia, State Department Dispatch 316: Jan. 12, 1956.

Brazil.—In 1955 the Brazilian Department of Mineral Production assisted mining companies to expand the output of tin-in-concentrates. Exploration work was conducted at Volta Grande, Ribeirao Cachoerinha, and Rio Das Mortes. Production in 1955 totaled about 460 tons of tin concentrate. Tin concentrate is smelted at the Companhia Estanifera do Brasil electric smelter at Volta Redonda. In 1955 tin-in-concentrate exported to Brazil from the Belgian Congo was 637 long tons; from Thailand, 573 tons; and Portugal, 81 tons.

Canada.—Production of tin-in-concentrate was virtually unchanged in 1955 compared with the previous years. Canadian output was in the form of concentrate (61 percent Sn) derived from tailings in the concentration of the lead-zinc-silver ore from the Sullivan mine of the Consolidated Mining & Smelting Co. of Canada, Ltd., Kimberley, British Columbia.

Denmark.—No tin is mined in Denmark. However, since 1951 Denmark's exports of tin alloys have been significant, totaling 5,850 long tons in 1955. Exports thereof to the United States have shown sizeable increases and in 1955 reached 5,275 tons valued at 64.8 million kroner (approximately $9.5 million). One firm, a leading and long-established enterprise in the Danish metal industry, Paul Bergsøe & Søn, Glostrup, near Copenhagen, has been responsible for all Danish production and exports. The firm was originally established for the purpose of utilizing a process for the detinning of tinplate and for manufacturing tin alloys. The production was subsequently extended to comprise also soft lead, antimonial lead, gun-metal, brass, and bronze ingots. The tin alloys (tin-antimony-copper-lead alloys) produced are type metal, tin solder, and babbitt. This production is partly from residues and scrap of domestic origin (old tin cans) and imported tin alloy scrap. Most of this is imported for the Bergsøe works (babbitt-metal dross, old babbitt metals, re-melted babbitt metals) from West Germany, United Kingdom, Hungary, France, and other European countries. Small quantities of imported pure tin are also used. In 1955 the United States imported 4,830 tons of tin alloys valued at $9 million from Denmark.

France.—A recent State Department dispatch reported on tin in France as follows: [37]

France is almost entirely dependent on imports for its tin supply. A negligible amount of tin ore and concentrates is mined in France at a single mine, that of Abbaretz in Brittany. In 1954 this mine produced 1,070 metric tons of 50% tin concentrates and 776 tons of 70% tin concentrates.

Since France possesses no facilities for recovering tin from the ore, the entire amount was exported to the Netherlands for processing.

Domestic consumption of tin metal amounted to an estimated 8,500 metric tons in 1954 compared to 7,200 tons in 1953. The principal uses were:

Use	*Metric tons*	*Percentage of total*
Tinplate	5,000	58.8
Soldering, antifriction	2,100	24.7
Oxides, chlorides and salts	350	4.1
Plating	250	2.9
Electrical construction	250	2.9
Tinfoil	200	2.4
Other	350	4.2
	8,500	100.0

[37] U. S. Embassy, Paris, France, State Department Dispatch 68: July 11, 1955.

In 1955 the production of tin-in-concentrate in France totaled 450 long tons, while the domestic consumption of tin metal was about 9,700 tons.[38]

Indonesia.—In 1955 Indonesia was the second largest tin producer in the world. Production of tin-in-concentrate totaled 33,360 long tons. This represented a decrease of 2,500 tons or 7 percent from the previous year. The Indonesian output of tin represented 19 percent of the world mine production. Tin production in Indonesia was confined to the Islands of Bangka, Billiton, and Singkep, which in 1955 supplied 68, 26, and 6 percent respectively. Exports of tin-in-concentrate from Indonesia in 1955, in long tons, were as follows:

United States	7, 384
Netherlands	24, 382
Malaya	2
Total	31, 768

At the end of 1955, tin-in-concentrate and stocks in Indonesia totaled about 4,900 long tons compared with 3,900 tons at the beginning of the year. The accumulation of tin was due in part to anticipation of resumption of exports of slab tin to Japan. Production of tin metal was 1,770 tons in 1955 compared with 1,351 in 1954.

Parliamentary debate on ratification of the International Tin Agreement took place sporadically during the final months of 1955, but actual ratification was delayed until early 1956.

Japan.—Mine and smelter production, imports, and consumption of tin reached a postwar high in Japan in 1955. Mine output, however, was only 900 tons compared with 2,200 tons in 1941, the peak year. Akenobe (the largest), Mitate (second largest), and Ikuno were the main tin producers. Normal operation began at the Mitate mine in 1955 after extension of mill and underground-development work. Virtually no concentrate was imported from 1945 to 1954. In 1955 a new joint venture by Mitsubishi Metal Mining Co. and Mitsubishi Shoji Co. began developing the Cheang Phra tin mines in Nazan, Thailand, near the Malayan border. The first postwar shipment of concentrate, containing 85 tons of tin, arrived in Japan for treatment from Thailand in 1955, and more is expected in future. During the period 1953–55, annual demand for primary tin in Japan averaged about 7,300 long tons, of which 11 percent was supplied from its own mines and the remainder imported, mainly from Malaya and Indonesia. Tin consumption increased from 7,500 long tons in 1954 to 8,000 in 1955. Japan signed the International Tin Agreement in June 1954 but has not yet ratified it.

TABLE 25.—Mine and smelter production, imports, and consumption of tin in Japan, 1950–55, in long tons of contained tin [1]

Year	Mine output	Smelter output [2]	Imports	Consumption
1950	326	389	599	3, 238
1951	433	575	2, 079	4, 067
1952	639	689	1, 744	4, 591
1953	737	844	4, 970	6, 350
1954	715	872	5, 046	7, 480
1955	897	1, 018	5, 712	7, 963

[1] Ministry of International Trade and Industry, Japanese Mining Industry, 1955, p. 77.
[2] From native ore plus small quantity from scrap and dross.

[38] International Tin Study Group, Statistical Bulletin: June 1956, pp. 5, 26.

Malaya.—During 1955 precautions still were necessary in Malaya for the security of staff and mines. Although defenses had to be maintained, the security position in Malaya continued to improve.

Production of tin-in-concentrate in Malaya was 61,244 long tons and represented an increase of 1 percent from the previous year.

In 1955 about 90 percent of the total Malayan production of tin was obtained by dredging (51 percent) and gravel pumping (39 percent). The percentages from other methods of mining were hydraulicking, 2 percent; open-cast mining, 2 percent; underground mining, 4 percent; dulang washing and others, 2 percent. About 39,560 mine workers were employed.

The total number of mines in operation, totaling 740 at the end of June, increased to 762 at the end of September and finally increased to 781 at the end of the year. During this same period the number of dredges in operation decreased from 79 at the beginning of the year to 76 on December 31. Mines using gravel pumps increased from 567 at the beginning of the year to 634 at the year end.

At the annual meeting of the London Tin Corp., Ltd., October 1955, the chairman made the following statements regarding the corporation's operations in Malaya:[39]

> * * * The output of tin concentrates during the year from the mines under the management of Anglo-Oriental (Malaya), Ltd., was 17,595 tons, as compared with 15,916 tons during the previous year. Three dredges started operating after having been transferred to new areas and two were closed down, having exhausted their ore reserves.
>
> * * * It was possible to undertake some prospecting during the year but certain areas are still difficult on account of security and for other reasons. It remains of first importance to find and prove fresh ore reserves to take the place of those now being mined and this need is receiving constant attention.

Operations of another large-scale tin producer were the subject of a recent report. It stated:[40]

> * * * Primarily, Tronoh Mines is a large scale tin producer operating in Malaya, but it also has considerable indirect interests in the Malayan tin mining industry. In the balance sheet as at December 31, 1954, quoted investments were carried at a book figure of £907,245, and the market value was £1,151,216. It also held unquoted investments with a book value of £44,175. Among these interests are big holdings in three of the group's important producers, Ayer Hitam Tin Dredging, Sungei Besi Mines and Sungei Way Dredging. It holds a stake in Harrietville (Tronoh), which has now closed down owing to high costs in the Australian gold industry, and has sold its dredge to Ayer Hitam for use in tin recovery. Tronoh operates a wholly owned subsidiary, Tin Lay, in Siam, and it possesses shares in the companies Tromal Prospecting and Aokam Tin.

In 1955 the smelting of tin in Malaya was carried on at two large smelters: Eastern Smelting Co., Ltd., Penang; and Straits Trading Co., Ltd., Singapore, which initiated operations at its new smelter at Butterworth, Penang. Usually, a small quantity of concentrate is smelted by a Chinese smelter for local consumption. The total smelter production in Malaya was 70,631 long tons during 1955. This represented a decrease of 535 tons (1 percent) from the previous year. The Malayan smelting industry supplied 39 percent of world production in 1955. The tin content of concentrate available from Malaya was 61,244 tons compared with 60,690 tons in 1954. Imports contained 11,032 tons of tin-in-concentrate compared with 9,809 tons in 1954. Concentrate exported in 1955 containing 36

[39] Mining Magazine (London), London Tin Corp., Ltd.: Vol. 43, No. 5, November 1955, p. 53.
[40] Mining Journal (London), Annual Review: May 1956, pp. 308–309.

TABLE 26.—Summary of output, profit and taxation—Tronoh-Malayan Tin Group

Name of company	Period ending	Ground treated (thousand cubic yards)	Tin ore recovery (long tons)	Income			Expenditure		Profit before Tax	Government tin royalty	Taxation	Dividends
				Ore sales and stock (less Government tin royalty)	Tribute sundry mine revenue	Interest, dividends, etc.	Mining costs	Head office and other expenses				
Malayan Tin Dredging, Ltd.	June 30, 1955	8,243	1,584	£690,762	£13,141	£68,981	£339,881	£132,150	£300,853	£126,090	£193,728	£135,000
	June 30, 1954	8,068	1,884	739,344	23,732	78,982	286,392	159,323	396,343	133,633	228,073	132,000
Southern Malayan Tin Dredging, Ltd.	June 30, 1955	15,741	3,037	1,302,496	13,766	45,195	540,311	48,648	772,498	235,127	455,024	266,228
	June 30, 1954	15,329	[1] 3,030	1,176,203	13,864	41,480	509,081	43,174	671,592	212,550	377,448	190,300
Tronoh Mines, Ltd.	Dec. 31, 1954	8,330	2,595	1,120,120	42,835	73,868	442,222	62,737	731,864	204,078	405,674	216,375
	Dec. 31, 1953	7,691	1,982	854,493	58,554	98,239	468,456	61,085	481,745	155,181	251,649	130,500
Southern Tronoh Tin Dredging, Ltd.	Dec. 31, 1954	3,413	1,167	500,979	2,830	12,429	178,292	30,314	307,632	92,432	141,761	33,000
	Dec. 21, 1953	1,505	190	81,356	4,310	17,726	212,365	13,078	−122,051	15,473	8,115	Nil
Ayer Hitam Tin Dredging, Ltd.	June 30, 1955	2,176	1,413	625,080	2,769	23,507	145,422	57,444	448,517	112,425	227,259	101,250
	June 30, 1954	1,796	1,250	505,817	773	22,424	160,791	48,882	319,341	91,527	180,623	99,000
Sungei Besi Mines, Ltd.	Mar. 31, 1955	2,284	1,210	528,344	3,128	5,530	326,260	27,691	183,051	47,190	99,027	36,385
	Mar. 31, 1954	2,408	1,176	465,009	2,224	9,410	315,930	26,290	134,423	86,019	55,428	35,976
Sungei Way Dredging, Ltd.	June 30, 1955	6,958	1,566	687,325	6,623	6,896	391,190	114,905	194,750	(3)	42,999	84,070
	June 30, 1954	5,387	1,226	488,667	7,771	6,011	[2] 380,473	18,128	103,849	(3)	6,770	28,023

[1] Includes recovery from dumps and tribute.
[2] Includes tribute payment of £34,822 in year June 30, 1954, and £58,815 in year to June 30, 1955.
[3] Not available.

tons of tin (148 tons in 1954) was shipped largely to the United Kingdom. Table 27 shows imports of tin-in-concentrate into Malaya during 1955.

In 1955 the exports of tin metal totaled 71,161 tons compared with 70,280 tons in 1954. Table 28 shows exports of tin metal from Malaya during 1955.

Stocks of tin metal at the end of 1955 totaled 2,200 long tons compared with 2,800 tons at the beginning of the year; stocks of tin-in-concentrate increased from 4,500 tons at the beginning to 4,700 at the end.

TABLE 27.—Imports of tin-in-concentrate into Malaya in 1955

Country of origin:	*Long tons*
Burma	974
Indochina	36
Thailand	9, 938
Other countries	84
Total	11, 032

TABLE 28.—Malayan exports of tin metal, 1955

Destination:	*Long tons*
United States	43, 454
Japan	4, 324
Republic of India	3, 658
United Kingdom	2, 994
France, including Corsica	2, 667
Netherlands	2, 571
Italy, including Sardinia	2, 423
Argentina	2, 143
Canada	1, 355
Germany, West	552
Other countries in South America	509
Iran	304
All other countries	4, 207
Total	71, 161

The report of a mission [41] organized by the International Bank for Reconstruction and Development at the request of the Governments of the Federation of Malaya, the Crown Colony of Singapore, and the United Kingdom included the following paragraph:

> Expansion of tin production cannot be looked to as an important element in the future development of Malaya. On the contrary, the immediate problem is a threat of actual decline, arising from the economic circumstances facing the industry—its market prospects, and its exceptional tax burden—and from the difficulty of finding and acquiring suitable tin-bearing lands to replace worked-out mines.

Nigeria.—In 1955 Nigeria was the sixth ranking producer of tin concentrate in the Free World. 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 worked were alluvial or eluvial and were mined by placer methods. Lode deposits occur. Production of tin-in-concentrate in Nigeria totaled 8,158 long tons in 1955, a 3-percent increase from the previous year. Most of the world supply of columbium was produced

[41] International Bank for Reconstruction and Development, The Economic Development of Malaya: Johns Hopkins Press, Baltimore, Md., 1955, p. 94.

as a byproduct of tin mining in Nigeria. All of the tin concentrate was smelted in the United Kingdom.

A recent publication stated:[42]

* * * In general, the costs of the main forms of mining in Nigeria, measured in costs per cubic yard of ground worked, have shown in recent years a remarkably close similarity. The cost per cubic yard of gravel pumping, open cast paddocks and tributing during 1951–54 lay within the extremes of 18 to 22.4 pence. On the other hand, the costs of ground sluicing and heavy loaders and dumpers have lain within the 10 to 15 pence range; the cost of dredging has always been well under 10 pence.

Another publication reported:[43]

The accounts of the Amalgamated Tin Mines of Nigeria for the year ended March 31, 1955 show a profit of £502,069 after taxation, making with the sum brought in an available total of £769,271 of which dividends equal to 45 percent require £494,812. In the year ending March 31 last, the company produced 4,094 tons of tin concentrates and 615 tons of columbite concentrates. The company's ore reserves at March 31 last are estimated at 126,844,948 cu. yards of ground averaging 0.778 lb. of cassiterite per cu. yard.

The Mining Journal (London) commented on the Nigerian costs of producing tin as follows:[44]

* * * Plant modernization, coupled with careful and successful working, enabled tin producers generally to maintain satisfactory margins of profit during 1955 and arrest the gradual decline of production which, in the absence of further discoveries, appears to be inevitable as existing resources become progressively depleted. Production costs continue to rise, higher wages for African workers accounting for as much as £23 a ton before the latest increases came into effect. On the other hand, the average price received for Nigerian concentrates was substantially higher last year, due to the enhanced price of tin metal.

A new development in Nigerian-tin mining methods was reported:[45]

During 1955 there was only one new development in the method of tin mining introduced in Nigeria. This was an invention of a Swiss engineer and consists of steel casings which are sunk down to bedrock. Water jets are forced through the casings and tin bearing wash is evacuated on a radius of about 30 feet around the casing and raised to the concentrating plants on the surface. This invention is one feasible way of tapping the reserves that are known to lie below flows of basalt intrusions. Attempts are also being made to sink vertical shafts into the bedrock, drain the surrounding tin bearing area, and strengthen the rock sufficiently to mine the tin by ordinary means.

Rhodesia and Nyasaland, Federation of.—Mine production of tin in Southern Rhodesia was 208 long tons in 1955, the highest since 1943. The principal mining company was the Kamativi Tin Mines, Ltd. (a subsidiary of N. V. Billiton Maatscaappij), which began production of tin concentrate and completed and brought a smelter into operation. The total tonnage milled was 108,690 long tons, yielding 260 long tons of 70 percent SnO_2 concentrate. The smelter production was as follows: 113 tons of tin in ingot, 86 tons of solder, and 4 tons of white metal. Approximately 3 tons of 68.4 percent tin and 48 tons of slag containing 36.5 percent tin were shipped to the Netherlands.

South-West Africa.—Mine production in South-West Africa totaled about 380 long tons in 1955 compared with 450 tons in 1954.

[42] International Tin Study Group, Tin 1954—A Review of the World Tin Industry: September 1955, p. 45.
[43] Mining Magazine (London), vol. 43, No. 4, October 1955, p. 198.
[44] Work cited in footnote 40, p. 179.
[45] U. S. Embassy, Lagos, Nigeria, State Department Dispatch 125: Apr. 20, 1956, p. 1d.

The entire output in 1955 was by the Uis Tin Mines, Ltd., in which Frobisher, Ltd., Canada, has a substantial interest.

An article commented on mine operations in South-West Africa in 1955:[46]

> The future of the Uis Tin Mine is very much hanging in the balance judging by the latest report of the judicial manager. So far the grade of ore treated is well below the figure estimated when the undertaking was originally started. It was stated in the prospectus that it was expected that 0.28% metallic tin would be obtained, but actual results so far have yielded slightly less than 0.1%.
>
> The report goes on to say that in view of the low extraction rate obtained, representative samples of ore were despatched to independent metallurgical organizations in Europe and Canada with instructions that they should report to the judicial manager direct upon the results of their assays. In each case the assays reported substantially confirmed the actual results. * * *

A State Department dispatch reported:[47]

> Tin-wolfram concentrate production by the South West Africa Company at its operations near "the Brandberg", northeast of Swakopmund, was 448 short tons as compared with 322 tons in 1954. Development of the quartz vein deposits in this area has been excellent and production rate is expected to be sustained for some time.

Thailand.—Production of tin-in-concentrate in Thailand totaled 11,000 long tons in 1955, a 13-percent increase from 1954.

In 1955 exports had an approximate value of 466 million baht,[48] an increase in value of 25 percent above the previous year.

TABLE 29.—Exports of tin concentrate from Thailand, in long tons [1]

Destination:	*1955*
Malaya	11,042
United States	3,352
Brazil	796
South America (except Brazil)	24
Japan	118
Total	15,332

[1] Metal content of Thailand tin concentrate is 72-74 percent tin.

A dispatch reported as follows Thailand exports and Government regulations in 1955:[49]

> * * * Most of Thailand's tin exports go to Malayan smelters but in 1955 the Federal Facilities Corporation purchased about 20 percent of Thailand's tin ore production under U. S.-Thailand Tin Purchase Agreements, compared to 17 percent in 1954. In March 1955 the Tin Purchase Agreement between Thailand and the United States expired, but a new agreement providing for the purchase of 600 to 800 tons in concentrates was signed in September; and another agreement was negotiated in early November for the purchase of 1,250 tons by March 31, 1956.
>
> On October 10, 1955 the government ended the surrender requirement for the purchase of exchange derived from tin exports and simultaneously raised the tin export duty. This resulted in a very small increase in disposable revenue to tin producers and acted to free exports from administrative red tape, as had been done earlier for rubber exporters.

United Kingdom.—Mine production in the United Kingdom (Cornwall and Devon) totaled about 1,000 long tons in 1955 compared with 900 tons in 1954. United Kingdom smelter production of tin was the

[46] South African Mining and Engineering Journal, vol. 66, No. 3252, June 11, 1955, p. 609.
[47] U. S. Embassy, Johannesburg, Union of South Africa, State Department Dispatch 275: June 7, 1956, p. 10.
[48] Nominal exchange rate, 20.80=US$1.00.
[49] U. S. Embassy, Bangkok, Thailand, State Department Dispatch 547: Apr. 10, 1956, p. 4.

second largest in the world in 1955. The output of refined tin was about 27,000 tons, a decline of 500 tons from the previous year. Year-end stock of tin-in-concentrate was 2,200 tons (a decrease of about 300 tons from the beginning of the year) and of metal 3,000 tons (4,300 at the beginning). The total stock of tin in the United Kingdom, including tin metal and concentrate afloat and visible consumers' stocks, was 6,800 tons at the end of 1955, a 19-percent decrease from 8,400 tons at the beginning of the year. Exports of tin metal from the United Kingdom in 1955 were about 8,500 tons, compared with 8,100 in the previous year.

Tin consumption in the United Kingdom in 1955 increased 1,000 long tons from the previous year. Table 30 presents tin consumption in the United Kingdom by uses in 1952–55.

TABLE 30.—United Kingdom, tin consumption, 1952–55, excluding tin scrap, long tons [1]

Use	1952	1953	1954	1955
Tinplate	11,491	8,911	9,896	9,847
Tinning:				
Copper wire	506	405	596	527
Steel wire	108	78	113	112
Other	787	796	856	802
Total	1,401	1,279	1,565	1,441
Solder	1,849	1,651	2,130	2,428
Alloys:				
White metal	3,457	2,901	2,671	3,741
Bronze and gunmetal	2,601	2,001	2,568	2,508
Other	405	373	452	445
Total	6,463	5,275	5,691	6.694
Wrought tin: [2]				
Foil and sheets	299	255	326	338
Collapsible tubes	243	306	384	422
Pipes, wire and capsules	63	71	64	50
Total	605	632	774	810
Chemicals [3]	632	766	959	1,033
Other uses [4]	113	120	148	137
Grand total	22,554	18,634	21,163	22,390

[1] British Bureau of Non-Ferrous Metal Statistics, Bulletin-Statistics for January 1956: Vol. 9, No. 1, p. 5
[2] Includes compo and "B" Metal.
[3] Mainly tin oxide.
[4] Mainly powder.

Titanium

By Jesse A. Miller[1]

DUE TO increased quality, reduction in prices, and record high production, titanium metal gained wider acceptance as a structural material in 1955. Increased demand for titanium in nonmetal uses resulted in record-high domestic production of ilmenite and titanium pigments. Domestic rutile production was slightly below the peak established in 1947. The United States continued to be the world's largest consumer of ilmenite and rutile, exceeding all the previous highs established in former years.

The supply of titanium-sponge metal temporarily exceeded demand during 1955; therefore, Government assistance for the creation of additional sponge facilities was suspended. During the later part of the year supply and demand for titanium sponge were again in balance. Most titanium metal produced continued to find its biggest market in military airframes and engines, although the civilian

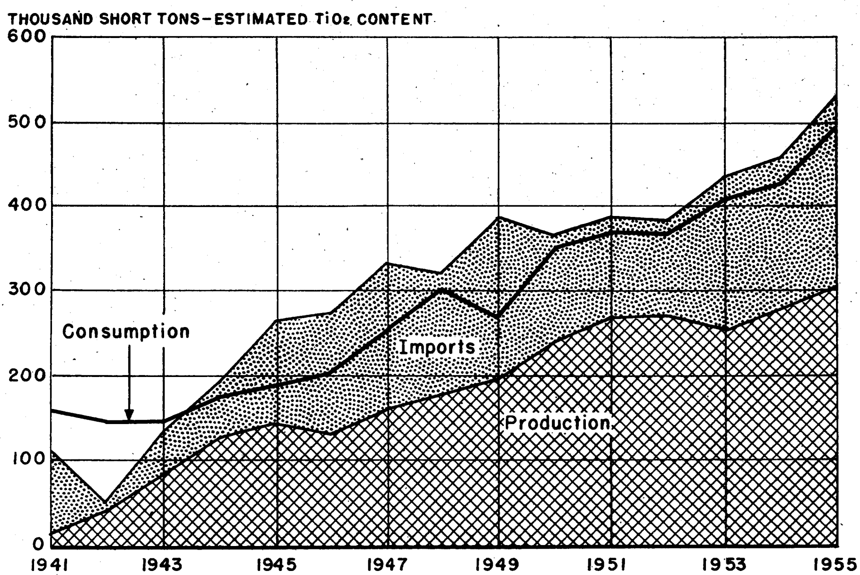

FIGURE 1.—Domestic production, imports, and consumption of ilmenite (including titanium slag and a mixed product), 1941–55.

[1] Commodity specialist.

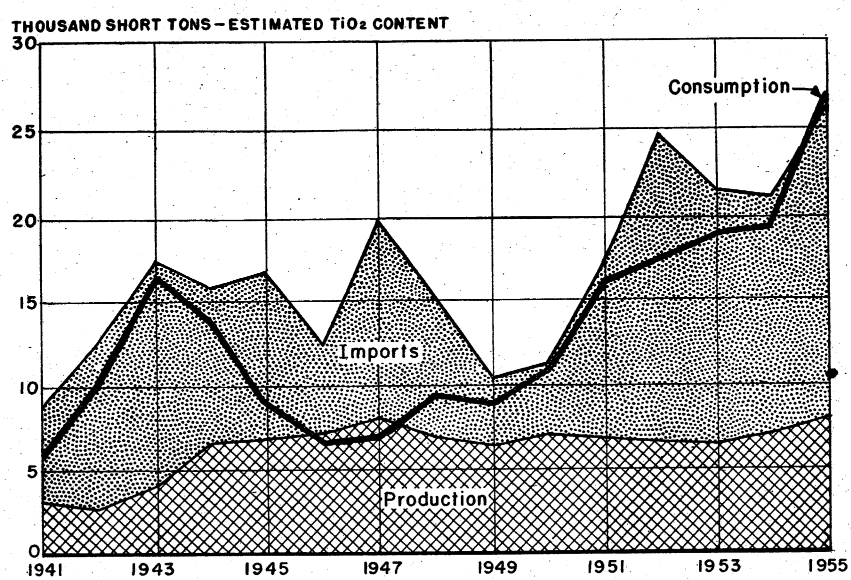

FIGURE 2.—Domestic production, imports, and consumption of rutile, 1941–55.

industry began to realize the value of titanium in certain applications as the results of use tests of prototype equipment were made public.

The price of titanium sponge metal decreased 23 percent, and mill-product base prices decreased as much as 12 percent. Because of a worldwide shortage of rutile, spot prices for these concentrates doubled, while ilmenite prices remained relatively constant in 1955.

Production of ilmenite and rutile increased on a worldwide basis with the United States the leading ilmenite producer and Australia the leading rutile producer. Titanium-slag production in Canada, the sole North American producer, was greater than ever before as demand from the United States for this material remained unsatisfied.

The first titanium-sponge-metal plant to use the sodium-reduction process began operations in the United Kingdom in the middle of the year. Of the three countries producing titanium sponge metal on a commercial basis in 1955, the United States continued to be the largest, followed by Japan and the United Kingdom.

Many of the technological problems besetting the titanium-metal industry were solved during the year. Chief of these was recognition of the role of hydrogen in the delayed cracking of titanium parts. Methods were suggested for welding, casting, extruding, and fabricating titanium in general, and a large quantity of technical literature became available to the public.

GOVERNMENT REGULATIONS

On August 11, 1955, the Office of Defense Mobilization suspended the expansion goals on rutile, titanium-sponge facilities, titanium-melting facilities, and titanium-processing facilities (Defense Mobilization Order VII–6, Supplement 1). ODM closed the goal on titanium-sponge facilities on September 29, 1955, and reopened the goals on rutile, titanium-melting facilities, and titanium-processing facilities (Defense Mobilization Order VII–6, Supplement 3). The rutile goal was increased 10,000 tons to 35,000 tons to be achieved by December 31, 1955. The goals on melting and processing facilities were reopened at 37,500 tons each, the same as those set originally in 1954. The last titanium-sponge-metal goal had been established at 25,000 tons in August 1953.

Government assistance for the creation of additional titanium-sponge capacity was suspended by the ODM (ODM Press Release 428) September 12, 1955. This program was independent of titanium-expansion goals and included such incentives as Government purchase of certain quantities of sponge in excess of demand and loans to finance building of plants. Contracts signed by the Government under the past titanium-metal expansion program called for an annual titanium output of 21,600 short tons in 1957. Operations under these contracts were to continue. This action was taken after review of a report submitted to ODM by Harold S. Vance, special consultant, ODM. It was recommended by Vance and the Defense Mobilization Board that General Services Administration (GSA) should include Brinell-hardness specifications, which will achieve higher quality and greater uniformity of titanium sponge in case of future purchase contracts, and hold purchases of titanium sponge to a minimum consistent with continuing development of a better product and with maintenance of production facilities. It was also recommended that the Department of Defense should make every effort to expand the use of titanium in military equipment on a production basis, despite its present high cost. The last recommendation would permit rapid advances in fabrication technology and lead to probable reduction in cost.

DOMESTIC PRODUCTION

Concentrates.—Domestic ilmenite production and shipments in 1955 set record highs of 583,000 and 573,000 short tons, respectively, exceeding the previous highs established in 1954. The titanium dioxide content of ilmenite shipments ranged from 45 to 66 percent in 1955. Ilmenite included a quantity of mixed product, containing altered ilmenite, leucoxene, and rutile. The mixed product was used in manufacturing titanium pigments and metal. Ilmenite was produced in 1955 by the American Cyanamid Co., Piney River, Va.; Baumhoff-Marshall Inc., Boise, Idaho; E. I. du Pont de Nemours & Co., Inc.; Starke and Lawtey, Fla.; Florida Ore Processing Co., Melbourne, Fla.; the Hobart Bros. Co., Winter Beach, Fla.; Idaho-Canadian Dredging Corp., Cascade, Idaho; National Lead Co., Tahawus, N. Y.; Rutile Mining Co. of Florida, Jacksonville, Fla.; and Titanium Alloy Manufacturing Division of the National Lead Co., Jacksonville, Fla.

Rutile production in the United States in 1955 was 8,513 short tons, an increase of about 1,100 tons from 1954 and slightly lower than the high record of 8,562 tons set in 1947. Shipments of rutile concentrate were 9,182 tons in 1955, an increase of 1,900 tons from 1954. Rutile was produced in 1955 by the Florida Ore Processing Co., Melbourne, Fla.; Hobart Bros. Co., Winter Beach, Fla.; Marine Minerals, Inc., Aiken, S. C.; Rutile Mining Co. of Florida, Jacksonville, Fla.; and Titanium Alloy Manufacturing Division of the National Lead Co., Jacksonville, Fla.

TABLE 1.—Production and mine shipments of titanium concentrates from domestic ores in the United States, 1946–50 (average) and 1951–55, in short tons

	Production (gross weight)	Shipments		
		Gross weight	TiO_2 content	Value
ILMENITE [1]				
1946–50 (average)	375,672	369,372	177,396	$5,530,506
1951	535,835	510,840	261,982	7,689,272
1952	528,588	522,515	265,596	8,022,752
1953	513,696	512,176	258,247	7,222,641
1954	547,711	531,895	270,651	7,375,344
1955	583,044	573,192	297,835	10,267,647
RUTILE				
1946–50 (average)	7,588	6,967	6,498	578,510
1951	7,189	10,919	10,166	545,000
1952	7,125	6,874	6,416	715,491
1953	6,825	6,476	6,043	702,791
1954	7,411	7,305	6,822	869,677
1955	8,513	9,182	8,617	1,122,000

[1] Includes a mixed product containing altered ilmenite, rutile, and leucoxene for 1949–55, inclusive.

On September 30 the National Lead Co. announced that it had supplemented its titanium-ore reserves by discovery of a large titanium deposit within 1½ miles of its Tahawus, N. Y., mine and by the purchase of 6,800 acres of land containing ilmenite sand at Trail Ridge, Fla.[2] Reportedly, ore reserves of 50 million tons have been proved to date at the New York deposit, and indications are that the deposit contains over 100 million tons of ore. The Florida reserves are expected to yield 5 million tons of ilmenite in 270 million tons of sands available for economic processing.

It was made public in September that E. I. du Pont de Nemours & Co., Inc., had leased 11,000 acres of land near Camp Blanding, Fla., thus increasing its holdings near its Highland mine to 18,000 acres. Royalty payments were reportedly 65 cents per gross ton of mineral produced to be split between the Federal and State Governments.[3]

Dredging operations conducted by Baumhoff-Marshall, Inc., and Idaho-Canadian Dredging Co. in the Cascade area, Valley County, Idaho, ceased in August 1955, reportedly because of a drop in monazite prices. The two companies recovered ilmenite as a byproduct from monazite operations.

Metal.—Domestic commercial production of titanium sponge metal established a record high of 7,400 short tons in 1955, a 38-percent increase above the previous record set in 1954. Sponge was made at commercial operations of E. I. du Pont de Nemours & Co., Inc., Newport, Del.; Titanium Metals Corporation of America, Henderson,

[2] Wall Street Journal, National Lead Lists 3 New Titanium Finds: Vol. 146, No. 65, Oct. 3, 1955, p. 4.
[3] Mining World, Du Pont Acquires More Florida Acreage to Substantially Increase Ilmenite Holdings: Vol. 17, No. 10, September 1955, p. 105.

Nev.; Dow Chemical Co., Midland, Mich.; and Cramet Inc., Chattanooga, Tenn. It was also produced as a byproduct of research by the Bureau of Mines Electrometallurgical Experiment Station at Boulder City, Nev. Du Pont and TMCA were the major manufacturers. All commercial sponge produced in 1955 was made by magnesium reduction of titanium tetrachloride under an inert atmosphere.

TABLE 2.—Salient statistics of the titanium-metal industry, in short tons, 1948–55

Year	Sponge production [1]	Sponge in revolving-fund stockpile Dec. 31	Mill-shape production	Year	Sponge production [1]	Sponge in revolving-fund stockpile Dec. 31	Mill-shape production
1948	[2] 10		(3)	1952	1,075	303	[2] 250
1949	[2] 25		(3)	1953	2,241	30	[4] 1,114
1950	[2] 75		(3)	1954	5,370	2,894	[4] 1,299
1951	495		[2] 75	1955	7,398	6,647	1,898

[1] Unconsolidated commercially pure metal in various forms.
[2] Estimate.
[3] Data not available.
[4] Shipments.

Titanium sponge purchased by the Government during the year, under a General Services Administration purchase and resale program, totaled 3,753 short tons, thus increasing the total in the revolving-fund stockpile to 6,647 tons. Government agreements with E. I. du Pont de Nemours & Co., Inc., Wilmington, Del., and Titanium Metals Corporation of America, New York, N. Y., to purchase titanium sponge under this program terminated September 30, 1955.

The Bureau of Mines entered into a cooperative agreement with the Wah Chang Corp., Glen Cove, N. Y., on May 5, 1955, that called for the Bureau to conduct research and development on an improved process for the production of titanium-sponge metal. A part of the Bureau titanium pilot plant at Boulder City, Nev., was reactivated for the project, which was to terminate May 1956 or sooner if the work was completed.

GSA entered into a cooperative agreement (Contract DMP–116) with the Bureau of Mines on September 30, 1955, that provided for a 2-year program of research and development by the Bureau for the purpose of developing an economical process for production of titanium tetrachloride from domestic ilemite and titaniferous magnetite. Under the program, smelting studies to produce titanium slag were to be conducted at the Bureau's Northwest Electrodevelopment Experiment Station at Albany, Oreg., and research on the subsequent chlorination of the titanium slag was to be done at the Boulder City, Nev., laboratory.

The Defense Department awarded Battelle Memorial Institute, Columbus, Ohio, in March 1955, a $1 million contract to establish a titanium metallurgical laboratory.[4] Initially, the titanium laboratory was to concentrate on gathering and disseminating information and providing technical advice to industry on the production and application of titanium for military equipment. The contract provided for

[4] Wall Street Journal, Battelle Gets U. S. Contract for Research on Titanium: Vol. 145, No. 51, Mar. 15, 1955, p. 15.

operation of the laboratory for 18 to 24 months from the effective date of the agreement.

Experiments with a new process for producing titanium metal and a new method of obtaining titanium from impure scrap were conducted under two contracts signed by GSA in 1955.

One agreement (Contract DMP-113, dated May 17, 1955) was with National Research Corp. and Monsanto Chemical Co. Under it, National Research Corp. was to test a new fused-salt process for producing titanium at Cambridge, Mass., as previous work had reached the point where larger scale operations were necessary for complete evaluation of the new process. A pilot plant having a rated capacity of 1,000 pounds per day was to be operated. The work was estimated to cost about $1,183,500. The Government was to reimburse the firms, but they were to receive no fee for the work. The Government was to get nonexclusive, royalty-free licenses on the inventions and patents that might be developed. The contract contained provisions for repaying the Government's investment, should the process prove to be feasible and commercial production result within 10 years.

The second agreement (Contract DMP-114, dated April 29, 1955) was with Horizons, Inc., of Cleveland, Ohio. The company was to regenerate titanium from impure scrap metal by its patented process. Horizons, Inc., also was to work without fee. Cost of the experimental operations was estimated at $96,500, to be paid by the Government. However, should the work prove successful and the process be put into commercial production within 10 years, the Government was to be reimbursed for its investment and was to receive nonexclusive, royalty-free licenses on inventions and patents that might be developed.

The construction of a multimillion-dollar titanium tetrachloride plant at Natrium, W. Va., was announced by Columbia-Southern Chemical Corp., Pittsburgh, Pa., on April 14, 1955.[5] Initial output of titanium tetrachloride, the basic material consumed in manufacturing titanium metal, was scheduled for April 1956. A 5-year contract to supply titanium tetrachloride to Electro Metallurgical Co., Division of Union Carbide & Carbon Corp., at Ashtabula, Ohio, was announced by Columbia-Southern in May 1955.

Over half of the sponge produced domestically, plus a quantity of scrap, was melted to make 4,573 short tons of ingots. Of this quantity, 4,442 short tons of ingot was consumed to produce 1,898 short tons of mill products, including sheet, plate, strip, forging and extrusion billet, rod, bar, wire, and tubing. Mill products were produced by plants of the following companies: Harvey Machine Co., Torrance, Calif.; Mallory-Sharon Titanium Corp., Niles, Ohio; Rem-Cru Titanium, Inc., Midland, Pa.; Republic Steel Corp., Massillon and Canton, Ohio; and Titanium Metals Corporation of America, New York, N. Y.

In June Mallory-Sharon Titanium Corp. completed a new melting

[5] American Metal Market, Columbia-Southern To Build Large Titanium Tetrachloride Plant: Vol. 62, No. 73 Apr., 15, 1955, pp. 1, 3.

plant to triple its melting capacity.[6] Four new double melting furnaces increased the melting capacity to 1,500 short tons per year. This same company purchased the Niles Rolling-Mill Division of Sharon Steel in December, to integrate its melting and rolling facilities.[7]

Rem-Cru Titanium, Inc., announced in September the purchase of a group of 5 buildings and 10 acres of land from the Crucible Steel Company of America, Midland, Pa., to expand its titanium-processing facilities.

Titanium Pigments.—Based on titanium dioxide content domestic production and shipments of titanium pigments in 1955 increased 14 and 22 percent, respectively, above the record established in 1954. Titanium pigments were produced by the American Cyanamid Co., Pigments Division, at Gloucester City, N. J., Savannah, Ga., and Piney River, Va.; Glidden Co., Chemicals-Pigments-Metals Division, at Baltimore, Md.; E. I. du Pont de Nemours & Co., Inc., at Edge Moor, Del., and Baltimore, Md.; and the National Lead Co., at St. Louis, Mo., and Sayreville, N. J.

E. I. du Pont de Nemours & Co., Inc., was the only pigment manufacturer to announce expansion plans during the year. It planned to expand production of titanium dioxide 25 percent at its Edge Moor, Del., plant by late 1956.[8]

Welding-Rod Coatings.—Production of titanium-coated welding rods was 233,353 short tons in 1955, an increase of 27 percent over 1954 production. Of this quantity, 46 percent was coated with natural rutile, 15 percent with manufactured titanium dioxide, 11 percent with a mixture of rutile and manufactured dioxide, and 28 percent with ilmenite. A small quantity of titanium slag was also used in some coatings.

CONSUMPTION AND USES

Concentrates.—Consumption of all three titanium raw materials—ilmenite, titanium-slag, and rutile—reached new peaks in 1955. Almost 99 percent of the 741,450 short tons of ilmenite consumed was used in producing manufactured titanium dioxide. This quantity included some ilmenite, in the form of a "mixed product," which was used to make titanium metal. Virtually all of the 134,953 tons of titanium slag was consumed for pigments and substituted for ilmenite in this use. Of the 28,762 tons of rutile consumed, 36 percent was used for titanium metal and 44 percent for welding-rod coatings; the remainder went into alloys and carbide, ceramics, and miscellaneous uses.

---

[6] Light Metal Age, Mallory-Sharon Triples Titanium-Melting Capacity: Vol. 13, Nos. 6 and 7, June 1955, p. 31.
[7] Iron Age, Mallory-Sharon Integrates Melting, Rolling Facilities: Vol. 176, No. 26, December 1955, p. 30.
[8] Oil Paint and Drug Reporter, Titanium Dioxide Pigments Output Boost Set by Du Pont: Vol. 167, No. 10, Mar. 7, 1955, p. 4.

TABLE 3.—Consumption of titanium concentrates in the United States, 1946–50 (average) 1951–53 total, and 1954–55, by products, in short tons

Product	Ilmenite [1]		Titanium slag		Rutile	
	Gross weight	TiO_2 content	Gross weight	TiO_2 content	Gross weight	TiO_2 content
1946–50 (average)	528,177	275,099			[1] 9,288	[1] 8,618
1951	713,363	273,037			17,227	16,018
1952	682,850	351,553	24,236	16,746	18,317	17,353
1953	687,075	354,470	73,528	52,511	20,170	19,033
1954						
Pigments (mfg. TiO_2) [2]	[3] 673,506	[3] 349,857	100,670	70,993		
Welding-rod coatings	845	501			8,817	8,169
Alloys and carbide	5,535	2,779			[3] 2,069	[3] 1,987
Ceramics	9	5			372	348
Miscellaneous	8	4	[4] 155	[4] 109	[3 5] 9,405	[3 5] 8,927
Total	[3] 679,903	[3] 353,146	100,825	71,102	20,663	19,431
1955						
Pigments (mfg. TiO_2) [2]	732,519	396,569	134,362	94,108		
Titanium metal [6]	(7)	(7)			10,337	9,821
Welding-rod coatings	1,188	689			12,614	11,848
Alloys and carbide	7,291	3,617			2,431	2,306
Ceramics	21	13			452	423
Miscellaneous	431	258	[4] 591	[4] 414	[8] 2,928	[8] 2,794
Total	741,450	401,146	134,953	94,522	28,762	27,192

[1] Includes a mixed product containing rutile, leucoxene, and altered ilmenite used to make pigments and metal.
[2] "Pigments" include all manufactured titanium dioxide.
[3] Revised figure.
[4] Includes consumption for welding-rod coatings and research purposes.
[5] Includes consumption for chemicals, metal, fiberglass, and welding flux.
[6] Not separately classified before 1955.
[7] Included with pigments to prevent disclosing individual company confidential data.
[8] Includes consumption for chemicals, fiberglass, and welding flux.

TABLE 4.—Distribution of titanium-pigment shipments, by industries, 1946–50 (average) and 1951–55, percent of total

Industry	1946–50 (average)	1951	1952	1953	1954	1955
Distribution by gross weight:						
Paints, varnishes, and lacquers	77.1	73.3	70.9	67.1	64.3	65.3
Paper	6.0	5.9	7.0	9.7	10.1	10.1
Floor coverings (linoleum and felt base)	3.9	4.4	5.0	4.8	4.5	4.6
Rubber	2.6	2.5	2.8	3.4	3.1	3.4
Coated fabrics and textiles (oilcloth, shadecloth, artificial leather, etc.)	1.8	1.5	2.1	2.0	2.4	2.7
Printing ink	.9	1.3	1.0	1.2	1.2	1.3
Other	7.7	11.1	11.2	11.8	14.4	12.6
Total	100.0	100.0	100.0	100.0	100.0	100.0
Distribution by titanium dioxide content:						
Paints, varnishes, and lacquers	70.1	64.9	62.9	58.8	55.4	58.4
Paper	8.5	8.9	10.4	14.1	14.1	13.5
Floor coverings (linoleum and felt base)	4.9	5.7	5.6	5.4	5.2	5.2
Rubber	3.5	3.4	3.6	4.5	4.0	4.4
Coated fabrics and textiles (oilcloth, shadecloth, artificial leather, etc.)	2.3	2.1	2.9	2.6	3.2	3.4
Printing ink	1.4	1.8	1.6	1.6	1.6	1.7
Other	9.3	13.2	13.0	13.0	16.5	13.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

Metal.—Most titanium mill shapes produced in 1955 went into defense applications, especially military aircraft and engines.

The advantages to be gained by using titanium in aircraft and jet engines were emphasized in an article.[9] According to the article, the use of titanium in production of jet-engine designs resulted in savings of 250 pounds of weight in certain engines, and the use of titanium in production airframe design achieved weight savings of more than 300 pounds in fighters and up to 600 pounds in bombers. These reductions were due to direct substitution of titanium for stainless steel, and further weight savings were possible if the plane or engine were redesigned to use titanium.

It was disclosed that five major assemblies of the Air Force's F–101A Voodoo were made of titanium, including the forward fuselage panel, keel assembly, fairing assembly, floor assembly, and the engine-mount trunnions.[10] Titanium was utilized where heat or abrasion previously had required the use of stainless steel.

A new type of titanium shroud was developed for the Air Force's F–102A supersonic interceptor. The new shroud, used to insulate the plane's J–57 engine from the surrounding fuselage, was made of "rigidized" metal, which consists of ridges and dimples rolled into the sheet.[11]

As a result of using titanium in the carrier-based fighters, FJ–2 and FJ–3, titanium parts were also designed into the FJ–4. Because of its high strength-to-weight ratio at temperatures up to 1,000° F. and low thermal conductivity, titanium was used in the engine shrouds and fire seals of the FJ–4. Titanium metal was also used in the aft section and a portion of the midsection of the Navy's experimental XF8U–1 jet-fighter plane made by Chance Vought Aircraft.

The first sizable order for titanium bolts to be used in aircraft was placed by the Convair Division of General Dynamics Corp. in October 1955. The order was for 360,000 shear bolts weighing 5,000 pounds and costing $650,000.

The results of the evaluation of titanium as a possible salt-water piping material for the Navy were released in a report. The piping was unaffected by 8 months of erosion and corrosion from sea water flowing through it at 20 feet per second.[12]

Actual uses of titanium in nondefense applications began to receive publicity in 1955. Pieces of equipment that had been fabricated and tested in operating conditions proved far superior to similar equipment made from conventional materials of construction in many instances. This superiority was due mainly to the corrosion resistance of titanium metal to a wide variety of corrosive agents. Some civilian applications reported follow:

Titanium was used for the contact parts of a filter press for pressing solid cakes from corrosive slurries of calcium hypochlorite. Stainless

---

[9] Metzger, Maj. Gen. Kern B., Strategic Uses of Titanium: Modern Metals, vol. 10, No. 12, January 1955, pp. 116–118

[10] Rem-Cru Titanium Review, Titanium Helps the Voodoo Work Its Magic: Vol. 3, No. 4, October 1955, pp. 1–2.

[11] Modern Metals, Rigidized Titanium Used in Jet-Engine Shroud: Vol. 11, No. 10, November 1955, p. 92.

[12] Schreitz, W. G., Evaluation of Titanium as a Salt-Water Piping Material: Naval Eng. Exp. Sta., Rept. 040037D, August 1955, 6 pp.

steel used in the filter press developed severe pitting after 2 weeks of service, while titanium showed no sign of corrosion after 7 months of operation.[13]

The superiority of titanium to stainless steel in handling hot nitric acid in chemical-processing equipment was dramatically demonstrated. In one prototype application a titanium "top-hat" condenser insert, consisting of 70 tubes welded to a titanium sheet, was subjected to service in a condenser handling vapors of 60 percent nitric acid at 300 p. s. i. and 195° C. The insert was unaffected after 14 months of use, whereas similar ones of stainless steel lasted 4 to 6 months.[14]

Steam-jet diffusers that had to be replaced every 3 months when they were made of cast iron were made of titanium and showed no sign of corrosion after 2½ years of operation.[15] The steam-jet diffusers were used to create a process vacuum and were subject to corrosion by high-velocity steam and dilute hydrochloric acid.

It was revealed that titanium was an excellent material for fabricating parts of anodizing racks used in anodizing aluminum.[16] The titanium parts were unaffected by the corrosive solutions used in anodizing, and the racks did not have to be stripped after each cycle, thus saving time and manpower. It was also pointed out that racks made of titanium could also be used advantageously in many electroplating solutions.

The General Motors Corp. announced in late 1955 that it had built and successfully tested an experimental turbine-powered car, called the Firebird II, which had a body shell made completely of titanium.

Some potential uses of titanium fittings on sailing craft were pointed out.[17] On one 22-foot craft the mast fittings, jib-halyard fitting tangs, spreaders, a tiller-head fitting, and other parts were made of titanium. The corrosion resistance and light weight of titanium were two properties cited as making it a desirable material for use on pleasure and racing boats.

STOCKS

Year-end stocks of ilmenite, titanium slag, and rutile decreased 2, 21, and 7 percent, respectively, in 1955 from 1954. Consumers' stocks of rutile increased about 1,000 tons, so that the total decline in rutile stocks was due to a lowering of inventories of mines and distributors. At the 1955 rate of consumption, total stocks (on a titanium dioxide content basis) represented supply of 6½ months for rutile, 9½ months for ilmenite, and 6 months for titanium slag.

Stocks of titanium sponge metal held by sponge producers and melters at the end of 1955 were 854 short tons. This quantity of sponge would have represented a 2½-month supply for the melters at the 1955 rate of consumption.

---

[13] Rem-Cru Titanium Review, Pennsylvania Salt Unit Proves Titanium Equipment's Value for Handling Commercial Bleach: Vol. 3, No. 3, July 1955, pp. 1–2.
[14] Modern Metals, Titanium Withstands 60 Percent Nitric Acid for 14 Months: Vol. 11, No. 6, July 1955, pp. 95–96.
[15] Rem-Cru Titanium Review, Titanium Performs in Key Corrosion Spot for Du Pont: Vol. 3, No. 2, April 1956, p. 5.
[16] Rem-Cru Titanium Review, Titanium Proves Optimum Material for Anodizing Racks: Vol. 3, No. 1, January 1955, p. 7.
[17] Du Pont Magazine, Titanium Afloat: Vol. 49, No. 3, July 1955, pp. 34–35.

TABLE 5.—Stocks of titanium concentrates in the United States at end of year 1954–55, in short tons

Stocks	Ilmenite		Titanium slag		Rutile	
	Gross weight	TiO_2 content	Gross weight	TiO_2 content	Gross weight	TiO_2 content
1954 [1]						
Mine	71,907	33,298			762	709
Distributors	715	425			1,934	1,855
Consumers	562,255	296,339	81,617	57,355	14,178	13,458
Total stocks	634,877	330,062	81,617	57,355	16,874	16,022
1955						
Mine	80,429	37,228			93	87
Distributors	407	242			519	495
Consumers	542,150	283,899	64,411	45,510	15,104	14,367
Total stocks	622,986	321,369	64,411	45,510	15,716	14,949

[1] Revised figures reflect inventory corrections reported by industry.

PRICES

Concentrates.—E&MJ Metal and Mineral Markets quoted the following nominal prices for ilmenite and rutile concentrates in 1955. Ilmenite, 59.5 percent TiO_2, f. o. b. Atlantic seaboard, was quoted at $18 to $20 per gross ton (2,240 pounds) from the beginning of the year to June 20, 1955, when the price changed to $20 per ton and remained the same to the end of the year. Rutile, 94 percent TiO_2, was listed at 7 to 7½ cents per pound at the beginning of the year; 7¼ to 7½ cents per pound on February 10, 1955; 8 to 8½ cents per pound on April 14, 1955; 9 to 9½ cents per pound on April 28, 1955; 9 to 10 cents per pound on June 7, 1955; and 10 to 15 cents per pound, depending on time of delivery, on September 22, 1955, to the end of the year. Price quotations for titanium dioxide in concentrate, metallurgical grade, were published in the Oil, Paint and Drug Reporter in December 1955 as follows:

Natural granular, bags, carlots, per short ton f. o. b. Jacksonville, Fla.	$120.00
Niagara Falls, N. Y., carlots	137.50
5-ton lots, same basis	142.50
1-ton lots, same basis	147.50

(Milled rutile, $7.50 per ton higher.)

Manufactured Titanium Dioxide.—Market prices for manufactured titanium dioxide remained the same in 1955 as those quoted in 1954. Price quotations on manufactured titanium dioxide at the end of 1955, published in the Oil, Paint and Drug Reporter, were as follows:

Anatase, chalk-resistant, regular and ceramic, carlots, delivered, per pound	$0.22½
Less than carlots, delivered, per pound	.23½
Rutile, nonchalking, bags, carlots, delivered East, per pound	.24½
Less than carlots, delivered East, per pound	.25½
Titanium pigment, calcium-rutile base, bags, carlots, delivered, per pound	.08⅜
Less than carlots, delivered, per pound	.08⅞

Metal.—Price reductions for titanium-sponge metal and a drop in the prices of titanium-mill products were announced by the titanium-metal industry in 1955. The price of titanium-sponge metal dropped from $4.50 to $3.45 per pound; price reductions for titanium-mill products ranged from 85 cents to $1.40 per pound in base price, and up to $3 per pound for extras. Prices for titanium-sponge were quoted by the titanium-metal industry in 1955, per pound, as follows:

	Jan. 1, 1955, to Mar. 31, 1955	Apr. 1, 1955, to Oct. 31, 1955	Nov. 1, 1955, to Nov. 23, 1955	Nov. 24, 1955, to Dec. 31, 1955
Grade A-1 [1]	$4.50	$3.95	$3.75	$3.45
Grade A-2 [2]	4.00	3.50	3.25	3.15

[1] Maximum iron content decreased from 0.30 percent to 0.25 percent on June 20, 1955, and to 0.20 percent on Nov. 1, 1955.
[2] Maximum iron content decreased from 0.50 percent to 0.45 percent on Nov. 1, 1955.

Price quotations for titanium-mill products in 1955, as quoted by the producers, base prices, per pound, in lots of 10,000 pounds and over, commercially pure, f. o. b. mill, were as follows:

	Jan. 1, 1955, to Apr. 1, 1955	Apr. 1, 1955, to Nov. 23, 1955	Nov. 23, 1955, to Dec. 31, 1955
Sheet	$15.00	$14.00 to $14.50	$13.10 to $13.60.
Plate	12.00	$11.50 to $12.00	$10.50 to $11.00.
Strip	15.00	$14.00 to $14.50	$13.10 to $13.60.
Wire	11.00	$10.50 to $11.00	$9.50 to $10.00.
Forging billets	9.00	$8.50 to $8.75	$7.90 to $8.15.
Hot-rolled bars	9.00	$8.50 to $8.75	$7.90 to $8.15.

Ferrotitanium.—The price of low-carbon ferrotitanium was quoted in Steel Magazine in 1955, as follows:

Low-carbon (Ti, 20 to 25 percent; Al, 3.5 percent max.; Si, 4 percent max.; C, 0.10 percent max.). Contract, ton lots 2″ x D, per pound of contained titanium	$1.50
Less-than-ton lots per pound	1.55
(Ti, 38 to 43 percent; Al, 8 percent max.; Si, 4 percent max.; C, 0.10 percent max.). Ton lots per pound	1.35
Less-than-ton lots per pound	1.37

The above prices were f. o. b. Niagara Falls, N. Y., freight allowed to St. Louis, spot, add 5 cents.

The prices for medium-carbon and high-carbon ferrotitanium were raised by the producers on January 1, 1955. Previous to this date medium-carbon ferrotitanium sold for $210 per ton and high-carbon for $187 per ton. The new prices, effective throughout 1955, were as follows:

High-carbon (Ti, 15 to 18 percent; C, 6 to 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	$195
Medium-carbon (Ti, 17 to 21 percent; C, 2 to 4.5 percent) contract per ton, f. o. b.. Niagara Falls, N. Y., freight not exceeding St. Louis rate allowed	215

FOREIGN TRADE [18]

Imports.—United States receipts of ilmenite concentrate in 1955 totaled 353,400 short tons. Of this total, India supplied 187,000

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

tons, and Canada supplied 166,300 tons. Most of the Canadian material was in the form of titanium slag containing about 70 percent titanium dioxide. Australia was the sole source of the rutile imports.

Imports of titanium metal for consumption totaled 567 short tons valued at $3,432,741. Canada furnished 800 pounds of nonductile metal, while all the remaining material was commercially pure sponge from Japan.

Two Japanese titanium producers—Osaka Titanium Co., Ltd., and Toho Titanium Co., Ltd.—contracted with the United States Government for the exchange of about 1,430 and 770 short tons, respectively, of titanium sponge for surplus American farm products. The contracts were to be effective until September 1957.

TABLE 6.—Titanium concentrates [1] imported for consumption in the United States, 1946–50 (average) and 1951–55, by countries, in short tons

[U. S. Department of Commerce]

Country of origin	1946–50 (average)	1951	1952	1953	1954	1955
ILMENITE						
North America: Canada	2,958	[2] 3,776	[3] 38,451	[3] 139,585	[3] 107,521	[3] 166,307
South America: Brazil	1,743	1	----	----	----	----
Europe:						
France	(4)	----	----	----	----	----
Norway	30,532	----	----	----	----	----
Total	30,532	----	----	----	----	----
Asia:						
Ceylon	(4)	----	----	----	----	----
India	228,602	185,145	145,562	147,005	167,484	187,044
Malaya	667	56	----	----	----	----
Total	229,269	185,201	145,562	147,005	167,484	187,044
Africa: Egypt	144	----	----	----	----	----
Oceania: Australia	354	100	----	54	----	----
Total as reported	265,000	189,078	184,013	286,644	275,005	353,351
Australia: In "zirconium ore" [5]	278	----	----	----	----	----
Grand total	265,278	189,078	184,013	286,644	275,005	353,351
Value of "as reported"	$1,733,519	$1,323,438	$2,478,077	$5,463,526	[6] $4,993,402	$7,031,060
RUTILE						
South America: Brazil	7	----	----	----	----	----
Europe: Norway	(4)	----	----	----	----	----
Asia: India	23	----	----	----	----	----
Africa: French Cameroon [7]	1	----	----	----	----	----
Oceania: Australia	5,424	11,023	19,394	16,098	14,965	19,526
Total as reported	5,455	11,023	19,394	16,098	14,965	19,526
Australia: In "zirconium ore" [8]	737	210	156	84	95	----
In "ilmenite [9]	1,012	----	----	----	----	----
Grand total	7,204	11,233	19,550	16,182	15,060	19,526
Value of "as reported"	$320,159	$491,383	$1,728,803	$1,791,494	$1,323,183	$1,984,431

[1] Classified as "ore" by U. S. Department of Commerce.
[2] Includes titanium slag.
[3] Chiefly all titanium slag, averaging about 70 percent TiO_2.
[4] Less than 1 ton.
[5] Ilmenite content of zirconium ore as reported to the Bureau of Mines by importers.
[6] Owing to changes in tabulating procedures by the U. S. Department of Commerce data known to be not comparable with other years.
[7] Includes quantities reported by the U. S. Department of Commerce as originating in French Equatorial Africa, from which no rutile production was recorded during 1946–50.
[8] Rutile content of zirconium ore as reported to the Bureau of Mines by importers.
[9] Rutile content of ilmenite ore as reported to the Bureau of Mines by importers

Exports.—Titanium pigments composed the bulk of titanium exports in 1955. Pigment exports were 15 percent lower than in 1954, totaling 54,400 short tons having a value of $18 million. Canada was the chief customer, with receipts totaling 25,493 tons. Other countries that received 1,000 tons or more were as follows: Belgium and Luxembourg, 2,566; Cuba, 1,228; France, 2,277; Italy, 1,238; Mexico, 2,489; Netherlands, 3,826; Norway, 1,058; Philippines, 1,067; Union of South Africa, 1,341; United Kingdom, 1,513; Venezuela, 1,348; and West Germany, 1,943.

Titanium concentrates were shipped to Canada (1,049 tons), Ireland (5 tons), Mexico (34 tons), Norway (50 tons), and Turkey (6 tons). Sponge metal and scrap totaling 10 tons were shipped chiefly to United Kingdom (4 tons) and West Germany (4 tons). A total of 35 short tons of intermediate shapes and mill forms was exported, Canada being the chief recipient (25 tons); United Kingdom received 9 tons, and the remainder was exported to France, Sweden, and Switzerland. The majority of the 245 tons of ferrotitanium shipped went to Canada (133 tons) and Italy (107 tons).

TABLE 7.—Exports of titanium products from the United States, 1946–50 (average) and 1951–55, by classes

[U. S. Department of Commerce]

	1946–50 (average)	1951	1952	1953	1954	1955
Ore and concentrates:						
Short tons	1,242	646	870	1,368	663	1,143
Value	$156,392	$63,050	$110,737	$109,878	$85,896	$193,752
Metal and alloys in crude form and scrap:						
Short tons	(1)	(1)	[2] 762	2	48	[3] 10
Value	(1)	(1)	[2] $31,134	$11,858	$1,107,582	[3] $36,353
Primary forms, n. e. c.:						
Short tons	(1)	(1)	3	31	[4] 171	[5] 35
Value	(1)	(1)	$38,979	$798,077	[4] $3,587,054	[5] $1,211,311
Ferroalloys:						
Short tons	378	175	325	185	172	245
Value	$62,169	$107,718	$88,664	$48,722	$39,885	$65,091
Dioxide and pigments:						
Short tons	25,318	39,242	35,636	39,780	63,802	54,353
Value	$6,468,850	$13,274,143	$10,691,698	$11,715,798	$23,281,039	$18,332,995

[1] Not separately classified.
[2] Believed to include material other than commercially pure titanium metal.
[3] Beginning Jan. 1, 1955, classified as sponge and scrap.
[4] Revised figure.
[5] Beginning, Jan. 1, 1955, classified as intermediate mill shapes and mill products, n. e. c.

TECHNOLOGY

A total of 120 tons of ilmenite concentrate was smelted in experimental work at the Bureau of Mines Electro-development Experiment Station, Albany, Oreg., to yield an average of 0.5 ton of high titania slag and 0.3 ton of pig iron per ton of ilmenite.[19] Slags containing 67 to 86 percent TiO_2 were made from ilmenite from Idaho with a TiO_2 content of 44 percent. Hogged wood and coke were used as reductants.

[19] Banning, L. H., Hergert, W. F., and Halter, D. E., Electric Smelting of Ilmenite Concentrates From Valley County, Idaho: Bureau of Mines Rept. of Investigations 5170, 1955, 18 pp.

A report was published describing operations of the Bureau of Mines titanium-sponge pilot plant at Boulder City, Nev.[20] It gave an account of the equipment and operating procedure used during the 2 years in which the plant was in continuous operation. This was the first published report to detail step-by-step procedures for making titanium-sponge metal by magnesium reduction of titanium tetrachloride on a pilot-plant scale.

The inventor of the magnesium-reduction process for making ductile titanium-sponge metal, Dr. W. J. Kroll, described some of his early experiments in an article.[21] His discovery in 1937 that the magnesium reduction of titanium tetrachloride had to take place under an inert atmosphere of argon or helium to produce a ductile metal laid the ground work for the later pilot plant development by the Federal Bureau of Mines.

Dr. H. H. Kellogg, chairman of the Government Titanium Advisory Committee, made some prognostications on the future of the titanium industry.[22] He discussed the technologic problems confronting the industry and predicted that the price of titanium sponge ultimately would be lowered to $1.15 per pound and sheet would sell for $2.34 per pound. He based these prices on a titanium industry capable of producing 200,000 tons of sponge annually, with individual plants having a capacity of 30,000 tons.

Two methods of producing titanium metal electrolytically were revealed. In one process titanium monoxide was electrolized at high temperatures in a melt of an alkaline-earth halide, such as calcium dichloride. The metal produced by this process was up to 99 percent pure but did not meet commercial specifications.[23] The second process was by electrolysis of potassium fluotitanate (K_2TiF_6) in a melt of an alkaline-earth halide, such as sodium chloride.[24] Some high-purity titanium crystals were obtained as a result of these studies.

The first titanium-sponge-metal plant to utilize sodium rather than magnesium reduction of titanium tetrachloride went into operation in August. The plant at Wilton, England, was owned by the Imperial Chemical Industries, Ltd. The designation and properties of various grades of titanium metal and alloys available from this company were published in a booklet which listed 2 commercially pure grades and 4 alloy grades of titanium.[25]

A compilation of some of the procedures for analyzing titanium tetrachloride, titanium sponge, and various intermediate products was released by the Bureau of Mines during the year.[26] The publication relates various chemical and spectrochemical methods that may be used to detect elements that are ordinarily associated with titanium sponge and certain other titanium products.

---

20 Baroch, C. T., and others, Titanium Plant at Boulder City, Nev.: Its Design and Operation: Bureau of Mines Rept. of Investigations 5141, 1955, 76 pp.

21 Kroll, W. J., How Commercial Titanium and Zirconium Were Born: Jour. Franklin Inst., vol. 260, No. 3, September 1955, pp. 169–192.

22 Kellogg, H. H., What the Future Holds for Titanium: Eng. and Min. Jour., vol. 156, No. 4, April 1955, pp. 72–85.

23 Sibert, M. E., and others, Electrolytic Reduction of Titanium Monoxide: Jour. Electrochem. Soc., vol. 102, No. 5, May 1955, pp. 252–262.

24 Steinberg, M. A., and others, Preparation of Titanium by Fluoride Electrolysis: Jour. Electrochem. Soc., vol. 102, No. 6, June 1955, pp. 332–340.

25 Imperial Chemical Industries, Ltd., Wrought Titanium: September 1955, 56 pp.

26 Perry, P. R., Lewis, R. W., and Sullivan, T. A., Methods for Analyzing Titanium Sponge and Intermediate Products: Bureau of Mines Rept. of Investigations 5168, 1955, 45 pp.

Titanium castings weighing as much as 110 pounds were successfully made at the Bureau of Mines Northwest Electro-development Experiment Station, Albany, Oreg. These large castings were made possible through the discovery that the maximum melting rate, and consequently the greatest molten pool depth, occured when titanium was melted in a low-pressure atmosphere of around 30 mm. of mercury.[27]

A method was developed on a laboratory scale for refining a titanium bar by cage zone melting.[28] The process consists of moving a square bar held vertically through an induction heating coil in a bell jar containing a low-pressure, inert atmosphere. As the bar moves through the coil the bar melts from the inside, and since some of the impurities in titanium, such as iron, prefer the liquid state, the impurities move with the molten zone. The corners of the bar remain solid and form a cage for the molten titanium. The ends and impure corners are cut away from the bar after the refining process.

In 1955 the titanium-metal industry became fully cognizant of the detrimental effect of interstitial hydrogen upon titanium metal.[29] Metal with a high hydrogen content failed in forming, and in some cases cracks appeared in unstressed metal several weeks after forming. The industry took steps to prevent hydrogen embrittlement and the Air Force placed a ceiling of 150 parts per million on the hydrogen content of titanium sheet and 125 parts per million on bar stock.

Some problems encountered in fabricating plate from commercially pure and alloy arc-melted titanium ingots were described in a report issued by the Bureau of Mines in 1955.[30] All stages in fabrication were related in detail from the melting of the sponge to the forging and rolling of the plate.

Titanium extrusions became available commercially in 1955 in shapes designed to meet Air Force specifications. The extrusions were made on aluminum presses utilizing pressures higher than those used for aluminum at temperatures in the range of 1,450° to 1,750° F.[31] Shapes such as I-beams and H- and T-sections were produced in 10- and 12-foot lengths.

Titanium sandwich structures were made by brazing two titanium sheets to a honeycomb structure under a vacuum.[32] The honeycomb sandwich was assembled with silver or silver-manganese brazing-alloy shim strips placed between the core and face sheets. The assembly was then weighted, placed in a vacuum retort, and heated to brazing temperature.

Titanium sheet was arc welded without using filler rod, resulting in a smoother joint that did not have to be ground to remove the weld

---

[27] Beall, R. A., Wood, F. W., and Roberson, A. H., Large Titanium Castings Produced Successfully. Jour. Metals, vol. 7, No. 7, July 1955, p. 801.

[28] Light Metal Age, Zone Refining of Titanium: Vol. 13, Nos. 8 and 9, August 1955, p. 19.

[29] Burte, Harris M., and others, Hydrogen Embrittlement of Titanium Alloys: Metal Progress, vol. 67, No. 5, May 1955, pp. 115–120.

[30] Huber, R. W., Petersen, V. C., and Wiley, R. C., The Fabrication of Arc-Melted Ingots of Titanium and Titanium-Manganese Alloys Into Plate: Bureau of Mines Rept. of Investigations 5117, 1955, 35 pp.

[31] Steel, Titanium Extrusion Ready for Planes: Vol. 137, No. 13, Sept. 26, 1955, p. 115.

[32] Materials and Methods, Fluxless Vacuum Brazing Joins Titanium Sandwiches: Vol. 42, No. 3, September 1955, p. 11.

bead.[33] Gas pressure was used on the underside of the weld to protect the weld from air contamination and to prevent the fused weld metal from dropping through and causing a bulge in the underside of the weld.

The Titanium Metallurgical Laboratory at Battelle Memorial Institute, functioning under a Government contract, issued 33 technical reports during the year on various aspects of the metallurgy of titanium. The reports ranged in scope from welding titanium to the effect of certain interstitial elements on the properties of titanium. The reports were written specifically to disseminate information to the titanium industry.

Five books became available that listed the titanium research and development projects underway or carried out by Government and private industry.[34] The reports listed the laboratories carrying out the research, scope of the project, past results, reports available on the project, and, in some cases, the funds allotted for research.

The first book published commercially on the technology of structural titanium was released in 1955.[35] It dealt mainly with the fabricating of titanium metal, although it also contained chapters on properties, alloying, analytical and metallographic techniques, and applications.

The first magazine in the English language to be devoted solely to titanium began publication in July 1955. Named the Titanium Abstract Bulletin, it was published and distributed monthly by the Metals Division of the Imperial Chemical Industries, Ltd., Birmingham 6, England.

WORLD REVIEW

The increasing demand for titanium concentrates for both titanium pigments and titanium metal was reflected in a 15-percent increase in ilmenite world production and a 31-percent increase in rutile world production over the previous records established in 1954. The United States continued to be the world's leading ilmenite producer, supplying 41 percent of the total, and Australia maintained its lead as the world's outstanding rutile producer, with 88 percent of the total. The United States was by far the largest ilmenite and rutile consumer, utilizing 62 percent of the world's new supply of ilmenite and 38 percent of the world's new supply of rutile. Most of the ilmenite production reported from Canada was in the form of titanium slag containing about 70 percent titanium dioxide, while all of the Japanese production was titanium slag containing about 80 percent titanium dioxide.

---

[33] Levy, Lana W., and Wickham, Robert, Fusion Welding Titanium Sheet Without Filler Rod: Modern Metals, vol. 11, No. 4, May 1955, pp. 48–54.

[34] Air Materiel Command, Titanium and Titanium Alloys Programs: Book 1, Projects Sponsored by Air Materiel Command, 35 pp.; Book 2, Projects Sponsored by Air Research and Development Command, 89 pp.; Book 3, Projects Sponsored by Department of the Navy, 72 pp.; Book 4, Projects Sponsored by Department of the Army, 121 pp.; Book 5, Projects Sponsored by Private Industry, U. S. Bureau of Mines, National Advisory Committee for Aeronautics, and National Bureau of Standards, 69 pp.; Wright-Patterson Air Force Base, Ohio, 1955.

[35] Abkowitz, Stanley, Burke, John J., and Hiltz, Jr., Ralph H., Titanium in Industry: D. Van Nostrand Co., Inc., New York, N. Y., 1955, 224 pp.

TABLE 8.—World production of titanium concentrates (ilmenite and rutile), by countries, 1946–50 (average) and 1951–55, in short tons [1]

[Compiled by Pearl J. Thompson]

Country	1946–50 (average)	1951	1952	1953	1954	1955
ILMENITE						
Australia (sales)[2]	(3)	1,403	52		526	600
Brazil	1,885					
Canada[4]	3,398	21,203	42,192	146,614	124,162	164,185
Egypt	582	359	2,202	2,787	3,148	2,694
Finland				3,465	55,765	93,668
India	267,957	250,975	251,883	214,091	269,375	300,661
Japan[5]			[6] 660	3,199	2,638	5,097
Malaya[7]	15,967	48,712	24,302	29,758	50,114	60,340
Norway	91,815	116,139	130,370	141,220	164,448	173,981
Portugal	444	186	476	746	563	612
Senegal	6,237	4,308	5,095	6,358	12,566	30,424
Spain	324	772	1,410	1,582	1,397	[6] 1,100
Union of South Africa				10		1,917
United States[8]	375,672	535,835	528,588	513,696	547,711	583,044
World total ilmenite (estimate)	765,000	979,900	987,200	1,090,500	1,232,400	1,418,300
RUTILE						
Australia	15,185	39,412	42,576	42,604	50,018	66,766
Brazil[7]	9		19			
French Cameroon	666	119	324	58		110
French Equatorial Africa	[9] 7					
India	130	51	164	117	117	[6] 110
Norway	35	20	47	3		10
Senegal		3	29			
United States	7,588	7,189	7,125	6,825	7,411	8,513
World total rutile (estimate)	23,600	46,800	50,300	49,600	57,500	75,500

[1] This table incorporates a number of revisions of data published in previous titanium chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[2] Owing to high chromium content in the ore, sales are shown.
[3] Data not available; estimate by author of chapter included in the total.
[4] Beginning 1950, includes Ti slag containing approximately 70 percent TiO_2.
[5] Represents titanium slag.
[6] Estimate.
[7] Exports.
[8] Includes a mixed product containing altered ilmenite, leucoxene, and rutile for 1949–55.
[9] Average for 1 year, as 1950 was first year of commercial production.

Australia.—Requirements for titanium pigments in Australia were about 12,000 short tons in 1955, of which about half was supplied by the one Australian producer, Australian Titan Products Pty., Ltd., Burnie, Tasmania. By 1958 it is anticipated that Australian pigment production will be about 11,000 short tons.[36] Imports of titanium dioxide pigments decreased in 1955 to 5,171 short tons, as compared with 6,615 tons imported in 1954 and 5,394 tons in 1953. Ilmenite imports in 1955, all of which came from India, totaled 10,244 short tons compared with 15,740 tons imported in 1954. About 12,000 tons of ilmenite was consumed in 1955, mainly in the production of pigments.

Australia continued to be the world's largest producer of rutile, with a record-high production of nearly 67,000 short tons. Only 600 tons of ilmenite was sold in this year because the high chromium content of the ilmenite made it an undesirable raw material for titanium pigments.

Nearly all the Australian output of rutile was exported, with the United States receiving more than any other country. Exports

[36] Australia Bureau of Mineral Resources, Australian Mineral Industry: Vol. 8, No. 4, May 1956, p. 73.

of ilmenite were 486 short tons compared with 192 tons exported in 1954.

All of the rutile output came from mines in coastal areas of northern New South Wales and southern Queensland. Investigations of beaches in Western Australia have indicated ilmenite occurrences with a low chromium content, which were being investigated more thoroughly in 1955. Most rutile producers were enlarging their facilities to meet the expanding demands for this mineral for metal production.

An article on the titanium-metal industry in the Australian Mineral Industry Quarterly Review, August 1955, was widely quoted and reproduced.[37] In addition to containing general information on titanium, it outlined the history of rutile mining in Australia, export and production statistics, and prices.

TABLE 9.—Exports of rutile concentrate from Australia, 1951–55, by countries of destination, in short tons [1]

[Compiled by Corra A. Barry]

Country	1951	1952	1953	1954	1955
Belgium				1,519	2,700
France	3,758	3,066	2,106	3,852	3,485
Germany, West				4,397	4,573
Italy				2,289	2,154
Japan				1,370	2,118
Netherlands	2,574	1,633	3,504	5,190	8,687
Sweden	2,897	1,856	2,824	1,742	3,093
United Kingdom	11,130	10,161	9,701	11,078	13,702
United States	11,048	20,599	15,026	16,148	23,798
Other countries	7,838	4,857	7,244	2,162	2,539
Total	39,245	42,172	40,405	49,747	66,849

[1] Compiled from Customs Returns of Australia.

In September the National Lead Co. announced that it had formed a new Australian subsidiary, Mineral Deposits Pty., Ltd., to mine the property formerly held by Mineral Deposits Syndicate. The new subsidiary was to be owned 80 percent by National Lead Co. and 20 percent by Mineral Deposits Syndicate. The latter company owned a mine and plant at Southport, New South Wales, and held mineral leases in Queensland and New South Wales.[38] Another subsidiary of the National Lead Co., Titanium Alloy Manufacturing Co. Pty., Ltd., completed a new concentration plant at Cudgen, New South Wales.

Titanium & Zirconium Industries Pty., Ltd., outlined a program to expand its rutile capacity on Stradbroke Island, Queensland, to about 13,000 short tons per year by 1956.[39] An aerial tramway seven miles long was to be constructed from the mining area on the east side to the separation plant at Dunwich, on the west side of the island. A concentration plant at Dunwich was to be built, in addition to storage facilities and a diesel generating plant. Mining was to be carried out with a suction dredge equipped with Humphrey spirals for primary concentration. It was estimated that the company

[37] Dunn, J. A., and Morgan, J. W. Titanium and Australia: Am. Metal Market, vol. 62, No. 173, Sept. 7, 1955, pp. 9, 20; vol. 62, No. 174, Sept. 8, 1955, pp. 11, 13.
[38] Wall Street Journal, National Lead Acquires Australian Minerals Firm as a Subsidiary: Vol. 146, No. 51, Sept. 13, 1955, p. 6.
[39] The Conveyor, Stradbroke Island Operations of "T. A. Z. I.": June 1955, pp. 6–9.

reserves of beach sand were adequate for 15 years at the expanded rate of operation.

A new company, Western Titanium N. L., was formed during the year to exploit an ilmenite deposit in the form of old dunes at Capel, south of Bunbury, Western Australia. A plant was to be installed by late 1956 to treat 220,000 short tons of sand annually containing 81,000 short tons of ilmenite, 490 tons of rutile, 630 tons of monazite, and 4,900 tons of zircon.[40] The ilmenite is chrome-free, contains 55 percent titanium dioxide, and probably will be partly utilized by the Australian pigment industry.

Canada.—The Quebec Iron & Titanium Corp. smelted 348,600 short tons of titaniferous hematite at Sorel, Quebec, in 1955 to produce 162,800 tons of titanium slag. This was the most slag produced in the 5-year production history of this company, exceeding the 1953 high by 15 percent. Three of the five smelting furnaces were operated during the first quarter of the year and four during the remainder of the year. As a result of experimental work in 1954, the smelting furnaces were modified extensively during 1955, and construction was begun on a $7.5 million beneficiation plant and rotary kiln to treat the ore before smelting. It was anticipated that these facilities would be completed by March 1956, resulting in improved furnace conditions, increased production, and lower costs.

The only other production of titanium minerals in Canada was 1,400 short tons of ilmenite mined in the St. Urbain area of Quebec.

TABLE 10.—Quebec Iron & Titanium Corp. smelting operations, 1951–55, in short tons

Item	1951	1952	1953	1954	1955
Ore crushed	379,931	265,719	158,218	308,974	413,149
Ore smelted	(1)	(1)	(1)	268,139	348,578
Titanium slag produced	19,330	42,141	141,883	122,960	162,784
Titanium slag shipped	8,041	38,908	145,402	119,292	157,378
Estimated TiO_2 content of slag produced	13,531	29,499	99,318	88,408	117,042
Value of slag produced	$738,577	$1,238,103	$4,206,496	$3,841,270	$5,192,810
Desulfurized iron produced	14,422	32,422	106,875	90,562	121,312
Desulfurized iron shipped	5,701	33,630	94,587	100,509	118,104

[1] Data not available.

Canadian exploration for ilmenite and rutile was summarized in the annual report of the Canadian Department of Mines and Technical Surveys.[41]

In August it was announced that the National Lead Co. through its subsidiary, Canadian Titanium Pigments, Ltd., was to build Canada's first titanium-pigment plant near Varennes, Quebec, about 15 miles northeast of Montreal.[42] The plant will cost approximately $15 million and be ready for production in 1957. According to the company, plant capacity was designed to meet all of Canada's pigment requirements. Titanium slag used as a raw material will be supplied from Sorel, Quebec, about 40 miles downstream on the St. Lawrence River.

[40] The Bureau of Mineral Resources, Australian Mineral Industry: Vol. 8, No. 2, November 1955, p. 36.
[41] Buck, K. W., A Survey of Developments in the Titanium Industry During 1955: Canadian Dept. Mines and Tech. Surveys, Mineral Resources Inf. Circ., M. R. 18, April 1956, 24 pp.
[42] American Metal Market, National Lead to Build Titanium-Pigments Plant in Canada: Vol. 62, No. 163, Aug. 23, 1955, p. 1.

The Shawinigan Water & Power Co. continued to operate its electrolytic titanium-metal pilot plant at Shawinigan Falls, Quebec. Dominion Magnesium at Haley, Ontario, produced titanium metal on a pilot-plant scale by the two-stage thermal reduction of manufactured titanium dioxide, utilizing magnesium and calcium, respectively, in the first and second stages. Canadian Steel Improvement, Ltd., Etobicoke, Ontario, and Thompson Products, Ltd., St. Catharines, Ontario, were active in forging titanium compressor blades for jet aircraft. Vanadium-Alloy Steel Canada, Ltd., at its London, Ontario, plant, fabricated titanium-mill products on a small scale from billets purchased in the United States.

Ceylon.—The Government of Ceylon invited companies throughout the world to bid on exploitation of a sand deposit of heavy minerals at Pulmoddai on the eastern coast. According to the Ceylonese press, 8 tenders were received; as a result 3 firms were invited to a conference with the Government. The deposit was estimated to contain 4 million tons of heavy minerals, with an approximate composition as follows: Ilmenite, 72–75 percent; rutile, 10–12 percent; and zircon, 6–8 percent.[43]

France.—Total titanium-ore consumption in France in 1955 was about 24,400 short tons, mainly in the form of ilmenite. Of this quantity, about 16,000 tons was imported from Senegal and the remainder from Australia and Malaya. Principal uses of the ore were in welding-rod coatings and manufactured titanium dioxide.

Two new titanium companies were formed, one to produce titanium metal and the other to manufacture titanium dioxide. The metal company named Le Titanium français was to build a plant at La Praz (Savoie). It was owned jointly by Fabriques de produits chimiques et métallurgiques Péchiney, Électro-métallurgique du Planet, fabriques de produits chemiques de Thannet Mulhouse, and Bozel Maletra.

The titanium dioxide company, Le Produits du titane, planned to have a plant at Le Havre operating at a capacity of about 16,000 short tons per year by late 1957.[44] It was owned by three companies: Fabriques de produits chimiques de Thann et Mulhouse (50-percent ownership), Fabriques de produits chimiques et métallurgiques Péchiney, and Les Manufactures de glaces et produits chimiques de St. Gobain.

Germany, West.—Germany's one producer of manufactured titanium dioxide, Titangesellschaft m. b. H., Leverkusen, continued to expand its capacity, so that output in 1955 should have exceeded the estimated 50,000 short tons produced in 1954. Titangesellschaft was also the only commercial producer of titanium-sponge metal, although its plant capacity at Leverkusen was only about 2.2 short tons of sponge per month.[45]

Two German firms, Krupp of Essen and Deutsche Edelstahlwerke A. G., indicated their interest in melting and fabricating titanium by displaying samples of titanium-mill products at trade fairs. These products had been made on a laboratory rather than on a commercial scale.

---

[43] U. S. Embassy, Colombo, Ceylon, State Department Dispatch 685, Mar. 1, 1956, p. 43.
[44] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 6, December 1955, p. 20.
[45] U. S. Consulate, Düsseldorf, Germany, State Department Dispatch 311, Mar. 24, 1955.

India.—Tariff protection of manufactured titanium dioxide granted by the Government of India in December 1953 to Travancore Titanium Products, Ltd., was extended until December 31, 1955. Effective July 2, 1955, the rates were revised to 44 percent ad valorem (standard) and 34 percent ad valorem (preferential) and extended until the end of 1957.

Ilmenite exports during 1955 totaled 275,740 short tons, of which 183,616 tons was consigned to the United States and 74,217 tons to the United Kingdom.

The Government of India announced that it had decided to nationalize the British-owned firm of Hopkin & Williams, which had been processing ilmenite and monazite in the state of Travancore.[46]

Japan.—In 1955, production of titanium sponge metal more than doubled and achieved a new high of 1,380 short tons. Exports were 1,229 tons, of which 1,144 tons went to the United States, 80 tons to the United Kingdom, and the remainder to West Germany, Netherlands, Sweden, France, and Australia.

Osaka Titanium Co., Ltd., and Toho Titanium Co., Ltd., concluded contracts with the Commodity Credit Corp. for the delivery of about 2,200 short tons of titanium sponge to the United States Government over a 2-year period ending in September 1957. In return the Japanese were to receive surplus agricultural commodities. Osaka was to furnish 1,430 tons and Toho 770 tons.

Output of manufactured titanium dioxide increased 38 percent over 1954 production to 19,000 tons in 1955. Production was reported from Ishihara Industrial Co., Sakai Chemical Industry Co., Tochigi Chemical Industry, Teikoku Chemical Industry, Titanic Industry, Furukawa Mining Co., and Mitsui Metal Co.

TABLE 11.—Japan's titanium sponge production, by companies, 1952–55, in short tons

Company	1952	1953	1954	1955
Osaka Titanium Co., Ltd	9	66	338	639
Toho Titanium Co., Ltd		5	263	608
Nippon Soda Co., Ltd		6	37	115
Nippon Electric Metallurgical Co., Ltd		(1)	28	9
Mitsui Mining & Smelting Co., Ltd		(1)	7	7
Total	9	77	673	1,378

[1] Less than 1 ton.

TABLE 12.—Titanium dioxide production, exports, and stocks in Japan, 1950–55, in short tons

Year	Production	Exports	Stocks
1950	2,163	25	64
1951	4,456	823	714
1952	5,000	108	775
1953	6,793	536	592
1954	13,820	5,218	882
1955	19,068	8,677	538

[46] Mining World, India: Vol. 17, No. 12, November 1955, p. 76.

Norway.—The only company in Norway mining ilmenite—A/S Titania—revealed that it had expanded its ore reserves by 100 million tons with the possibility that 300 million tons will be proved when drilling is complete. The new deposit is about 4 miles from the present mine at Sokndal and was discovered by a magnetometor survey. A/S Titania is a subsidiary of Titan Co. A/S which is in turn a subsidiary of the National Lead Co. An experimental plant has been erected at Jossignfjord to seek means of raising the titanium dioxide content of the Norwegian concentrate which averaged 45 to 50 percent.[47]

Union of South Africa.—The Umgababa deposit in Natal, Union of South Africa, started initial production in 1955 with an output of 1,917 short tons. The Titanium Corp. of South Africa, which mined this deposit, announced in its annual report that the 1955 production rate was uneconomic and that the plant capacity would have to be expanded to make the operation profitable.

A deposit of ilmenite was discovered on the coast of Namaqualand, Union of South Africa. It was planned to form a company to mine the deposit.[48]

United Kingdom.—Two companies were producing unconsolidated titanium metal in England in 1955. Imperial Chemical Industries, Ltd., began production from its new 1,700 short tons per year plant at Wilton, Yorkshire, in August and by the end of the year was operating at full capacity. McKechnie Bros., Ltd., operated a pilot plant for the production of titanium sponge metal by the magnesium reduction process.

Crystalline titanium made by I. C. I. was melted at its Kynoch Works in Birmingham. I. C. I. also made public plans to construct a plant at Waunarlwydd, Swansea, South Wales, for the production of mill shapes such as sheet, strip, plate, rod, tube, and wire. The plant will cost about £2 million and should be in operation by 1958.[49]

William Jessop & Sons, Ltd., announced that it would begin melting titanium on a production basis at Sheffield, England, in early 1956.[50] Initial production was to be at the rate of about 400 short tons of ingot per year. The various grades of titanium were to be marketed under the name of "Hylite" and were to be available as forgings, stampings, bar, ingots, and billet for bar.

The duty-free status of manufactured titanium dioxide continued throughout 1955. In two 6-month extensions of the order established in September 1954, the duty-free status was guaranteed until March 26, 1956.

---

[47] Mining World, Norwegian Ilmenite Firm Announces Ore Discovery: Vol. 17, No. 13, December 1955, p. 79.
[48] Mining World, Union of South Africa: Vol. 17, No. 3, March 1955, p. 71.
[49] Chemical Age (London), I. C. I. Titanium Factory: Vol. 73, No. 1897, Nov. 19, 1955, p. 1104.
[50] Metallurgia, Titanium Alloy Production: Vol. 52, No. 311, September 1955, pp. 137–138.

457676—58——76

Tungsten

By R. W. Holliday [1] and Mary J. Burke [2]

DOMESTIC production of tungsten concentrate in 1955 was highest in the Nation's history. Imports were third highest and industrial consumption was highest since 1951.

Domestic production plus imports was more than four times larger than consumption and thus the question of future markets gained increasing attention as the Domestic Tungsten Purchase Program neared completion. As of December 31, 1955, deliveries to the Government totaled 2,379,975 of the authorized 3 million short-ton units of tungsten trioxide (WO_3).[3] Legislation (H. R. 6373) which would, in effect, have extended the purchase program was passed by the 84th Congress, 1st session, but vetoed by the President. Opposite views on the legislation were expressed in the hearings:

> That private industry had been encouraged to invest in discovery, development, and production of tungsten (and other) minerals, and participants had proceeded on the assumption that any quantities produced up to the termination date of the program, July 1, 1958, would be accepted for purchase. Continued Government purchase from foreign producers was evidence that the Government was committed to a period of purchase from domestic producers, beyond the mid-1956 completion date.
>
> That there was no present defense need for extending the program in the manner and degree contemplated by the proposed legislation and enactment thereof would appear to be primarily a program of economic assistance to certain elements of the domestic mining industry.

The record domestic production unquestionably resulted from the Domestic Tungsten Purchase Program and virtually all production went to the National Strategic Stockpile. Mines and mills were operated at maximum capacity because of the higher-than-market price paid by Government; but expenditures for new plant and equipment were curtailed because of the uncertain market after mid-1956.

The continued high rate of imports also resulted from purchasing activity by the United States Government: first, because industrial consumers, unable to obtain domestic concentrate at market prices,

[1] Commodity specialist.
[2] Statistical clerk.
[3] A short-ton unit is 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.

relied on foreign supply; second, because large quantities of concentrate were delivered to the National Stockpile under long-term foreign contracts.

Industrial consumption in 1955 exceeded the average for the preceding 10 years by 11 percent and more than doubled the low consumption of 1954. Such fluctuation is characteristic of the tungsten industry, which reflects many trends of industrial activity because of use of this metal in processing other materials.

TABLE 1.—Salient statistics of tungsten ore and concentrate in the United States,[1] 1946–50 (average) and 1951–55, in thousand pounds of contained tungsten

	1946–50 (average)	1951	1952	1953	1954	1955
Mine production	3,718	5,914	7,233	9,259	13,166	15,833
Mine shipments:						
Thousand pounds of contained tungsten	3,789	5,973	7,244	9,128	13,030	15,619
Short tons, 60 percent WO_3 basis	3,981	6,275	7,611	9,590	13,691	16,412
General imports [2]	8,252	7,533	16,995	29,130	[3] 23,044	20,789
Consumption	6,936	11,410	8,634	7,734	4,037	8,967
Stocks:						
Producers	452	234	208	363	362	523
Consumers and dealers	4,334	4,038	2,816	4,335	3,913	3,502
Total	4,786	4,272	3,024	4,698	4,275	4,025

[1] Includes Alaska.
[2] Ore and concentrate received in the United States; part went into consumption during year, and remainder entered bonded warehouses or Government stocks.
[3] Revised figure.

DOMESTIC PRODUCTION

Domestic production of tungsten concentrate exceeded consumption for the third consecutive year and reached a new high for the second consecutive year. Previous records had been established in 1943 and 1954. Mine shipment and value data, table 3, reveal the effects of the sustained price incentive; production increased more than threefold between 1950 and 1955. Table 4 shows that Nevada and California, with more than 60 percent of total production to date, have supplied nearly equal quantities of concentrate.

Scheelite comprised about 74 percent of the total production in 1955 and hübnerite, wolframite, and ferberite minerals, about 26 percent. California, Nevada, and Montana produced chiefly scheelite; North Carolina, Idaho, and Colorado (Lake County) produced hübnerite; and Colorado (Boulder County) produced ferberite. These six States supplied 98 percent of domestic output.

The 5 largest mines in 1955 produced 48 percent of the Nation's tungsten ore; the 10 largest, 73 percent; the 15 largest, 82 percent; and the 40 largest, 92 percent; more than 700 other producers combined supplied only 8 percent. None of this latter group produced as much as 1,000 units during the year.

All ore produced required beneficiation, and typically the mine and mill were in close proximity under single ownership. Otherwise mine operators were limited by haulage costs and by possible shortage of custom-milling facilities. A further limitation was in the grade of concentrate that a given beneficiation plant could produce. Many plants produced both specification-grade concentrate, for direct sale to the Government, and low-grade concentrate, for shipment to a chemical plant (for conversion to synthetic scheelite).

Salt Lake Tungsten Co. (in the intermountain area), Union Carbide Nuclear Co. (near Bishop, Calif.), and Wah Chang Corp. (at Glen Cove, Long Island, N. Y.) were the largest firms accepting low-grade concentrate for chemical treatment on a custom basis.

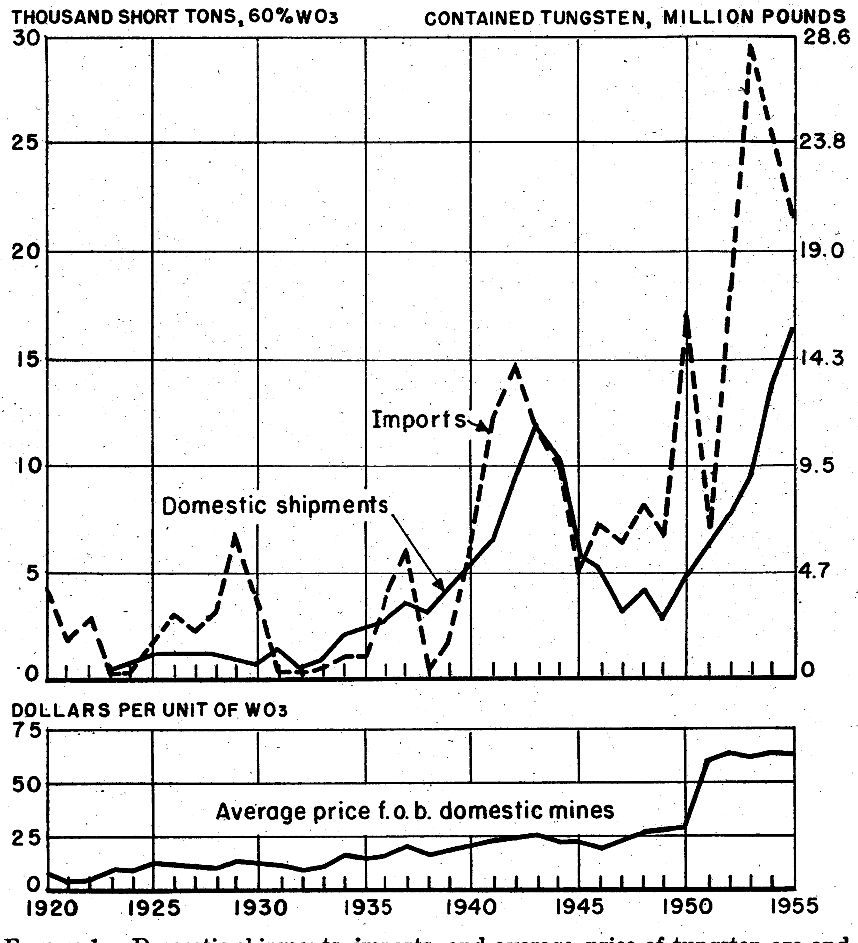

FIGURE 1.—Domestic shipments, imports, and average price of tungsten ore and concentrate, 1920–55.

The Hamme mine of Tungsten Mining Corp., Vance County, N. C., was the only major tungsten producer in the Eastern States and the leading tungsten producer in the Nation in 1955. Nearly 1,000 tons per day was hoisted through 2 operating shafts, each 1,625 feet deep. Mining of the steeply dipping, quartz-vein deposit was by a square-set method. The well-equipped mill produced high-grade hübnerite concentrate plus lesser quantities of scheelite. The high-grade concentrate was sold directly to the Government for stockpiling. The

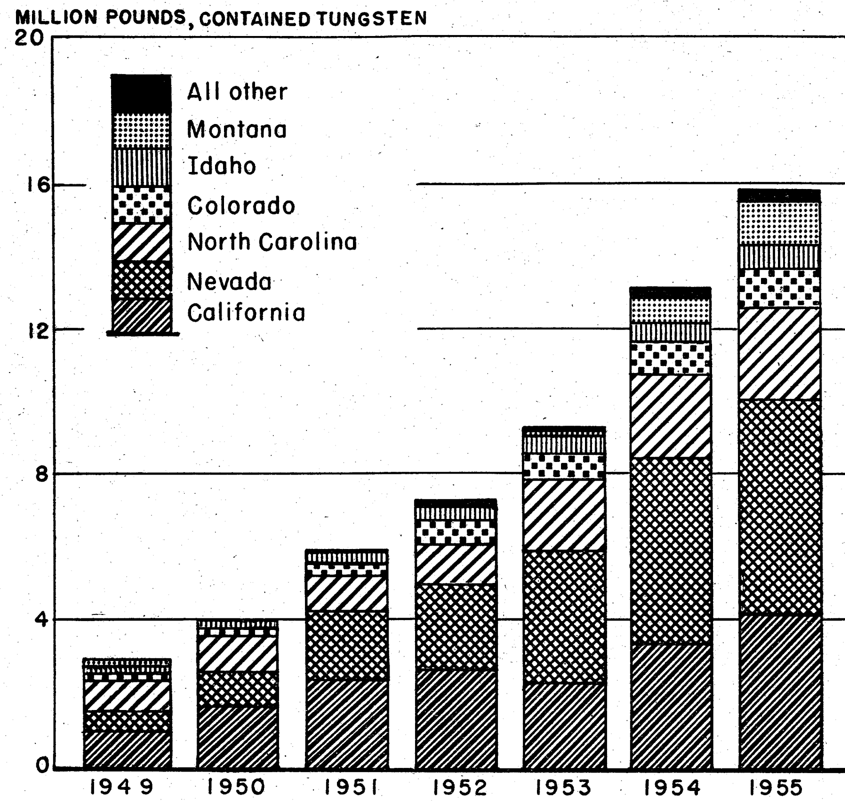

FIGURE 2.—Domestic tungsten production, by States, 1949–55 (pounds of contained tungsten).

low-grade concentrate was converted to high-grade synthetic scheelite, at the mine site in a chemical plant, which began operation on March 15, 1955.

The Climax Molybdenum Co. mine, Lake County, Colo., produced a substantial quantity of byproduct hübnerite. The ore was mined by a large-scale caving method, and tungsten concentrate was recovered (after removal of molybdenum) with Humphrey Spirals.

Scattered and relatively small scale operations in Boulder County, Colo., produced ferberite.[4] Ores were treated chiefly in custom mills, which employed gravity methods. A small chemical plant in Boulder produced synthetic scheelite (10 to 15 short-ton units of WO_3 per day) from low-grade concentrate.

Nevada and California mines produced ore, principally scheelite, from underground, open-pit, and, to a smaller extent, placer operations. Of the 15 largest producers in 1955, 6 were in Nevada and 4 in California. The ore was beneficiated primarily by flotation, followed by acid leaching of calcium and phosphorus. The Pine Creek mine of Union Carbide Nuclear Co., Inyo County, Calif., was the second

[4] Belser, Carl, Study of Tungsten Potential in Boulder County, Colo.: Bureau of Mines Inf. Circ. 7721 July 1955, 39 pp.

TABLE 2.—Tungsten concentrate produced and shipped in the United States, 1954–55, by States [1]

State	Produced				Shipped from mines			
	1954		1955		1954		1955	
	Tungsten content (1,000 pounds)	Short-ton units (WO_3)[2]	Tungsten content (1,000 pounds)	Short-ton units (WO_3)[2]	Tungsten content (1,000 pounds)	Short-ton units (WO_3)[2]	Tungsten content (1,000 pounds)	Short-ton units (WO_3)[2]
Alaska	(3)	15	(3)	3				
Arizona	126	7,951	172	10,857	125	7,890	172	10,857
California	3,342	210,674	4,180	263,517	3,343	210,743	4,172	263,002
Colorado	884	55,694	1,094	68,937	883	55,643	1,097	69,145
Idaho	488	30,752	574	36,160	448	28,231	611	38,514
Montana	641	40,427	1,299	81,902	645	40,681	1,152	72,642
Nevada	5,189	327,125	5,929	373,812	5,073	319,854	5,858	369,329
New Mexico	(3)	25	(3)	51	(3)	25	(3)	51
North Carolina	2,398	151,166	2,511	158,304	2,416	152,296	2,483	156,537
Oregon	(3)	3	(3)	30	(3)	3	(3)	30
South Dakota	(3)	8			(3)	8		
Utah	80	5,031	62	3,873	80	5,031	62	3,873
Washington	18	1,153	12	725	17	1,058	12	731
Total	13,166	[4] 830,024	15,833	998,171	13,030	[4] 821,463	15,619	984,711

[1] Concentrate has been credited to State in which it was mined, although subsequent beneficiation and sale may have been elsewhere.
[2] For conversion to short tons of 60 percent WO_3, divide by 60.
[3] Less than 1,000 pounds.
[4] Revised figure.

ranking domestic producer; the firm also treated substantial quantities of ore on a custom basis.

The Ivanhoe mine, Beaverhead County, Mont., operated by Minerals Engineering Co., produced 800 tons of ore per day by an open-pit method. In subsequent beneficiation, a high-grade scheelite concentrate for direct sale to the Government and a low-grade concentrate for shipment to Salt Lake Tungsten Co., Salt Lake City, Utah, were produced.

The leading producer in Idaho was the Bradley Mining Co. Ima mine, Lemhi County. Square-setting and room-and-pillar mining methods were used. This firm also produced high-grade concentrate

TABLE 3.—Tungsten concentrate shipped from mines in the United States,[1] 1946–50 (average) and 1951–55

Year	Quantity		Reported value f. o. b. mines [2]		
	Short-ton units WO_3	Tungsten content (pounds)	Total	Average per unit of WO_3	Average per pound of tungsten
1946–50 (average)	238,864	3,788,877	$5,907,328	$24.73	$1.56
1951	376,532	5,972,551	22,976,028	61.02	3.85
1952	456,663	7,243,589	28,970,264	63.44	4.00
1953	575,448	9,127,756	35,943,533	62.46	3.94
1954	[3] 821,463	[3] 13,030,046	[3] 51,433,357	62.61	3.95
1955	984,711	15,619,486	60,841,157	61.79	3.90

[1] Includes Alaska.
[2] Values apply to finished concentrate and in some cases are f. o. b. custom mills.
[3] Revised figure.

TABLE 4.—Shipments from domestic mines of tungsten ore and concentrate (60-percent WO_3 basis) by States, 1946–50 (average) and 1951–55, shipments for maximum year, and total shipments, 1900–55, in short tons [1]

State	Maximum shipments		Shipments by years							Total shipments, 1900–55	
	Year	Quantity	1946–50 (average)	1951	1952	1953	1954	1955 Quantity	1955 Percent of total	Quantity	Percent of total
Alaska	1916	47	9	10	8	3				211	0.11
Arizona	1936	489	12	11	71	134	132	181	1.10	4,443	2.41
California	1955	4,383	1,280	3,007	2,980	2,382	3,512	4,383	26.70	55,693	30.23
Colorado	1917	2,707	182	336	625	817	927	1,152	7.02	29,109	15.80
Connecticut	1916	3								11	.01
Idaho	1943	4,648	215	377	333	441	471	642	3.91	17,846	9.69
Missouri	1940	13	1							37	.02
Montana	1955	1,211	25	1		14	678	1,211	7.38	2,449	1.33
Nevada	1955	6,155	1,486	1,482	2,329	3,683	5,331	6,155	37.50	57,546	31.23
New Mexico	1915	45					(2)	1	.01	104	.06
North Carolina	1955	2,609	764	1,041	1,254	2,074	2,538	2,609	15.90	13,694	7.43
Oregon	1952	4	1	1	4	(2)	(2, 3)	1	.01	9	(4)
South Dakota	1917	270	(2)		(2)	2	(2)			1,298	.70
Texas	1946	1	(2)							1	(4)
Utah	1954	84	6	(2)	3	35	84	65	.40	426	.23
Washington	1938	303	(2)	9	4	5	18	12	.07	1,374	.75
Total	1955	16,412	3,981	6,275	7,611	9,590	13,691	16,412	100.00	184,251	100.00

[1] Shipments are credited to the State where final concentrate was produced, except for 1953, 1954, and 1955, when shipments are credited to State where ore was mined.
[2] Less than 1 ton.
[3] Revised figure.
[4] Less than 0.01 percent.

for direct sale and low-grade concentrate requiring additional treatment.

The Defense Minerals Exploration Administration reported 433 tungsten applications from inception of the program to December 31, 1955, an increase of 42 during the year. Contracts executed numbered 111, of which 32 remained in force at the year end. Certifications of discovery totaled 32. The maximum Government participation authorized to date was $3.1 million, and the total estimated cost of the projects was $4.1 million.

CONSUMPTION AND USES

During 1955 consumption of tungsten concentrate increased 122 percent compared with 1954. Table 5 shows that the largest quantity of concentrate was consumed by manufacturers of hydrogen-reduced metal powder. The metal powder was subsequently used in carbides, pure metal applications, and steel and other alloys. In 1955 manufacture of carbides for metal cutting tools, rock bits, hard facing, and other materials consumed 2,687,000 pounds of tungsten-metal powder including both hydrogen and carbon reduced. Pure metal products for lamp filaments, electronics, and other applications used an estimated 1,250,000 pounds of hydrogen-reduced metal powder, and a smaller amount went into steel and other alloys. Steel-ingot manufacturers consumed a larger proportion of total tungsten than is shown in table 5 because, in addition to concentrate, they also used metal powder and substantial quantities of scrap.

TABLE 5.—Distribution of tungsten concentrate consumed in 1955

	Tungsten (pounds)	Short tons (60 percent WO_3)	Percent of total
Manufacturers of steel ingots and ferrotungsten	2,957,000	3,107	33
Manufacturers of hydrogen-reduced metal powder [1]	3,948,000	4,148	44
Manufacturers of carbon-reduced metal powder and tungsten chemicals and consumption of firms making several products [1]	2,062,000	2,167	23

[1] Includes the entire consumption by firms that use tungsten concentrate primarily for the purpose listed except the quantities used to produce ferrotungsten.

The high melting point of tungsten (3,410° C.) does not permit ready melting and casting, with the result that chemical refining and powder-metallurgy fabrication have been developed for producing tungsten metal and tungsten carbide. Chemical processes designed for treating wolframite-type minerals are unsatisfactory for treating scheelite and vice versa. The principal consumers of wolframite-type concentrate were the manufacturers of hydrogen-reduced powder. Whereas the principal consumers of scheelite were the manufacturers of alloy steel.

Table 6 lists shipments of High Speed and Tool steels in recent years and, for comparison, in 1949. Percentages of constituent alloys for the different grades are given and the trend to Class A from Class B High-Speed steel can be seen. The following data, in tons, computed from table 6, show a 25-percent increase in tungsten consumption compared with a 374-percent increase in molybdenum consumption.

	1949	1955
Class A (tungsten content)	203	895
Class B (tungsten content)	1,036	657
Class A (molybdenum content)	229	1,152
Class B (molybdenum content)	16	10

As in previous years, tungsten was added to steel and certain other alloys, as scheelite (either natural or synthetic), as ferrotungsten, as scrap, or as metal powder. Scheelite of suitable grade was added without further treatment, except that it was usually nodulized to prevent dust losses. Scrap was processed in various ways depending on its composition and physical properties; some was converted to synthetic scheelite; some was cleaned and formed into buttons or briquets, and in some instances it was charged to the furnace without processing. Ferrotungsten was produced by reduction of concentrate in electric furnaces with carbon or silicon or by aluminothermic or silicothermic methods.

For conversion to ferrotungsten any of the tungsten minerals may be used, separately or in combination, provided the iron-tungsten ratio will permit formation of an alloy containing 70 percent or more of tungsten.[5] Because of its high melting temperature, ferrotungsten cannot be conveniently melted and tapped. It is made during a campaign of about 3 days during which a button of ferrotungsten builds up as new charges are added and slag is removed. When the furnace is full it must be dismantled so that the ferrotungsten can be cleaned of lining material and broken to size.

[5] Li, K. C., and Wang, C. Y. Tungsten: Reinhold Publishing Corp., New York, 1955, 506 pp.

TABLE 6.—Shipments of High-Speed and Tool steel [1] (excluding hollow drill steel)

(Short tons)

CLASS A HIGH-SPEED STEEL

Grade	C (min.)	Cr (max.)	W (max.)	Mo (max.)	V	Co	Shipments 1955	1954	1953	1949
I	0.60	4.5	6.75	5.5	[2] 2.1	0.0	10,504	6,446	11,311	2,540
I-b	.90	4.5	6.75	6.5	[3] 2.25	.0	847	489	566	104
I-c	.60	4.5	6.75	5.5	[2] 2.2	[3] 3.5	118	59	85	208
II	.60	4.5	2.0	9.25	[2] 1.3	.0	5,899	3,222	5,283	560
II-c	.60	4.5	2.0	9.25	[2] 2.2	[3] 3.5	153	139	176	26
III	.60	4.5		9.25	[2] 2.2	.0	4,088	2,443	3,684	151
III-c	.60	4.5		9.25	[2] 2.2	[3] 3.5	7	17	44	29
Total							21,616	12,815	21,149	3,618

CLASS B HIGH-SPEED STEEL

Grade	C (min.)	Cr (max.)	W (max.)	Mo (max.)	V	Co	1955	1954	1953	1949
IV	0.55	4.5	19.0	0.0	[2] 1.3	0.0	2,366	1,838	2,336	4,041
IV-b	.55	4.5	19.0	[2] 1.25	[3] 1.75	.0	284	204	259	391
IV-c	.55	4.5	22.0	[2] 1.25	[2] 2.2	[3] 3.5	695	498	841	884
Total							3,345	2,540	3,436	5,316

OTHER TOOL STEELS

Grade	Description	1955	1954	1953	1949
V	All hot-work steel	12,062	8,857	14,229	5,140
VI	High chromium (4 percent Cr. minimum) die steels.	10,488	7,832	8,619	4,707
VII	All other alloy tool steels	52,949	40,342	53,257	26,251
VIII	Carbon tool steels, excluding hollow drill steel	15,468	12,626	16,941	12,968
Total		90,967	69,657	93,046	49,066
Grand total		115,928	85,012	117,631	58,000

[1] American Iron and Steel Institute.
[2] Maximum.
[3] Minimum.

STOCKS

Stocks held by industry at the year end were lower than in 1954 and 10 percent below the preceding 10-year average. Virtually all stocks of consumers and dealers came from foreign sources, and stocks held by producers were destined for the Government stockpile.

PRICES

Domestic tungsten concentrate of specification grade [6] was purchased throughout 1955 by the General Services Administration for the Government stockpile at a base price of $63 per short ton unit of WO_3. The average price reported to the Bureau of Mines for concentrate shipped was $61.79.

United States Government purchases of foreign concentrate were under terms of individually negotiated long-term contracts, and the prices varied.

Prices in 1955, quoted from E&MJ Metal and Mineral Markets, are given in table 7.

[6] Geehan, Robert W., Tungsten: Minerals Yearbook, 1952, pp. 1070–1072.

TABLE 7.—Prices of tungsten concentrate in 1955

Domestic price per short-ton unit, f. o. b. milling point[1]		Imported, c. i. f. U. S. ports, duty extra[2]		London per long-ton unit of WO_3 wolfram
		Wolfram	Scheelite	
Jan. 6	$63	$25.75@$26.25	$27.50@$28.00	196s bid, 200s asked.
Feb. 3	63	30.00@ 31.00	31.00@ 32.00	240s bid, 250s asked.
Mar. 3	63	33.00@ 33.50	34.00@ 34.50	250s 6d bid, 262s 6d asked.
Apr. 7	63	27.50@ 28.00	31.00@ 32.00	208s bid, 218s asked.
May 5	63	33.00@ 33.50	33.50@ 34.00	260s bid, 265s asked.
June 2	63	32.50@ 33.00	33.50@ 34.00	252s bid, 257s asked.
July 7	63	32.00@ 33.00	33.00@ 34.00	252s bid, 257s asked.
Aug. 11	63	33.50@ 34.50	34.50@ 35.00	260s bid, 265s asked.
Sept. 1	63	33.50@ 34.00	34.50@ 35.00	257s 6d bid, 262s 6d asked.
Oct. 6	63	34.00@ 34.50	35.00@ 35.50	271s bid, 275s asked.
Nov. 3	63	33.50@ 34.00	34.50@ 35.00	256s 2d bid, 259s asked.
Dec. 1	63	33.00@ 33.50	34.00@ 34.50	244s bid, 249s asked.
Average		31.77	33.31	
Duty		7.93	7.93	
Average price duty paid		39.70	41.24	

[1] Specifications cited in footnote 6 (p. 8).
[2] Known good analysis, basis 65 percent.

FOREIGN TRADE [7]

Imports of tungsten concentrate in 1955 were third highest in history, with Bolivia, by far the largest supplier. Korea, Portugal, Canada, Australia, Brazil, Belgian Congo, and Spain followed in that order, and each supplied over 1 million pounds (tungsten content). These 8 countries furnished 77 percent of United States imports.

Table 8 lists general imports and imports for consumption in 1954 and 1955. Both classifications include concentrate that entered duty free for the United States Government.

In 1955, 283 tons of concentrate was reexported and 34 tons exported compared with 149 and 39 tons in 1954. This is expressed in gross weight because the tungsten content is not known.

Imports for consumption of ferrotungsten are listed in table 9. A slight decrease in imports from Europe and a substantial increase in imports from Japan is shown. The reported value, per pound of contained metal, increased from $1.67 in 1954 to $1.88 in 1955. Reexports of ferrotungsten were 10,000 pounds (to the United Kingdom) and exports were 3,318 pounds (to Canada).

Imports of tungsten metal, tungsten carbide, and combinations containing tungsten or tungsten carbide were 89,221 pounds (tungsten content); value was listed as $241,116.

Other tungsten-bearing materials imported for consumption in 1955 were tungstic acid (220 pounds, tungsten content, valued at $394); tungsten nickel, etc.; and other tungsten alloys not specifically provided for (44,861 pounds, tungsten content, valued at $152,260).

Reexports of tungsten metal and alloys in crude form and scrap were 353,532 pounds valued at $82,071; exports were 520,618 pounds valued at $231,670.

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

Scrap was imported duty-free under Public Law 869, 81st Congress; imports of tungsten metal, alloy, or carbide scrap in recent years are listed below:

	Gross weight, pounds
1953	202, 836
1954	314, 622
1955	347, 546

Semifabricated forms exported were 42,020 pounds valued at $711,892 and also 106,260 pounds of tungsten powder, exported mostly to Canada, valued at $705,584.

TABLE 8.—Tungsten ore and concentrate imported into the United States, 1954–55, 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
1954					
North America:					
Canada	[3] 2, 381, 388	[3] 1, 317, 468	[3] 2, 360, 685	[3] 1, 315, 952	[3] $4, 257, 783
Mexico	1, 531, 891	814, 089	1, 494, 762	794, 482	2, 203, 573
Total	[3] 3, 913, 279	[3] 2, 131, 557	[3] 3, 855, 447	[3] 2, 110, 434	[3] 6, 461, 356
South America:					
Bolivia	9, 808, 195	4, 896, 346	9, 808, 195	4, 896, 346	16, 706, 586
Brazil	2, 633, 515	1, 454, 628	2, 491, 768	1, 366, 767	3, 122, 505
Peru	1, 423, 106	791, 249	1, 606, 383	892, 153	2, 477, 484
Total	13, 864, 816	7, 142, 223	13, 906, 346	7, 155, 266	22, 306, 575
Europe:					
Finland	37, 799	20, 240	37, 799	20, 240	30, 790
France	563, 830	288, 059	607, 922	310, 789	818, 952
Germany, West	30, 000	17, 256	30, 000	17, 256	24, 048
Portugal	3, 133, 451	1, 812, 134	3, 746, 654	2, 118, 199	5, 794, 907
Spain	5, 912, 970	3, 192, 067	5, 965, 645	3, 222, 126	10, 687, 254
Total	9, 678, 050	5, 329, 756	10, 388, 020	5, 688, 610	17, 355, 951
Asia:					
Burma	925, 002	493, 450	1, 966, 074	1, 010, 787	1, 660, 498
Hong Kong	36, 792	17, 620	166, 356	91, 710	184, 877
Indonesia	44, 757	25, 182			
Japan	35, 026	17, 733	35, 026	17, 733	15, 068
Korea, Republic of	9, 010, 360	4, 289, 331	9, 010, 360	4, 289, 331	17, 244, 832
Malaya	275, 849	148, 994	264, 371	142, 721	227, 149
Thailand	1, 011, 416	549, 184	1, 194, 232	663, 896	1, 327, 899
Total	11, 339, 202	5, 541, 494	12, 636, 419	6, 216, 178	20, 660, 323
Africa:					
Belgian Congo	1, 884, 680	1, 046, 842	1, 869, 978	1, 038, 664	3, 574, 020
Egypt	30, 010	15, 470			
Rhodesia and Nyasaland, Federation of	264, 910	147, 079	284, 343	158, 865	270, 992
Union of South Africa	609, 433	323, 496	683, 694	365, 042	1, 238, 689
Total	2, 789, 033	1, 532, 887	2, 838, 015	1, 562, 571	5, 083, 701
Oceania:					
Australia	2, 645, 787	1, 329, 442	2, 797, 458	1, 417, 814	4, 314, 532
New Zealand	66, 847	37, 205	66, 847	37, 205	68, 730
Total	2, 712, 634	1, 366, 647	2, 864, 305	1, 455, 019	4, 383, 262
Grand total	[3] 44, 297, 014	[3] 23, 044, 564	[3] 46, 488, 552	[3] 24, 188, 078	[3] [4] 76,251, 168

See footnotes at end of table.

TABLE 8.—Tungsten ore and concentrate imported into the United States, 1954–55, by countries—Continued

[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
1955					
North America:					
Canada	3, 571, 784	1, 920, 782	3, 571, 730	1, 920, 708	$6, 826, 499
Mexico	1, 689, 790	855, 129	1, 670, 205	846, 138	2, 281, 184
Total	5, 261, 574	2, 775, 911	5, 241, 935	2, 766, 846	9, 107, 683
South America:					
Argentina	1, 669, 734	888, 255	1, 669, 734	888, 255	2, 548, 443
Bolivia	9, 363, 317	4, 601, 357	9, 363, 317	4, 601, 357	14, 875, 093
Brazil	2, 381, 546	1, 317, 237	2, 458, 826	1, 347, 273	3, 226, 622
Peru	1, 679, 499	953, 431	1, 668, 154	947, 304	3, 107, 155
Total	15, 094, 096	7, 760, 280	15, 160, 031	7, 784, 189	23, 757, 313
Europe:					
Finland	185, 186	100, 845	130, 401	69, 824	119, 559
France	386, 432	203, 921	571, 989	306, 699	581, 843
Germany, West	26, 610	14, 608	81, 725	45, 901	61, 575
Netherlands	11, 052	6, 416	11, 052	6, 416	12, 947
Portugal	3, 424, 163	1, 933, 615	3, 507, 825	2, 000, 161	4, 264, 386
Spain	1, 970, 081	1, 035, 436	1, 915, 077	1, 009, 475	3, 206, 321
United Kingdom	26, 450	19, 143	18, 734	14, 860	29, 524
Total	6, 029, 974	3, 313, 984	6, 236, 803	3, 453, 336	8, 276, 155
Asia:					
Burma	609, 584	324, 391	948, 683	527, 509	813, 010
Hong Kong			21, 783	11, 905	25, 143
Japan	279, 276	161, 291	300, 951	174, 407	328, 751
Korea, Republic of	4, 388, 900	2, 413, 434	3, 062, 038	1, 721, 799	2, 720, 531
Malaya	236, 693	128, 268	229, 723	127, 630	191, 916
Thailand	1, 340, 546	741, 719	1, 643, 422	914, 973	1, 529, 756
Total	6, 854, 999	3, 769, 103	6, 206, 600	3, 478, 223	5, 609, 107
Africa:					
Belgian Congo	2, 058, 466	1, 162, 417	2, 007, 333	1, 132, 040	2, 988, 085
Egypt			1, 067	550	1, 190
Federation of Rhodesia and Nyasaland	19, 322	10, 043	15, 322	7, 991	14, 124
Nigeria			5, 130	2, 844	6, 715
Union of South Africa	609, 034	316, 515	623, 832	328, 251	1, 268, 856
Total	2, 686, 822	1, 488, 975	2, 652, 684	1, 471, 676	4, 278, 970
Oceania:					
Australia	3, 075, 499	1, 678, 583	3, 196, 074	1, 742, 678	5, 122, 129
New Zealand	4, 274	2, 203	4, 274	2, 580	3, 368
Total	3, 079, 773	1, 680, 786	3, 200, 348	1, 745, 258	5, 125, 497
Grand total	39, 007, 238	20, 789, 039	38, 698, 401	20, 699, 528	56, 154, 725

[1] Comprises ore and concentrate received in the United States; part went into consumption during year, and remainder entered bonded warehouses.
[2] Comprises ore and concentrate withdrawn from bonded warehouses during year and receipts during year for consumption.
[3] Revised figure.
[4] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data known not to be comparable with other years.

TECHNOLOGY

The surplus of tungsten supply in 1955 brought increased impetus to the search for new and expanded utilization. Concurrent developments in jet and rocket transport, electronics, nuclear energy, and possibly other fields stimulated research for development of new and

TABLE 9.—Ferrotungsten imported for consumption in the United States, 1954–55, by countries

[U. S. Department of Commerce]

Country	1954			1955		
	Gross weight (pounds)	Tungsten content (pounds)	Value	Gross weight (pounds)	Tungsten content (pounds)	Value
Europe:						
Austria				33,069	26,454	$51,505
Netherlands	10,479	8,801	$15,526			
Portugal	333,166	269,895	496,810	307,390	251,630	478,409
Sweden	6,831	5,003	10,772	77,058	64,436	110,962
United Kingdom	256,194	207,576	299,943	102,203	84,077	188,594
Total	606,670	491,275	823,051	519,720	426,597	829,470
Asia: Japan	11,023	8,929	14,367	315,600	250,391	446,038
Grand total	617,693	500,204	837,418	835,320	676,988	1,275,508

better materials. These factors combined to focus attention on the exceptional properties of tungsten.

A research program initiated in November 1955 by the Tungsten Institute (an association of producers of concentrate) and conducted by the Stanford Research Institute was aimed at increased use of tungsten. In particular, development of a tungsten-base alloy for high-temperature applications (such as blades and vanes of jet aircraft), was sought.

Despite the abundance of tungsten in 1955, domestic measured reserves were believed to be inadequate for long-term self-sufficiency, and Bureau of Mines research continued its efforts to develop a dependable domestic supply. Projects included: Investigation and classification of tungsten deposits, studies of flotation techniques to improve recovery, and studies of hydrometallurgy to improve the quality of products.

Research reported by the consuming industry was largely related to improvement in operating and manufacturing techniques [8] and new processes.[9]

[8] Engineering and Mining Journal, How Shop Practice Can Improve Tungsten Carbide Bit Performance: Vol. 156, No. 8, August 1955, p. 84.
Elliott, B., and Evans, J., The Use of Tungsten Carbide in the Sheet-Metal Industry: Sheet Metal Ind., vol. 32, No. 343, November 1955, pp. 813–821.
Loftin, G. E., Carbide Program Slashes Tool-Breakage Costs: Iron Age, vol. 175, No. 11, Mar. 17, 1955, pp. 106–108.
Caldwell, Van, War on Wear: Steel, vol. 137, No. 22, Nov. 28, 1955, pp. 98–101.
Thurston, G. H., How to Choose Hard Surfacing Alloys: Ind. and Welding, vol. 28, No. 6, June 1955, pp. 54–57, 140–141.
Levi, R., New Method for Machining Sintered Tungsten: Precision Metal Molding, vol. 13, No. 3, March 1955, pp. 58–60.
Cotter, P. G., Kohn, J. A., and Potter, R. A., Improved Tungsten Carbide-Cobalt Compacts by Electric-Resistance Sintering: Bureau of Mines Rept. of Investigations 5100, 1955, 19 pp.
Stevens, A. D., New Manufacturing Techniques Assure Maximum Carbide Utility: Tooling and Production, vol. 20, No. 11, February 1955, pp. 91–95.
Shierlaw, N. C., Retipping Tungsten Carbide-Tipped Drill Steel: Chem. Eng. and Min. Rev., vol. 47, No. 12, Sept. 10, 1955, pp. 473–482.

[9] Iron Age, Flame Plating Clads for Better Wear Resistance: Vol. 176, No. 17, Oct. 27, 1955, pp. 88–89.
Powell, C. F., Campbell, I. E., and Gonser, B. W., Vapor Plating: John Wiley & Sons, Inc., New York, 1955, 158 pp.
National Bureau of Standards, Analysis of Jet-Engine Alloys: Tech. News Bull., vol. 39, No. 10, October 1955, p. 146.
U. S. Atomic Energy Commission, The Reactor Handbook, General Properties of Materials: AECD-3647, March 1955, pp. 113–122, 373–381.

The third revision of a comprehensive survey of the tungsten mining and processing industry was published during the year,[10] and a publication of the Tungsten Institute was also released.[11]

Mining.—Methods varied with the size and mode of mineral occurrence. Mines were scattered and essentially small scale, with no more than 3 or 4 of the largest producing as much as 1,000 tons of ore per day. About 80 percent of the mine production came from underground; shrinkage, open-stope, and square-set methods were commonly used, as well as various adaptations of other methods. In addition to production from underground, substantial components of the output of Nevada-Massachusetts Co., Getchell Mine, Inc., and the Benton Division, California mine of Wah Chang Mining Corp., came from open-pit operations.

Open-pit methods at the Ivanhoe mine in Montana, a small-lease operation in the Atolia district of California, a Boulder County, Colo., operation, and the Lincoln mine in Nevada were described.[12]

Milling.—Beneficiation methods tended to remain unchanged from those of 1954, although flowsheets varied widely. There appeared to be a preference for straight flotation of scheelite ores gravity concentration of ferberite, and combined gravity and flotation of hübnerite. The crude ore treated totaled approximately 2,270,000 tons, and concentrate recovered was reported at about 945,000 short-ton units of WO_3, excluding byproduct concentrate. Recoveries of 90 percent were not uncommon, but the average was undoubtedly closer to 80 percent. Thus, assuming an 80-percent recovery, the average grade of ore mined and milled was about 0.5 percent WO_3; the lowest grade was probably not much below 0.3 percent. The mill product was frequently below the grade specified by industrial consumers, because stockpile specifications were somewhat less rigid; industry usually specified concentrate containing 70 percent or more WO_3, whereas the National Stockpile minimum requirement was 55 percent WO_3. The latter specifications were listed in the Tungsten chapter of Minerals Yearbook, 1952. The chemical treatment of low-grade concentrate by the Salt Lake Tungsten Co. was described.[13]

Mining and beneficiation methods of the principal producers are listed in table 10.

---

[10] Work cited in footnote 5.
[11] Andrews, Mildred Gwin, Tungsten: Tungsten Inst., Washington, D. C., 1955, p. 28.
[12] Mining World, How Minerals Engineering Opens Big Low-Grade Tungsten Deposit: Vol. 17, No. 1, January 1955, pp. 38–43.
Rintoul, Bill, Teen Agers Mine Tungsten for a Profit: Eng. Min. Jour., vol. 156, No. 11, November 1955, pp. 97–99.
Mining World, How a Small Miner Makes 0.15-Percent Tungsten Pay: Vol. 17, No. 9, August 1955, pp. 44–47.
Dayton, Stanley H., Low Mining Costs Spark Growth at Wah Chang's Nevada Operation: Mining World, vol. 17, No. 11, October 1955. pp. 46–51.
[13] Burwell, Blair T., Synthetic Scheelite: Min. World, vol. 17, No. 7, June 1955, pp. 44–49.

TABLE 10.—Fifteen principal tungsten mines in the United States

Company	Mine	Mine location	Principal mineral	Type of deposit	Ore mined, tons	Mining method	Milling method	Remarks
Bradley Mining Co.	Ima	Lemhi County, Idaho.	Hübnerite	Quartz vein	63,000	Square-set, room and pillar.	Gravity, flotation, magnetic.	
Climax Molybdenum Co.	Climax	Lake County, Colo.	See remarks	Disseminated	See remarks.	Caving	Humphrey spiral	Hübnerite byproduct recovered from molybdenum ore.
Cold Spring Tungsten, Inc.	Cold Spring	Boulder County, Colo.	Ferberite	Quartz vein		Square-set	Gravity.	
Gabbs Exploration Co.	Victory	Nye County, Nev.	Scheelite	Contact-metamorphic.	22,000	Shrinkage, open-stope.	Gravity, flotation, acid leach, magnetic.	
Getchell Mines, Inc.	Getchell	Humboldt County, Nev.	do	do	183,000	Shrinkage and open-pit.	Flotation, acid leach.	
Minerals Engineering Co.	Ivanhoe	Beaverhead County, Mont.	do	do	227,000	Open-pit	Flotation	Ships to Salt Lake Tungsten
Nevada-Massachusetts Co.	Tungsten Group	Pershing County, Nev.	do	do	213,000	Shrinkage, square-set and open-pit.	Gravity, flotation, acid leach.	
Nevada Scheelite Division of Kennametal, Inc.	Leonard	Mineral County, Nev.	do	do	42,000	Square-set	Gravity, flotation, magnetic.	
New Idria Mining & Chemical Co.	Strawberry	Madera County, Calif.	do	do	23,000	Open-stope, glory hole.	Gravity, flotation, magnetic.	
Surcease Mining Co.	Atolia	San Bernardino County, Calif.	do	Quartz vein, alluvium.		Open-pit, square-set.	Gravity flotation	Block leasing supplies nearly 60 percent of output.
Tungsten Mining Corp.	Hamme	Vance County, N. C.	Hübnerite	Quartz vein	324,000	Square-set	Gravity, flotation, magnetic.	Low-grade converted to synthetic scheelite.
Union Carbide & Nuclear Co.	Pine Creek	Inyo County, Calif.	Scheelite	Contact-metamorphic.		Sub-level, open-stope.	Flotation, chemical	Produced synthetic scheelite.
Do	Riley	Humboldt County, Nev.	do	do		Open-stope	None, ore treated by Getchell.	
Wah Chang Mining Corp.	Benton Division	Mono County, Calif.	do	do	108,000	Open-pit, room and pillar.	Flotation, leaching	
Do	Lincoln Division	Lincoln County, Nev.	do	do	225,000	Shrinkage	Flotation, gravity, acid leach.	

WORLD REVIEW

World production of tungsten concentrate was slightly higher in 1955 than in 1954, with much of the increase from United States mines. United States production plus imports comprised 46 percent of the estimated world production, and (excluding Russia, China, and North Korea) comprised 73 percent of the Free World production. North and South America increased their output, while Europe decreased; Asia, Africa, and Oceania increased production by small amounts. Improved supply and approaching fulfillment of United States stockpile objectives, generally discouraged expansion of existing productive facilities.

Africa.—All of Africa supplied only an estimated 6 percent of Free World production. Belgian Congo, including Ruanda-Urundi, furnished the largest share, and the Union of South Africa ranked second in importance. Operations in the O'okiep district, South Africa, were described.[14]

Argentina.—A new concentrating plant at the Los Condores mine supplied most of the 50-percent production increase over 1954, although Government fiscal policies were also a factor. It was reported that some production was held by producers in anticipation of better prices until December 1955, when a decree permitted foreign-exchange conversion of tungsten exports at the free-market rate of 40 pesos to the dollar instead of the previous rate of 14 to the dollar.

Australia.—Production in 1955 increased slightly from the 1954 output, with the largest quantity coming from King Island Scheelite, Ltd., which treated nearly 1,000 tons of ore per day.

Bolivia.—Although exports to the United States were less in 1955 than in 1954, Bolivia supplied nearly one quarter of the total United States imports of concentrate.

Brazil.—Production and exports to the United States changed little from 1954. Brazil was the sixth ranking supplier to the United States; however, the potential productive capacity was believed to be greater than past output would indicate.

Burma.—Production more than doubled, although exports to the United States declined. The Mawchi mine, formerly a large-scale producer of tin-tungsten concentrate, was reportedly undergoing rehabilitation, but final plans were not announced.

Canada.—The Department of Mines and Technical Surveys, Ottawa, reported the following preliminary data:

Item:	*1954, short tons*	*1955, short tons*
Production (shipments), WO_3	1,085	1,141
Imports (gross weight):		
Scheelite	4	46
Ferrotungsten	43	57
Exports, scheelite (W content)	619	855
Consumption (W content):		
Scheelite	7	24
Ferrotungsten	31	42
Tungsten metal and tungsten powder	14	22
Tungsten carbide and carbide powder	26	47
Tungsten wire and misc	7	6
Total consumption	85	141

[14] Richardson, D. R., High-Grade WO_3 Concentrate From Complex Low-Grade Ore: Min. World, vol. 17, No. 6, May 1955, pp. 50-51.

TABLE 11.—World production of tungsten ore and concentrate (60-percent WO_3 basis), by countries, 1946–50 (average) and 1951–55, in short tons.[1]

(Compiled by Pearl J. Thompson)

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	368	2	1,243	2,037	1,809	1,903
Mexico	91	358	488	752	759	626
United States (shipments)	3,981	6,275	7,611	9,591	13,691	16,412
Total	4,440	6,635	9,342	12,380	16,259	18,941
South America:						
Argentina	138	157	474	661	873	[2] 1,225
Bolivia (exports)	2,705	2,996	4,086	4,216	4,900	5,935
Brazil (exports)	1,197	1,567	1,967	2,146	1,513	1,410
Peru	532	517	644	1,001	849	893
Total	4,572	5,237	7,171	8,024	8,135	9,463
Europe:						
Finland	[3] 26	9	52	24	139	146
France	553	866	1,082	1,443	1,043	1,187
Italy	8	8	8	30	33	26
Norway	------	------	13	9	------	------
Portugal	2,629	5,675	5,824	5,581	5,076	5,115
Spain	773	2,814	6,040	3,252	2,827	1,461
Sweden	432	422	371	485	504	510
U. S. S. R.[2]	5,200	8,300	8,300	8,300	8,300	8,300
United Kingdom	88	67	61	67	101	[2] 110
Yugoslavia	------	------	------	132	[2] 110	[2] 110
Total (estimate)	9,700	18,200	21,800	19,300	18,100	17,000
Asia:						
Burma	1,001	1,816	2,425	2,205	1,323	2,927
China [2]	9,400	17,400	22,000	18,700	19,800	19,800
Hong Kong	------	25	115	165	33	28
India	1	17	11	17	1	------
Japan	29	183	531	805	860	873
Korea:	2,255					
North [2]		1,300	1,300	1,650	1,650	1,650
Republic of		1,433	4,519	8,267	4,630	3,757
Malaya	54	60	87	162	127	138
Thailand	[2] 900	[2] 1,500	[2] 1,750	1,929	1,323	1,367
Total (estimate)	13,600	23,700	32,700	33,900	29,700	30,500
Africa:						
Algeria	------	24	54	33	------	------
Belgian Congo [4]	449	720	1,113	1,403	1,685	1,733
Egypt	3	8	23	15	4	21
French Morocco	2	42	20	13	14	------
Nigeria	6	25	25	20	1	3
Rhodesia and Nyasaland, Federation of: Southern Rhodesia	55	255	463	419	281	270
South-West Africa	8	36	130	165	115	133
Tanganyika (exports)	[3] 21	17	15	13	6	10
Uganda (exports)	166	176	157	197	204	177
Union of South Africa	198	207	290	425	675	708
Total	908	1,510	2,290	2,703	2,985	3,055
Oceania:						
Australia	1,355	2,076	2,393	2,660	2,563	2,765
New Zealand	30	39	69	44	33	[2] 33
Total	1,385	2,115	2,462	2,704	2,596	2,798
World total (estimate)	34,600	57,400	75,800	79,000	77,800	81,800

[1] This table incorporates a number of revisions of data published in previous Tungsten chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[2] Estimate.
[3] Average for 1948–50.
[4] Including Ruanda-Urundi.

In British Columbia, the Emerald, Dodger, and Feeney ore bodies of Canadian Exploration, Ltd., supplied 151,912 tons of scheelite ore averaging 0.88 percent WO_3, furnishing about 85 percent of the total Canadian output.

Burnt Hill Tungsten & Metallurgical, Ltd., New Brunswick, reported considerable development and two shipments of wolframite concentrate during the year.

A plant operated by a division of Kennametal, Inc., Port Coquitlam, British Columbia, produces tungsten carbide and tungsten powder. No ferrotungsten was made in Canada.

Korea.—Plans by the Korea Tungsten Mining Co. for constructing a chemical plant to treat mill concentrate was reportedly nearing completion at the year end. Construction of the plant was estimated to require about 18 months; the capacity, after completion, will be about 400 tons of tungsten product a month. During 1955 production was limited by lack of demand, and concentrate was sold at auction to industrial consumers in the United States. Production dropped nearly 20 percent compared with 1954.

Portugal.—Production was between 5,000 and 6,000 tons of concentrate, a rate held since 1950. This appears to indicate near-capacity production from the two leading producers, the Panasqueira wolfram mine and the Borralha.

Spain.—Production declined almost 50 percent to a rate lower than any year since 1950; a principal factor was termination of purchases for stockpiling by the United States Government.

Uranium

By John E. Crawford [1]

HIGHLIGHT of the year 1955 was the First International Conference on the Peaceful Uses of Atomic Energy at Geneva, Switzerland, August 8–20, 1955. The United States was a major participant, furnishing evidence of its leadership in the field of atomic energy. Representation by 73 other countries indicated worldwide interest in nuclear energy to supplement conventional fuels.

In the United States, interest in uranium prospecting had reached a zenith by mid-1955. Established metal-mining firms and oil companies were becoming a major factor in the uranium-exploration picture. Many small uranium producers were consolidating or selling out to larger concerns. This shift was partly because deposits were no longer being found as frequently near the surface; deep drilling required capital and equipment not heretofore necessary in uranium exploration.

Milling capacity gave indications of catching up with mine production. With expansion of existing facilities and planned construction underway, there appeared to be some hope for relief from the delay in ore processing that was reported to be of concern to the industry.

Uranium-refinery production of normal uranium metal and uranium tetrafluoride proceeded satisfactorily, and fissionable-materials centers continued their recovery of plutonium and uranium–235 during 1955.

Research, test, propulsion, prototype power, and power-reactor investigations were given considerable attention the world over. U. S. S. R. announced the completion and operation of the first full-scale commercial power reactor. Construction of the Atomic Energy Commission (AEC) Westinghouse power reactor at Shippingport, Pa., continued. The AEC received several interesting proposals for power reactors, which were being considered carefully.

GOVERNMENT REGULATIONS

In 1955, Defense Minerals Exploration Administration (DMEA) contracts in uranium exploration totaled $1.3 million representing 41 executed and amended. The Government has participated for a total of $3.2 million in contractual obligations since inception of the program.

The Office of Defense Mobilization (ODM), Executive Office of the President, issued six certificates of necessity in 1955 involving uranium raw-material projects. Construction included mine and mill facilities, and the total amount certified for accelerated amortization was about $12.8 million.

[1] Commodity specialist.

Of 470 miles of access roads to uranium mines begun, 84 miles was completed. Total cost of the 470 miles involved was estimated to be about $5.9 million.

Public Law 357, approved August 11, 1955, commonly referred to as the Lignite Bill, provided for the location, upon discovery of a valuable uraniferous material, on public lands of the United States classified as or known to be coal bearing.

TABLE 1.—Defense Minerals Exploration Administration contracts involving uranium executed and amended during 1955, by States [1]

State and contractor	County	Contract	
		Date	Total amount
ARIZONA			
Globe Uranium, Inc	Gila	July 1955	$49,285
Marble Canyon Uranium, Inc	Coconino	September 1955	32,440
COLORADO			
Bowles-Heflin Mining Co	San Miguel	December 1955	19,228
Climax Uranium Co.	Mesa (and Grand County, Utah).	July 1955	69,385
Eula Belle Uranium, Inc	Mesa and Montrose	June 1955	12,603
Foothills Mining Co	Jefferson	September 1955	15,276
Golden Cycle Corp	San Miguel and Montrose	April 1955	30,440
Hamilton et al. Mining Co	Mesa	July 1955	36,004
Do	San Miguel	July 1955	25,836
Radium Hill Uranium, Inc	Montrose	May 1955	10,124
Kenneth J. Revis, et al	Larimer	September 1955	11,800
Uranium Prospectors Co., Ltd	Montrose	June 1955	11,502
W. A. Greer	San Miguel and Montrose	July 1955	37,535
Western Oil Fields, Inc	Montrose	July 1955	10,550
Yankee Uranium Co	do	August 1955	33,828
IDAHO			
Bitterroot Uranium, Inc	Lemhi	Amended: June 1955	[2] 18,175
MONTANA			
George M. Hoffman	Jefferson	June 1955	26,025
NEW MEXICO			
Colamer Corp	McKinley	do	114,430
Do	McKinley and Valencia	do	12,555
Richard Vopat	McKinley	Amended: March 1955	[2] [3] 2,975
NEW YORK			
Edward John Chalmers	Westchester	February 1955	11,020
UTAH			
Amuranium Corp	San Juan	January 1955	147,650
Chatu Uranium Mining Co., Inc	Grand	September 1955	19,480
Continental Uranium Co	San Juan	June 1955	46,330
Great Frontier Mining Corp	Grand	do	21,138
J. Walter Duncan, Jr	San Juan	July 1955	76,088
Klondike Uranium, Inc	Grand	October 1955	19,132
Mid-Continent Uranium Corp	do	September 1955	48,420
Ray Ryan & Jim R. Maynard	Emery	July 1955	34,824
Silver Pick Uranium, Inc	San Juan	November 1955	16,304
Sunnyside Uranium Co	Piute	Amended: July 1955	[2] [3] 19,220
Uranium King Corp	San Juan	October 1955	18,700
Uranium Prospectors Co. Ltd	Emery	do	57,552
Uranium Prospectors Co. Ltd	do	May 1955	32,742
Utah Premier Uranium Co	San Juan	July 1955	25,400
Utah Uranium, Inc	Washington	April 1955	7,290
Vaughey and Vaughey	Emery	September 1955	31,824
WASHINGTON			
Dahl Uranium Mine, Inc	Spokane	August 1955	4,300
WYOMING			
Gaddis Mining Co	Fremont	July 1955	31,220
Shannon Oil Co	Crook	September 1955	59,360
Wyoming Uranium Corp	Fremont	August 1955	25,500

[1] Government participation, 75 percent, except as noted.
[2] Does not include amount of contract executed in 1954.
[3] Government participation, 90 percent.

TABLE 2.—Certificates of necessity involving uranium, certified by Office of Defense Mobilization for assistance through tax amortization during 1955, by States [1]

Company	Type of project	Date certified	Percentage of depreciable assets certified	Amount allowed for accelerated amortization
ARIZONA				
Rare Metals Corp	Uranium-ore-processing plant	Sept. 29, 1955	80	$1,883,000
COLORADO				
Climax Uranium Co	Facilities for mining uranium ore.	Apr. 29, 1955	80	75,000
Do	Uranium-ore-processing plant	do	80	1,216,000
SOUTH DAKOTA				
Mines Development Co., Inc.	do	Sept. 23, 1955	80	1,352,000
UTAH				
Uranium Reduction Co	do	Sept. 8, 1955	80	8,000,000
Vitro Uranium Co	do	Mar. 21, 1955	80	246,000
Total				12,772,000

[1] Office of Defense Mobilization, SIC listing of certificates of necessity.

TABLE 3.—Construction in 1955 of defense access roads serving uranium mines and cumulative total for 1952–55

[Bureau of Public Roads]

State	Total work involved			Projects completed			Work accomplished on incomplete projects		
	Total estimated cost [1]	Access funds [2]	Miles	Total estimated cost	Access funds	Miles	Total estimated cost [2]	Access funds [2]	Miles
Arizona	$195,000	$195,000	86.7	$85,000	$85,000	18.2			68.5
Colorado	2,599,423	2,438,424	72.9	1,191	1,191	(3)	$210,037	$172,848	72.9
New Mexico	46,000	46,000	5.3						5.3
Utah	2,735,475	2,401,470	255.2	247,192	247,192	65.4	657,858	389,081	189.8
Wyoming	270,000	270,000	50.0						50.0
Total	5,845,898	5,350,894	470.1	333,383	333,383	83.6	867,895	561,929	[4] 386.5
Cumulative total, 1952–55	11,530,378	10,849,303	1,347.5	6,947,691	6,455,654	1,127.0			

[1] Includes Federal aid, State, and county funds.
[2] Funds based on percentage of work completed.
[3] Engineering study only.
[4] No work started on 220.5 miles.

DOMESTIC PRODUCTION

Mine Production.—In 1955 exploration and development activities of private industry were contributing successfully to the efforts initiated years earlier by AEC. Government-exploration drilling was less than 600,000 feet; industry drilling totaled approximately 5 million feet.

About 20 miles north of Grants, McKinley County, N. Mex., in the Ambrosia Lake area, a major uranium discovery was made. Initial results of investigations immediately available indicated a multi-million-ton ore deposit at depth.

Development of and production from the autunite occurrences on the Spokane Indian Reservation, Stevens County, Wash., continued. The mineralization was found in fractures at or near the contact of metamorphosed sediments of Paleozoic age and a granite intrusive.

Commercial-grade uranium ore was developed from sediments of the Gulf Coastal Plain in Texas. Secondary uranium minerals occurred in tuffaceous sandstone. Active exploration was being conducted on the deposits, the largest of which were believed to be in Karnes County.

Most deposits were flat-lying sedimentary beds, the uranium content of which as a rule averaged 0.1 to 0.5 percent of U_3O_8. Many deposits were small, containing 10,000 tons or less of ore, but it was estimated than 80 percent of the present production was derived from deposits of 50,000 tons to several of 100,000 tons, with several in the multimillion-ton class. Ore production increased 43 percent over 1954.[2]

Large metal-mining, oil, and coal companies established comprehensive programs for exploration for and production of uranium. More costly deep-drilling investigations with major capital investment were necessary to explore for and develop uranium occurrences adequately, because surface outcrops had been explored and exploited in past years.

Appreciable quantities of uranium were recognized in South Dakota, North Dakota, and Montana lignites. Only a small amount of the considerable tonnage of uranium-bearing bituminous material estimated to be available was mined during 1955, owing to lack of satisfactory uranium-recovery processes.

The first find in Oregon of uranium of commercial significance was made. Secondary uranium minerals were discovered near Lakeview, Lake County, associated with some realgar and orpiment and controlled by faulting in brecciated, altered tuffaceous beds. No output was recorded from the area.

Because of detailed development work, impressive additions to ore reserves were made on the Laguna Indian Reservation, N. Mex.; Big Indian Wash, Lisbon Valley district, Utah; the Red Canyon and White Canyon areas of Utah; and other districts of the Colorado Plateau.

Uranium mining in the Colorado Plateau area of Arizona, Colorado, New Mexico, and Utah continued during 1955. Underground mining operations were becoming more extensive, and deeper deposits were worked with more modern equipment and techniques.

Mill Production.—The uranium-milling capacity of the United States about doubled in 1955; nevertheless, more ore was produced than could be processed. Nine mills operating in 1955 were: Union Carbide Nuclear Co., Rifle and Uravan, Colo.; Vanadium Corp. of America, Durangeo and Naturita, Colo.; Climax Uranium Co., Grand Junction, Colo.; Kerr-McGee Oil Industries, Inc., Shiprock, N. Mex.; Anaconda Co., Grants, N. Mex.; Vitro Uranium Co., Salt Lake City, Utah; and the Atomic Energy Commission, Monticello, Utah. Major expansion took place at six plants: Anaconda Co. Bluewater, N. Mex., unit; the Government-owned Monticello, Utah, mill; Climax Uranium Co. Grand Junction Colo. plant; Vanadium Corp. of America, Naturita, Colo., mill; the Vitro Chemical Co. Salt Lake City (Murray), Utah, operation; and Union Carbide Nuclear Co. Uravan, Colo., plant.

In 1955 five additional processing-mill contracts were signed; mills under construction were: Uranium Reduction Co., Moab, Utah; Mines

[2] Rude, Eric R., Uranium: Min. Cong. Jour., vol. 42, No. 2, February 1956, pp. 78–81.

Development Inc., Edgemont, S. Dak.; Rare Metals Corp. of America, Tuba City, Ariz.; Trace Elements Corp., Maybell, Colo.; and Continental Uranium, Inc., La Sal, Utah. The new construction was expected to be completed by early 1957. Negotiations were underway between AEC and industry relative to the construction of additional facilities on the Colorado Plateau and elsewhere. When the 5 new mills mentioned above are completed, 14 uranium-ore-processing mills will be operating in the United States.

As a byproduct of phosphatic fertilizer and chemical production, a small tonnage of uranium was recovered from Florida phosphate rock. The processing units were operated by: Blockson Chemical Co., Joliet, Ill.; International Minerals & Chemical Corp., Bartow, Fla.; and Virginia-Carolina Chemical Corp., Nichols, Fla. The U. S. Phosphoric Products Division, Tennessee Corp., was constructing a unit for obtaining uranium as a byproduct from phosphate at East Tampa, Fla.

The AEC established ore-buying stations at Riverton, Wyo., and Cutter, Ariz. An ore-buying station was to be opened at Tuba City, Ariz., early in 1956, and another ore-buying station near Grants, N. Mex., was being considered. American Smelting & Refining Co. operated the AEC ore-purchase stations under a fixed-fee contract.[3]

Refinery Production.—Uranium refineries, called feed-materials production centers by the AEC, continued to produce natural uranium metal and uranium tetrafluoride from foreign and domestic material. The Fernald, Ohio, refinery was run by National Lead Co. of Ohio and the St. Louis, Mo. plant by Mallinckrodt Chemical Works. Mallinckrodt Chemical Works will operate a facility under construction at the Weldon Springs Ordinance Works, 27 miles west of St. Louis.

In October 1955 the AEC publicly indicated interest in industrial participation with respect to the refining of uranium ores and concentrates. It requsted that qualified firms submit proposals by October 1956 for processing concentrates to produce uranium trioxide, uranium tetrafluoride, or uranium hexafluoride, with deliveries of product to begin about April 1, 1959. Proposals would be considered that allowed for any production rate up to 5,000 tons of equivalent U_3O_8 per year.

Production of Fissionable Uranium.—Fissionable uranium–235 was produced at Oak Ridge, Tenn.; Paducah, Ky.; and Portsmouth, Ohio. Union Carbide & Carbon Corp. operated the plants at Oak Ridge, Tenn., and Paducah, Ky.; for the AEC. Goodyear Atomic Corp., a subsidiary of Goodyear Tire & Rubber Co., managed the Portsmouth installation for the AEC.

Phillips Petroleum Co. recovered uranium–235 from spent reactor-fuel elements at the AEC National Reactor Testing Station near Arco, Idaho.

---

[3] Rude, Eric R., Uranium: Min. Cong. Jour., vol. 42, No. 2, February 1956, pp. 78–81.
Johnson, Jesse C., Uranium Resources for Industrial Power: Mines Mag., vol. 45, No. 5, May 1955, pp. 35–36, 48.
Kratchman, Jack, Uranium: Eng. Min. Jour., vol. 157, No. 2, February 1956, pp. 90–92.
Clark, Edward L., Uranium Activity on the Colorado Plateau: Min. Eng., vol. 8, No. 2, February 1956, p. 152.
Atomic Energy Commission, Domestic Uranium Program in 1955: Press release, Jan. 1, 1956, 9 pp.
Colorado Mining Association, 1956 Mining Yearbook, Domestic Uranium Program in 1955: Denver, Colo., pp. 172–175.

TECHNOLOGY

United States delegates to the Geneva Conference on the Peaceful Uses of Atomic Energy presented detailed geologic descriptions of uranium deposits in Colorado, Arizona, New Mexico, Utah, Wyoming, South Dakota, Montana, Tennessee, Florida, and other parts of the United States. Methods of prospecting for uranium were also explained.[4]

Some 25 to 30 detailed papers on uranium milling were presented at the conference. The AEC found the conference an appropriate time to declassify nearly all data relative to recovering uranium concentrate from ore.

Five processes for precipitating uranium from the sulfuric-acid leach solutions were described: straight precipitation, reduction precipitation, electrolysis, ion exchange, and solvent extraction.[5]

During late 1955 the AEC proceeded to review all papers and reports on uranium milling in an attempt to declassify as many as possible during 1956 and make them available for public distribution.

At the Geneva Conference, information was also released on uranium-refining procedures.[6]

The process being used by the United States involved: (1) Digestion of the ore concentrate in nitric acid, forming an aqueous uranyl nitrate solution; (2) extraction of uranium from the solution by solvent extraction with tributyl phosphate in kerosene or with ether; (3) reextraction of the uranium into water, producing a highly purified aqueous uranium solution; (4) evaporation of the dilute aqueous solution to a more concentrated form; (5) thermal decomposition (denitration) of the concentrated solution, forming an orange-colored uranium trioxide; (6) reduction of the trioxide with hydrogen to form the brown uranium dioxide; and (7) contacting the brown dioxide with gaseous hydrogen fluoride to produce uranium tetrafluoride.[7]

Many new data on the design and operation of power-reactor prototypes, reactor-fuel metallurgy, and chemical processing were

[4] International Conference on the Peaceful Uses of Atomic Energy, Geology of Uranium and Thorium: Proc., vol. 6, 1956 825 pp.

[5] The following references are from Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, August 8–20, 1955, vol. 8, 1956:
Marvin, G., Upchurch, T., Greenleaf, E., Van Blarcom, E., and Morphew, A., Recovery of Uranium From Its Ores; Production Technology of the Materials Used for Nuclear Energy: pp. 3–7.
Gaudin, A. M., Principles and New Developments in Uranium Leaching: Pp. 8–12.
Stephens, F. M. Jr. and Macdonald, R. D., Alkaline Leaching of Uranium Ores: Pp. 18–25.
McClaine, L. A., Bullevinkel, E. P., and Huggins, J. C., Carbonate Chemistry of Uranium Theory and Applications: Pp. 26–37.
Rosenbaum, J. B., and Clemmer, J. B., Accelerated Thickening and Filtering of Uranium Leach Pulps: Pp. 38–44.
Preuss, A., and Kurin, R., A General Survey of Types and Characteristics of Ion-Exchange Resins Used in Uranium Recovery: Pp. 45–48.
Grinstead, R., Ellis, D. A. and Olson, R. S., Recovery of Uranium From Sulfuric Acid and Carbonate Leach Liquors by Anion Exchange: Pp. 49–53.
Hollis, R. F., and McArthur, C. K., The Resin-in-Pulp Process for Recovery of Uranium: Pp. 54–63.
Grinstead, R. R., Shaw, G. K., and Long, R. S., Solvent Extraction of Uranium From Acid Leach Slurries and Solutions: Pp. 71–76.
Huttl, J. B., Vitro's Key to Successful Uranium Leaching: Eng. Min. Jour., vol. 156, No. 9, September 1955, pp. 100–104.
Engineering and Mining Journal, Uranium Milling Roundup at Geneva: Vol. 156, No. 10, October 1955, pp. 75–77, 103.

[6] Wilhelm, H. A., The Preparation of Uranium Metal by the Reduction of Uranium Tetrafluoride With Magnesium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 8, Production Technology of the Materials Used for Nuclear Energy, pp. 162–174.
Kopelman, B., Fundamental Considerations in the Reduction Processes of Thorium and Uranium: Pp. 175–183.

[7] Kelley, W. E., Separating and Purifying Reactor Fuel From Uranium-Ore Concentrates: Nucleonics, vol. 13, No. 11, November 1955, pp. 68–71.
Chemical Engineering, In Uranium Drama Chemical Process Plays Star Role: Vol. 62, No. 10, October 1955, pp. 112–114.

released at Geneva. The exchange of information was expected to result in the advancement of nuclear-power technology.[8]

CONSUMPTION AND USES

Production Reactors.—Natural uranium metal prepared at feed-materials production centers was used in production reactors to produce the element plutonium artificially. The large, water-cooled, graphite-moderated reactors were located at the AEC Hanford, Wash., installation, operated by General Electric Corp., and the Savannah River center of the AEC near Aiken, S. C., managed by E. I. du Pont de Nemours & Co. The plutonium recovered by remote chemical methods was required in manufacturing atomic bombs and other nuclear weapons developed by the Department of Defense and the AEC.

Power Reactors.—Good progress was made on the first full-scale nuclear-power reactor—the pressurized water reactor at Shippingport, Pa. Westinghouse Electric Corp. was responsible for the nuclear portion of the plant and Duquesne Light Co. for the conventional side.

Yankee Atomic Electric Co. and Consolidated Edison proposed to build modified versions of the PWR without Government financial support.

The AEC received 4 proposals for power reactors, each with a capacity of 75,000 or more kilowatts of electricity, which it planned to review and determine if practicable. The proposals were:

1. Dresden, Ill.; 180,000-kilowatt-capacity, boiling-water reactor, to be completed by 1960, proposed by Nuclear Power Group, primary member of which was Commonwealth Edison Co., Chicago, Ill.
2. Northwest Massachusetts; 100,000-kilowatt-capacity, light-water moderated and cooled reactor, to be completed by 1958, proposed by Yankee Atomic Electric Co., Boston, Mass.
3. Monroe, Mich.; 100,000-kilowatt-capacity, fast-breeder reactor, to be completed by 1959, proposed by a public utilities study group, the primary member of which was Detroit Edison Co., Detroit, Mich.
4. Columbus, Nebr.; 75,000-kilowatt-capacity, sodium-graphite reactor, to be completed in 1959, proposed by Consumers Public Power District of Columbus, Nebr.

The proposals of Commonwealth Edison Co. and associates and Detroit Edison Co. and associates were approved for contract negotiation in 1955. It was determined later in the year that the Commonwealth Edison proposal was not a request for financial assistance under the power demonstration reactor program and could be considered, therefore, a request for license.

The AEC determined that Yankee Atomic Electric Co. and Consumers Public Power district of Columbus, Nebr., proposals were not acceptable under criteria established for the demonstration program. Both proposals were revised and resubmitted to the AEC later in 1955. The Consumers Public Power plan was accepted by the Commission as a basis for contract negotiations. The Yankee Atomic Electric proposal was still being reveiwed at the end of 1955.

---

[8] International Conference on the Peaceful Uses of Atomic Energy, Power Reactors: Proc., vol. 3, 1956, 389 pp. Reactor Technology and Chemical Processing: Proc., vol. 9, 1956, 770 pp.

In March 1955 Consolidated Edison Co. asked permission to erect at Indian Point, N. Y., a 236,000-kilowatt (electrical output) nuclear power reactor. The pressurized-water reactor would consume enriched uranium and breed fissionable uranium–233 produced from thorium.

The Rural Cooperative Power Association at Elk River, Minn., in June 1955 suggested to the Rural Electrification Administration and the AEC that a 22,000-kilowatt nuclear powerplant be established at Elk River, Minn. It requested the AEC to pay for the reactor and REA to finance the turbogenerator system. The reactor was outlined as a closed-cycle boiling-water model, with a secondary steam system.[9]

The AEC was notified by Westinghouse Electric Corp. and Pennsylvania Power & Light Co. that jointly they were engaged in the design development of a full-scale homogeneous nuclear-power reactor. Apparently no Government support was requested.

The Army Package Power Reactor, a small transportable type for remote locations, was under construction at Fort Belvoir, Va., and was expected to develop some 1,825 kilowatts of electricity.

Propulsion Reactors.—The first nuclear-propelled submarine, the U. S. S. *Nautilus,* traversed more than 25,000 miles without reactor mishaps. The second nuclear-powered submarine, the U. S. S. *Seawolf,* was being outfitted at the Electric Boat Division of the General Dynamics Co., Groton, Conn.

At the Knolls Atomic Power Laboratory, Schenectady, N. Y., run by General Electric Co., work was underway on the Submarine Advanced Reactor project, the prototype of the reactor that is expected to propel the third nuclear submarine.

Combustion Engineering, Inc., contracted with the AEC to design and develop a reactor for the Submarine Reactor, Small, project, the fourth of the submarine nuclear applications studies instigated by the AEC and the Department of the Navy.

The design and development work on the Large Ship Reactor project were continued during 1955 by Westinghouse Electric Corp. at its Bettis Plant, Pittsburgh, Pa. The prototype of the reactor was to be constructed at the National Reactor Testing Station in Idaho.

Work on the aircraft nuclear propulsion project was accelerated in 1955. General Electric Co. Aircraft Nuclear Propulsion Department, Evandale, Ohio, continued its investigations, and a test facility was erected at the National Reactor Testing Station in Idaho. Some test work at the facility was begun. Pratt & Whitney Engine Division of United Aircraft was engaged in studies on nuclear power for aircraft at Middleton, Conn., in conjunction with the United States Air Force.[10] The Consolidated Vultee Aircraft Corp. at Fort Worth, Tex., also conducted some cooperative research on Air Force nuclear problems.

Prototype Power-Reactor Studies.—The Borax reactor studies were results of Argonne National Laboratory work. The Borax II reactor was put to test in early 1955 at the National Reactor Testing Station, Idaho, to ascertain the effects of transient conditions upon boiling-

[9] Atomic Energy Commission, 18th Semiannual Report of the Atomic Energy Commission: July 1955, p. 42. Major Activities in the Atomic Energy Programs: January 1956, pp. 47–48.
Bello, F., Year One of the Peacetime Atom: Fortune, vol. 52, No. 2, August 1955, pp. 112–116, 170, 172, 175.
Lane, J. A., Economics of Nuclear Power: Research and Eng., vol. 1, No. 3, October–November 1955, pp. 22–27.
Nucleonics, vol. 13, No. 4, April 1955, p. 11.

[10] Atomic Energy Commission, Major Activities in the Atomic Energy Programs: January 1956, p. 51.

water reactor operations. Borax III, which was the Borax II reactor with a new fuel core installed and a 3,500-kilowatt turbine-generator added, went critical on June 9, 1955. On July 17, 1955, the nearby town of Arco, Idaho, was provided for 1 hour and 5 minutes with electricity from the plant.

The Experimental Boiling-Water Reactor project, the fourth of the series, was initiated during 1955. Construction was underway on the 5,000-kilowatt electrical output reactor at Lemont, Ill., under supervision of the Argonne National Laboratory.

The Sodium Reactor Experiment involved building a sodium-cooled, graphite-moderated, experimental reactor of 20,000-kilowatt heat capacity and was the responsibility of North American Aviation, Inc., in cooperation with the AEC. The unit was being erected at Santa Susana, Calif., 25 miles northeast of Los Angeles, to test the potentialities of the sodium heat-transfer mediums and other aspects of heterogeneous reactor design.

Experimental Breeder Reactor—2 was under development, but no construction was reported. The reactor was to generate 62,500 kilowatts of heat, 15,000 kilowatts of which would be converted into electricity.

The Homogeneous Reactor Experiment—2, being prepared by the Oak Ridge National Laboratory, was expected to be operating in 1956, utilizing a fuel solution of uranyl sulfate (about 90 percent uranium–235) in heavy water. A blanket of thorium oxide in heavy water will be tried as a breeder. The reactor was expected to operate at 5,220 kilowatts of heat.

The Los Alamos Power Reactor Experiments 1 and 2 were also aqueous-homogeneous-type reactors being completed at Los Alamos for testing in 1956. The fuel for both reactors was to be a uranyl phosphate solution but with a fuel-element design unlike that of the Homogeneous Reactor Experiment No. 2. Heat output of both reactors was expected to be less than 2,000 kilowatts. No electricity was to be generated.

The Organic-Moderated Reactor Experiment was the subject of negotiation between Atomics International, Inc., and the AEC. The reactor, which would demonstrate the use of hydrocarbon diphenyl as a moderator-coolant, was to be constructed at the National Reactor Testing Station. The Atomics International proposal was said to be the best of five submitted to the AEC.

The Brookhaven National Laboratory basic study of the liquid-metal fuel reactor was evaluated by a Babcock & Wilcox Co. group, which suggested that the necessary research and development required to bring a full-scale plant of the LMFR design into existence was justified. Construction and test of a small reactor experiment to explore the uranium in liquid-bismuth fuel theory were then to be considered.

Research and Test Reactors.—The Special Power Excursion Reactor Test facility and its remote control instrumentation was completed at the National Reactor Testing Station. The reactor was a light-water-moderated, heterogeneous reactor utilizing fully enriched uranium-fuel assemblies. It was to be operated by Phillips Petroleum Co. for research on transient condition in reactors.

The AEC indicated in August 1955 that it intended to construct and operate an Engineering Test Reactor at the National Reactor Testing Station, Idaho. Such a reactor would provide irradiation facilities of sufficient size for developing reactor components for military and civilian powerplants. The reactor was expected to operate at a level of 175,000 kilowatts of heat, be moderated and cooled with light water, and be fueled with uranium enriched in the isotope uranium–235.

The Materials Testing Reactor was used to its fullest capacity during 1955. The flux level of the test reactor was raised from about 3.5×10^{14} to 4.5×10^{14} neutrons per centimeter squared per second, allowing for more loadings at higher fluxes. The MTR was used by the AEC, the military department, and private industry, in determining the effects of neutron and gamma irradiation upon specified materials. It also provided for the production of high-intensity radioactive isotopes.

The Pennsylvania State University swimming-pool-type research reactor was brought to criticality in 1955. The reactor operated at a power level of 100 kilowatts (heat) but was expected to be raised to 1,000 kilowatts in the near future.

The North Carolina State College homogeneous "water boiler" research reactor was operating again, after shutdown for replacing the fuel-containment vessel, which had been badly corroded by the uranyl sulfate solution.

A heavy-water, CP–5 type, research reactor was under construction at the Massachusetts Institute of Technology. A Washington State University proposal requested the AEC to supply the fuel elements and some financial assistance for construction of a swimming-pool research reactor.

The Naval Research Laboratory swimming-pool research reactor was being constructed at Washington, D. C.

The Bulk Shielding Facility, the original swimming-pool research reactor at Oak Ridge National Laboratory, determined characteristics of various shielding arrangements.

The Oak Ridge Research Reactor was being erected at the Oak Ridge National Laboratory in 1955. It was a modified, enclosed swimming pool and had a forced water-cooling system separate from the shielding tank water.

The Low-Intensity Test Reactor, originally a mockup of the Materials Test Reactor, was converted into an active reactor in 1952 and has since operated at Oak Ridge successfully. The LITR is one of the cheapest reactors in existence per unit of flux.

The Brookhaven National Laboratory research reactor, a graphite-moderated, normal-uranium-fueled reactor at Upton, N. Y., was in constant operation during 1955. It was the first large-scale nuclear reactor designed and erected for fundamental research programs.

At Oak Ridge, Tenn., the graphite-moderated, air-cooled, normal-uranium-metal-fueled reactor continued to function. About 54 tons of uranium was used to maintain criticality and to provide enough excess reactivity for experimentation and radioisotope production.

Isotopes.—Radioactive isotopes were produced in Government research and test reactors, including the Oak Ridge National Laboratory Graphite Reactor, the Low-Intensity Test Reactor at Oak Ridge, the Brookhaven National Laboratory Reactor, the Materials Testing Reactor at the National Reactor Testing Station, and the CP–5 Reactor at the Argonne National Laboratory.

Iodine–131 made up 39 percent of total shipments of radioisotopes in 1955; phosphorus–32 furnished 20 percent of shipments; and 7 other radioisotopes supplied the remaining 41 percent.

TABLE 4.—Radioisotopes shipped by the U. S. Atomic Energy Commission, by kinds, 1946–55, in number of shipments

[Atomic Energy Commission]

Radioisotope	Shipments		Total shipments, Aug. 2, 1946 to Dec. 31, 1955
	Aug. 2, 1946, to Dec. 31, 1954	Jan. 1, 1955, to Dec. 31, 1955	
Iodine 131	23,736	4,964	28,700
Phosphorus 32	14,464	2,501	16,965
Carbon 14	1,918	467	2,385
Sodium 24	2,376		2,376
Gold 198	2,192		2,192
Hydrogen 3	243		243
Strontium 89, 90	776	148	924
Cobalt 60	945	239	1,184
Cesium 137	515	121	636
Iridium 192	131	62	193
Tritium		86	86
Polonium 210	113		113
Other	16,793	4,023	20,816
Total	64,202	12,611	76,813

Total shipments of radioisotopes in 1955 were 12,611, an increase of less than 1 percent over 1954 shipments.

Nonenergy Uses.—In 1955 the AEC authorized the use of 1,553 pounds of U_3O_8 contained in uranium compounds for nonenergy purposes.

Less uranium was apparently used in nonenergy fields in 1955 than in any other year of the 1951 through 1955 period. Total authorizations in 1955 were 38 percent less than in 1954. Chemical-industry requirements were 81 percent of total authorizations in 1955.

Weapons.—Fissionable uranium–235 and plutonium derived from natural uranium were consumed in manufacturing nuclear weapons designed by the Department of Defense and the AEC.

TABLE 5.—Radioisotopes shipped from Oak Ridge National Laboratory, by years, 1946–55

[Atomic Energy Commission]

Year	Shipments per year	Total shipments	Year	Shipments per year	Total shipments
1946	281	281	1951	9,475	28,899
1947	1,897	2,178	1952	10,691	39,590
1948	3,618	5,796	1953	12,027	51,617
1949	5,633	11,429	1954	12,585	64,202
1950	7,995	19,424	1955	12,611	76,813

TABLE 6.—Atomic Energy Commission authorizations for purchase of uranium compounds for nonenergy purposes in the United States, 1951–55, in pounds of contained U_3O_8

[U. S. Atomic Energy Commission]

Industry	1951	1952	1953	1954	1955
Chemical (including catalytic)	2,016	3,048	2,539	2,462	1,256
Glass (nondecorative uses)	875	1,627			205
Electrical	88	226	42	58	92
Total	2,979	4,901	2,581	2,520	1,553

PRICES

Uranium Ore.—The AEC-guaranteed purchase prices for uranium ore were the same in 1955 as in 1954. The ore-buying schedule was effective through March 31, 1962. The bonus plan for initial production of uranium ores from domestic mines was valid through February 28, 1957. AEC circulars 2, 5 (revised), and 6, describing specifications uranium-bearing materials must meet to be salable to the AEC and list prices paid by that agency for uranium ore, were published in the Uranium and Radium chapter of Minerals Yearbook, 1954.

Uranium Metal.—In August 1955 the AEC declared a sale price of normal uranium metal at $40 per kilogram, about $18 per pound, to qualified and licensed users in the United States and abroad, in those nations where bilateral agreements were signed with the United States.

Uranium–235.—The lease price for fissionable uranium–235 was announced by the AEC in August 1955 at $25 per gram of contained uranium–235, available in the United States to authorized purchasers and to countries that signed bilateral agreements with the United States.

FOREIGN TRADE

The United States received uranium ore and concentrate imports from the following: The Shinkolobwe mine in Belgian Congo; 13 plants that recovered uranium from gold ores and old tailings on the Witwatersrand, Union of South Africa; Canadian deposits at Great Bear Lake, Northwest Territories, the Beaverlodge region, Saskatchewan, and the Blind River area, Ontario; the Rum Jungle mine and mill, Australia; and the Urgeirica mine, Portugal. Purchases from foreign sources other than Canada were made through the Combined Development Agency, consisting of members of United States, Canada, and Great Britain atomic energy groups. Canadian material was received under contracts between the AEC and the responsible Canadian Government agency, Eldorado Mining & Refining, Ltd.

WORLD REVIEW

The world in 1955 viewed nuclear energy with less awe and more understanding than before. The Geneva Conference on the Peaceful Uses of Atomic Energy helped to disseminate much information of a technical and semitechnical nature relative to atomic energy which heretofor was unobtainable. Many lesser countries were encouraged with the possibility of developing within their universities and research organizations adequate knowledge for evolution of peacetime applications for the atom in their lands.

World requirements for nuclear power will depend in part upon the ability of man to produce energy more economically from fissionable material than from other sources, chiefly coal and petroleum. An integral part of the problem is the availability of the raw materials. Some countries lack coal and petroleum reserves; in others the cost of recovering the material makes the prospects for economic nuclear power in the next decade look promising. England, France, and Russia have begun important nuclear-power-station construction programs, and many other countries, including Belgium, Denmark, India, Italy, Hungary, Japan, Netherlands, Norway, Sweden, and Yugoslavia, are establishing nuclear-research institutes for the development of peaceful applications of nuclear energy. Uranium and thorium may economically complement coal and petroleum in some high-cost power areas by 1970 or earlier.

About 73 countries were represented at the International Conference on the Peaceful Uses of Atomic Energy, August 8–20, 1955, at Geneva, Switzerland. The meeting was supported by the world as a whole. Discussions revealed that the accomplishments of nations working individually and in strict secrecy up to this point actually were very similar. Reports were made by many countries of the world. The Geneva papers (more than 1,000 reports) were to be published in several languages in 1956.

NORTH AMERICA

Canada.—Uranium-ore production increased markedly in 1955. The Gunnar mine in the Lake Athabaska area of Saskatchewan came into production, and the Pronto mine in the Algoma district, Ontario, also began to recover uranium ore. Eldorado Mining & Refining, Ltd., placed in operation new refining facilities at Port Hope, Ontario, for the production of metal-grade uranium oxide (UO_3).

The 1,250-ton-per-day mill at the Gunnar mine began treating ore in August 1955 and was officially opened in October 1955. The Gunnar mine was initially an open-pit operation, but a 1,200-foot shaft was being sunk to permit recovery of ore from greater depths.

Eldorado Mining & Refining, Ltd., continued full-scale production at its Beaverlodge properties in Saskatchewan. Plans were undertaken to expand the capacity of the Eldorado Beaverlodge treatment plant to 2,000 tons per day. Consolidated Nicholson, National Explorations, Nesbitt LaBine, and Rix-Athabaska also mined ore in the same area and shipped it to the Eldorado mill for concentration.

In the Northwest Territories, production continued at Eldorado Mining & Refining, Ltd., mine at Port Radium. Re-treatment of old tailings, accumulated when the mine was operated for radium, furnished some of the output. Other companies conducted exploration and development work on properties in the Northwest Territories, including Rayrock Mines, Ltd., Consolidated Northland Mines, Ltd., and United Uranium Corp., Ltd.[11]

Large reserves of relatively low grade but commercial, uranium-bearing material were indicated by diamond drilling in the Blind River region of Ontario. The Pronto mine in the Blind River region brought its 1,250-ton-a-day mill into operation in August 1955. Algom Uranium Mines, Ltd., began to erect two 3,000-ton-a-day processing plants in the Blind River region, 1 at its Quirke Lake property and the other at the Nordic Lake prospect. The Quirke Lake mine was expected to go into operation in 1956 and the Nordic Lake mine in 1957. Consolidated Denison Mines, Ltd., in the same area, sank shafts on its holdings and planned a 5,700-ton-a-day mill to be completed in 1957. Many other companies developed smaller holdings in the Blind River region, Ontario.

Bicroft Uranium Mines, Ltd., was constructing a 1,000-ton-per-day mill to treat ore from extensive uranium-bearing pegmatite dikes near Bancroft, Ontario. Faraday Uranium Mines, Ltd., planned to sink a shaft and construct a treatment plant of 750-ton-per-day

[11] Stephens, Fred H., Uranium Mining in the Northwest Territories: Western Miner and Oil Review, vol. 28, No. 10, October 1955, pp. 39–40, 42, 44, 46.

capacity in the Bancroft area. Nu-Age Uranium Mines, Ltd., completed a 300-ton-per-day dry concentrator and began testing the equipment. The uranium mineralization found in the Bancroft area was of higher grade than is usual in pegmatites.

Near North Bay, Ontario, Beaucage Mines, Ltd., continued underground development of a columbium (niobium)-uranium deposit A 50-ton-a-day concentrator was under construction.

In the Kenora and Fort Frances regions of Ontario, uranium occurrences in pegmatites were investigated.

Diamond drilling and underground exploration of the Rexspar property near Birch Island, British Columbia, was undertaken. Other uranium occurrences were explored near Lytton, British Columbia.

Uranium in the region between the Ottawa and Saguenay Rivers in the Province of Quebec was reported in 1955, and uranium in pegmatites was discovered in northeastern Alberta and in the Manigotagan Lake region of Manitoba.

Scattered occurrences of uranium also were reported from the Provinces of New Brunswick, Nova Scotia, and Labrador. Some pitchblende was found in several occurrences.[12]

It was announced in 1955 that the first Canadian nuclear-power station would soon be constructed at the facilities of the Ontario Hydro-Electric Power Commission, near the village of Des Joachims on the Ottawa River, about 150 miles west-northwest of Ottawa. The nuclear reactor was estimated to produce 10,000 to 20,000 kilowatts of electrical energy, but the cost of the electricity was expected to be more than that of electricity produced by conventional means. The power reactor will consume natural uranium fuel, slightly enriched with uranium-235, and will require heavy water both as a coolant and a moderator.[13]

Canada agreed to contribute to the cost of the Indian NRX-type reactor project, paying for the equipment and machinery that Canada will send to India for the reactor.

Cuba.—The Cuban Government, by decree 1996 on July 16, 1955, declared that radioactive minerals were in a special category and not subject to the mining rights and sales concessions of the established mining code. The decree promulgated the right of the Government to purchase all production of radioactive minerals and to approve or prohibit the sale of such minerals to foreign countries.[14]

Radiometric surveys resulted in the location of anomalies on the Isle of Pines and near Sancti Spiritus, Cuba.[15]

A Cuban nuclear energy commission, established by decree 1777 on June 25, 1955, will study: Possible application of atomic energy to agriculture, industry, and medicine; practicality of constructing a nuclear reactor in Cuba; and need for regulating the uses of radioactive products in Cuba.[16]

---

[12] Lang, A. H., Uranium in Canada, 1955 (Preliminary): Dept. of Mines and Technical Surveys, Ottawa, 6 pp.

[13] Canadian Metals, Canada's First Atomic Power Station: Vol. 18, No. 11, October 1955, pp. 62–64.
Cook, S. J., Canada Looks at Atomic Power: Chem. Eng. News, vol. 33, No. 18, May 2, 1955, p. 1882.
Western Miner and Oil Review, Nuclear Power for Canada; an Appraisal of the Energy Needs of the Near Future: Vol. 28, No. 10, October 1955, pp. 50–52.
Engineering News-Record, Canadians Plan to Build Atomic Power Plant: Vol. 154, No. 14, Apr. 7, 1955, p. 23.
Foreign Commerce Weekly, Canada to Construct Atomic Power Plant: Vol. 53, No. 10, U. S. Department of Commerce, Mar. 7, 1955, p. 25.

[14] U. S. Embassy, Havana, Cuba, State Department Despatch 62: Aug. 2, 1955, 2 pp.

[15] Mining World, vol. 17, No. 9, August 1955, p. 77.

[16] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 1, July 1955, p. 25.

The Cuban Ministry of Agriculture reported that a total of 28 land claims for radioactive materials had been filed. Nine claims were made in the Province of Pinar del Rio, 7 in Matanzas, 6 in Havana, 5 in Las Villas, and 1 in Camaguey.[17]

Mexico.—Published information mentioned the discovery of uranium at Villa Aldama in the State of Chihuahua,[18] and the National Technological Institute announced that small deposits of uranium were found in the Mascota district, State of Jalisco.[19]

There were reports of uranium occurrences averaging 17 to 23 percent uranium in the Etla district, State of Oaxaca, and there was some confusion relative to the rights of Mexican citizens and foreign interests in exploiting the purported uranium deposits.[20]

The National University and the Mexican Light & Power Co. jointly sponsored a visit and conferences by Walker L. Cisler, president, Detroit Edison Co., in April 1955. Cisler discussed atomic energy and the electric power industry.[21]

American & Foreign Power, Inc., indicated in New York that a 10,000-kilowatt nuclear power reactor would be constructed by its subsidiary, Ebasco Services, Inc., for Impulsora de Empresas Electricas, S. A., at an undisclosed location in Mexico. The reactor was to be a sodium-cooled graphite-moderated type. A bilateral agreement between the Governments of the United States and Mexico had not yet been signed, however, and an agreement must be reached before an American firm can provide the reactor for a foreign country.[22]

In December 1955 the Mexican Government passed a proposal creating a National Commission of Nuclear Energy. The objects of the commission were stated as: (1) The development and control of the exploration and exploitation of radioactive materials and other elements required in the construction of nuclear reactors; (2) the possession of such materials; (3) the importation and exportation of materials and equipment needed in the utilization of nuclear energy; (4) interior trade and transport of nuclear materials and equipment; (5) production and utilization of nuclear energy; (6) scientific investigations and training in the nuclear field; and (7) advice to the Government on needed legislation in nuclear energy. The Government, private industry, and individuals are required to inform the commission of any deposits of nuclear materials that may exist. The Mexican Ministry of Economy must assign to the commission land which that group may request for exploration and exploitation of materials of interest to the nuclear energy industry. The commission may contract with interested private companies or individuals for recovering such materials.[23]

---

17 Mining World, vol. 17, No. 13, December 1955, p. 86.
18 Mining World, vol. 17, No. 1, January 1955, p. 68.
19 Mining World, vol. 17, No. 6, May 1955, p. 83.
20 South African Mining and Engineering Journal (Johannesburg), Uranium Causes Uproar in Mexico: Vol. 96, part II, No. 3267, Sept. 24, 1955, p. 131.
21 U. S. Embassy, Mexico City, Mexico, State Department Despatch 1575: Apr. 6, 1955, p. 1.
22 Atomic Energy Newsletter, Nuclear Power Plants Scheduled for Latin America: Vol. 14, No. 5, Oct. 18, 1955, p. 2.
23 U. S. Embassy, Mexico City, Mexico, State Department Despatch 555: Oct. 26, 1955, 3 pp.; State Department Despatch 937: Dec. 19, 1955, 1 p.

SOUTH AMERICA

Argentina.—Six producers of uranium ore were reported in Argentina. Two mines were in the Province of Mendoza, and one each in the Provinces of Malargue and Portrerillos. There was also a mine near Sanogasta, one near Paganzo, and another at Guanchin in La Rioja Province.[24]

The only purchaser of uranium in Argentina, the National Atomic Energy Board, announced the prices that it would pay for uranium ores. For uranium-bearing minerals containing 0.20 percent or more of U_3O_8 the organization offered 280 pesos per kilo, plus a bonus of 100 pesos for every kilo of U_3O_8 over 4 contained in 1 ton of dry minerals. For minerals containing less than 0.20 percent of U_3O_8 and for certain compounds the price would be determined upon request.[25]

Pegmatites with uraninite and secondary uranium minerals were reported in the Sierra Pampeanas of Cordoba and San Luis, the Sierra de Velazco of La Rioja, the Sierra de la Huerta of San Juna, and Sierra de Ambato of Catamarca. Owing to the scattered and sporadic distribution of the uranium, however, production was insignificant and at times limited to byproduct recovery from mica, beryl, and feldspar mining.

The principal uranium deposits in Argentina were described.[26] At the San Santiago mine about 35 kilometers north of the village of Jaque in the Province of La Rioja, pitchblende occurs with nickel. The average concentration of the 2 materials at depth was 8 percent of Ni and 0.7 percent of U_3O_8. Vein deposits in the San Brigida group of mines and the San Victorio, San Sebastian, and Fidelidad mines, 3–6 kilometers west of Sanogasta, Eva Peron Department, contain uranophane, tyuyamunite, gummite, and pitchblende at depth. The average uranium content of the veins was 1 percent of U_3O_8. Fluorite, uranophane and an unidentified primary uranium mineral were located at the La Marquesa deposit in the Rio Seco Valley, 8 kilometers northeast of Villa Larca, Department of Chacabuco, Province of San Luis. The U_3O_8 content of minerals mined averaged 0.3 to 0.5 percent. At the Presidente Peron, Soberania, and Independencia deposits, some 17–20 kilometers from Mendoza, Department of Las Heras, Province of Mendoza, uranophane schroeckingerite, meta-autunite, phosphuranylite, and pitchblende were associated with iron and manganese oxides and copper carbonates, the uranium content varying between 0.3 and 0.7 percent of U_3O_8. Irregular distribution of carnotite, oxidized compounds of uranium, and secondary copper minerals associated with lutite were discovered, and some relatively rich concentrations of uranium were noted at the La Cienequita occurrence, 20 kilometers southwest of Tinogasta, Department of Tinogasta, Province of Catamarca. La Niquelina mine, 73 kilometers southeast of La Quiaca, Department of Santa Victoria, Province of Jujuy, was the source of pitchblende in niccolite-impregnated quartzite. At the Esperanza prospect, 85 kilometers from Iturbe station, Department of Iruya, Province of Salta, pitchblende was discovered in a hydrothermal vein associated with bornite and chalcocite and at the Cerro Huemul (Eva Peron), Aqua Botada,

[24] Engineering and Mining Journal, vol. 156, No. 8, August 1955, p. 158.
[25] Engineering and Mining Journal, vol. 156, No. 5, May 1955, p. 172.
[26] Angelelli, V., Distribution and Characteristics of the Uranium Deposits and Occurrences in the Argentine Republic; Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 63–74.

Cerro Mirano, and Pampa Amarillo discoveries, about 40 kilometers southwest of Malarque, Department of General Peron, Province of Mendoza, carnotite and some uraninite mineralization was found in conglomerates and conglomeratic sandstones.

A large synchro-cyclotron, manufactured by Phillips Co. of the Netherlands, was put into operation for nuclear research by the National Atomic Energy Board during 1955.[27]

Bolivia.—The Amazonia Foundation of New York reported that it would investigate rare-mineral deposits in the Amazon River area of Bolivia as a nonprofit, goodwill venture to assist Bolivia to diversify and increase its mineral-production potential.[28]

It was mentioned that significant deposits of radioactive minerals were found in the Covendo Triangle at the junction of the boundaries of the Departments of La Paz, Cochabamba, and Beni.[29]

Brazil.—Under an agreement between the United States and Brazil signed August 3, 1955, a joint cooperative program for reconnaissance of uranium resources in Brazil was to be undertaken with the Federal Geological Survey assisting Brazilian geologists and engineers in the search for radioactive minerals. A United States-Brazilian bilateral agreement included development of an experimental research reactor in Brazil.[30] The swimming-pool-type reactor was to be delivered in 1956 and installed by the National Research Council of Brazil in cooperation with Sao Paulo University. Reports indicated that Brazil would receive up to 6 kilos of uranium–235 from the United States to fuel the reactor.

The more important uranium occurrences in Brazil were at Pocos de Caldas and Barreira de Araxa, in the State of Minas Gerais. Two processing plants were ordered from French concerns, one of which will be used for the chemical separation of uraniferous minerals, the other to produce uranium metal from the concentrate.[31]

Uraniferous pegmatites at Sao Joao del Rei and Volta Grande on the Rio das Mortes in Minas Gerais were being investigated in 1955.[32]

On a Rio de Janeiro television program, November 26, 1955, Gen. Bernardino C. de Mattos, chairman, Brazilian Atomic Energy Commission, spoke with regard to Brazil's future in nuclear energy research and development. He urged the widest possible participation by private enterprise and warned against expecting immediate and dramatic results. General de Mattos also denounced the idea that the country was widely endowed with reserves of materials required in nuclear energy development.[33]

Chile.—The United States Atomic Energy Commission in 1955 indicated its willingness to discuss with Chilean officials the exploitation and purchase of Chilean uranium ores. Uranium-bearing material is found with copper minerals, closely associated with intrusive rocks such as diorites and granodiorites, and with metamorphic rocks.[34]

Peru.—Uranium oxide ore was investigated in the Colquijirca mines near Cerro de Pasco by the Junta de Control de Sustancias Radioactivas, the Government atomic energy authority.

---

[27] Chemical and Engineering News, vol. 33, No. 18, May 2, 1955, p. 1881.
[28] Metal Bulletin (London), Bolivian Rare-Metal Search: No. 3973, Mar. 1, 1955, p. 12.
[29] Mining World, vol. 17, No. 12, November 1955, p. 76.
[30] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 5 November 1955, p. 29.
[31] Mining Journal (London), Atomic Activities in Brazil: Vol. 245, No. 6279, Dec. 23, 1955, p. 737.
[32] Mining Journal (London), vol. 244, No. 6253, June 24, 1955, p. 716.
[33] U. S. Embassy, Rio de Janeiro, Brazil, State Department Despatch 734: Dec. 6, 1955, 3 pp.
[34] Engineering and Mining Journal, vol. 156, No. 6, June 1955, pp. 178 and 182.

The Vilcamba region of southern Peru was confirmed as a source of uranium-bearing material assaying as much as 1.8 percent of U_3O_8.[35]

Uruguay.—Radioactive sands that might contain uranium were found in the Province of Maldonado near Pan de Azucar and Sauce.[36]

EUROPE

Belgium.—Under the agreements signed during 1955 by the Government of Belgium, the United States and Great Britain agreed to cooperate and assist Belgium in developing a nuclear-energy industry.[37]

The Syndicat d'étude de l'énergie nucleaire (Brussels), consisting of leading Belgian manufacturing, steel, chemical, and utility firms, ordered a 11,500-kilowatt nuclear-power plant from Westinghouse Electric International Co. The reactor was to be of pressurized water design, and its cost was estimated at $5 to $5.5 million.[38]

Progress continued on the construction of a small research reactor at Mol. The unit was expected to go critical in February 1956.

The Société métallurgique de Hoboken conducted an extensive fuel-element development program, and it was expected that Belgium would concentrate on a program of fuel processing and reactor-component fabrication, with emphasis on exportation of transportable reactor items.[39]

The Banque de Bruxelles published a booklet entitled "Énergie nucleaire aspects financiers" as a means of showing the keen interest of industrial and financial circles in the future of nuclear energy in Belgium.

A Belgian counterpart of the American Atomic Industrial Forum, called L'Association belge pour le developpment pacifique de l'énergie nucleaire, was founded in 1955.

Bulgaria.—An underground uranium-processing plant was under construction near the Buhovo uranium mine. Soviet engineers were said to be supervising mining of the ore and construction of the mill.[40]

Czechoslovakia.—The Pribram uranium mines were rumored to be gaining importance as an ore producer. Some 14 shafts were sunk, and nearby camps at Voina and Bystiz were believed to house 3,000 prisoners used as mine laborers.[41] Operations at Pribram began in December 1954. Reserves were estimated to allow for 30 years of operation. The deposits were estimated to be larger than the Joachimstal occurrences, which may be completely depleted in 8 years.[42]

Denmark.—A Danish atomic-research center was to be constructed on the Risø Peninsula. A research reactor imported from the United States was included in the plans for the center. A larger reactor similar to the British Harwell reactor was to be purchased from Great Britain later.[43]

---

[35] Engineering and Mining Journal, vol. 156, No. 3, March 1955, p. 165. Metal Bulletin (London) No. 3977, Mar. 15, 1955, p. 27.
[36] U. S. Embassy, Montevideo, Uruguay, State Department Despatch 51: Aug. 17, 1955, p. 7.
[37] Light Metal Age, vol. 177, No. 5857, Nov. 26, 1955, pp. 777–778.
Mining World, vol. 17, No. 6, May 1955, p. 80.
[38] Atomic Energy Newsletter, vol. 14, No. 8, Nov. 29, 1955, p. 2.
[39] Nucleonics, vol. 13, No. 11, November 1955, p. 23.
[40] Mining World, vol. 17, No. 3, March 1955, p. 67.
[41] Mining World, vol. 17, No. 7, June 1955, p. 78.
[42] Engineering and Mining Journal, vol. 156, No. 7, July 1955, p. 176.
[43] Engineering and Mining Journal, vol. 156, No. 12, December 1955, p. 175.

Finland.—A uranium deposit was found at Loppi, about 50 miles from Helsinki. The Finnish Government drafted a bill making exploitation of radioactive materials a Government monopoly.[44]

France.—The formation of a new French uranium exploration and production company, entitled Compagnie française des minérais d'uranium, was announced in 1955. The organization was founded by Rothschilds Frères in conjunction with mining and chemical firms, including Penarroya, Ste. Le Nickel, Pechiney, Établissements Kuhlman, Compagnie des mines de Huaron, and Minérais et métaux. Of the initial 400 million franc investment, the State Atomic Energy Commission subscribed 15 percent. The new firm will prospect, mine, and process deposits of source material in France and abroad.[45]

The Commissariat a l'énergie atomique continued to obtain uranium from mines at Grury, Saône-et-Loire Department; Lachaux, Puy-de-Dôme Department; La Crouzille, Limousin Department; and Vendee Department at Clisson and Mortagne-sur-Sevre.[46] The commissariat also took measures to induce mining concerns to prospect in regions south of the Massif Central and Massif Armoricain Provinces.[47]

The geology of the producing areas in France and other French territories was described by the French delegate to the International Conference on the Peaceful Uses of Atomic Energy, Geneva, August 8–20, 1955.[48]

Roger Julia, director general of the Société alsacienne de constructions mécaniques, speaking in October 1955 at the National Industrial Conference Board Meeting in New York City, stated that French production of source material was sufficient to meet its needs. Uranium-ore output was forecast to increase by 400 percent within three years. Ores were enriched at the mine site by mechanical or chemical concentration, with subsequent refining at the Bouget plant in the Paris area. The Bouget refinery was built for the Government by three private companies, Minérais et métaux, Potasses et engrais chimiques, and Société des terres rares.[49] Uranium extraction and refining was indicated to be a Government monopoly in France.

The first small French research reactor at Chatillon, south of Paris, continued to operate. The uranium-oxide fuel elements were replaced with uranium-metal rods, and the heavy-water moderator was cooled externally, allowing a power increase to 150 kilowatts.

The Saclay research reactor operated at a heat-power level of 1,500 kilowatts, with a maximum neutron flux of 7×10^{12} neutrons per centimeter squared per second. It was used for radiation-damage studies and radioisotope production.

Two large natural uranium-fueled, graphite-moderated, gas-cooled, reactors were under construction at Marcoule. The reactors, known as G–1 and G–2, were each to require 100 tons of natural uranium. Although some of the heat from the reaction will be converted into electrical energy, they were planned essentially for the production of plutonium. The G–1 plant was expected to be completed by mid-1956

[44] Metal Bulletin (London), No. 4046, Nov. 22, 1955, p. 29.
Iron and Coal Traders Review, (London), vol. 171, No. 4576, Dec. 23, 1955, p. 1540.
[45] Mining World, vol. 17, No. 12, November 1955, p. 74.
Metal Bulletin (London), No. 4022, Aug. 30, 1955, p. 23.
Chemistry and Industry, No. 35, Aug. 27, 1955, p. 1082.
Atomic Energy Newsletter, vol. 14, No. 3, Sept. 20, 1955, p. 3.
[46] Mining World, vol. 17, No. 4, April 1955, p. 64.
[47] Metal Bulletin (London), No. 4028, Sept. 20, 1955, p. 11.
[48] Roubalt, Marcel, The Uranium Deposits of France and French Overseas Territories; Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 152–161.
[49] American Metal Market, Outlines France's A-Power Progress: Vol. 62, No. 211, Nov. 1, 1955, p. 9.

and to provide 5,000 kilowatts of electrical power and 12 to 15 kilograms of plutonium a year. The G–2 plant planned for operation in early 1957 was estimated at 10,000 kilowatts electrical capacity and 50 kilograms of plutonium production annually.[50]

Germany, East.—Information provided the press by the West German Government suggested that, although about three-quarters of the uranium ore mined in East Germany was low grade, the total production was significant. The Sorgesettendorf mine, as an example, produced an estimated 1,800 tons of ore per day.

East Germany uranium ore was mined in the mountainous region near the Czechoslovak border. Operations under the leadership of Wismut, A. G., were controlled by the Soviet Government. All quality ore was purportedly transported to the Soviet Union.[51]

Transformatoren und Rontgenwerke Co. of Dresden was manufacturing the necessary equipment and apparatus for erecting a nuclear reactor in the Soviet East Germany.[52]

Germany, West.—In the State of South Baden, uranium was found at three separate localities in the Black Forest and in the Kinzig Valley.[53]

Sixteen industrial firms and the Government united to form the German Association for Physical Research, capitalized at $740,000. The organization was to survey known uranium occurrences near the East German border and in the Bavarian forests.[54]

Bayer Works planned to assist in mining and processing uranium-ore deposits of the Black Forest and Bavaria.[55]

The West German Government announced the formation of an atomic-energy-research group, a non-profit-making company, with 49 percent of the capital furnished by the Government. The remaining funds would be furnished by 16 participating firms, including Krupp, Siemens, Farberwerke Hoechst, Beyerwerke, Degussa, and Gutehoffnungshütte.[56]

A center was established at the House of Technology in Essen for collecting, sorting, and evaluating specialized technical information relative to nuclear energy. In addition, courses will be held at the center on nuclear physics.[57]

Greece.—The chairman of the Greek Atomic Energy Commission, in a speech before a group of Greek scientists at Athens on May 4, 1955, set forth the aims of the subject organization as follows: (1) To support existing laboratories or those to be established in the future for research on nuclear physics; (2) to direct in Greece all operations related to utilization of atomic energy; (3) to import and supervise the use of isotopes; (4) to study the radioactivity of the Greek subsoil; (5) to train personnel in detecting areas contaminated by radioactivity; (6) to contact atomic energy organizations of other countries; and (7) to enlighten the public on matters related to atomic energy.[58]

---

[50] Metal Progress, Atomic Energy in France: Vol. 68, No. 1, July 1955, p. 83.
Engineering and Mining Journal, vol. 156, No. 8, August 1955, pp. 166 and 168.
Atomic Energy Newsletter, vol. 13, No. 4, April 1955, p. 1.
Atomic Scientists Journal (London), vol. 4, No. 6, July 1955, p. 357.

[51] South African Mining and Engineering Journal (Johannesburg), vol. 65, Pt. 2, No. 3229, Jan. 1, 1955, p.787.

[52] Atomic Energy Newsletter, vol. 14, No. 7, Nov. 15, 1955, p. 3.

[53] Engineering and Mining Journal, vol. 156, No. 3, March 1955, pp. 167 and 168.

[54] Nucleonics, vol. 13, No. 2, February 1955, p. 12.

[55] Mining World, vol. 17, No. 7, June 1955, p. 77.

[56] Atomics and Atomic Technology (London), vol. 6, No. 2, February 1955, p. 31.
Chemical and Engineering News, vol. 33, No. 4, Jan. 24, 1955, p. 330.

[57] Chemical Age (London), vol. 73, No. 1902, Dec. 24, 1955, p. 1378.

[58] U. S. Embassy, Athens, Greece, State Department Despatch 1236: June 13, 1955, 8 pp.

The Greek Government announced in 1955 that uranium discoveries had been made near the northern frontier of Greece. Investigations were being conducted.[59]

Hungary.—According to the Hungarian News and Information Service, in 1955 the Soviet Union will supply Hungary with a 2,000-kilowatt (heat), light-water cooled and moderated research reactor, using 10-percent-enriched uranium for fuel.[60]

Italy.—Exploration work by Montecatini Co. at Rio Freddo, Pradeboni, Rio Argentina, Valle dei Morti, and Ciarma in the Cuneo area resulted in discovery of uranium minerals. Near the surface autunite and torbernite were found, and at depth some pitchblende was noted. At Rio Freddo about 300 tons of ore was mined, with a uranium content of 2–5 percent.

The Societa mineraria e chimica per l'uranio mined uranium-bearing material at Bric Colme.[61]

The Italian Government was making plans for uranium exploration on Sardinia at an initial cost of 700 million lire.[62]

The Italian National Committee for Nuclear Research released information about Italy's first research reactor to be constructed near Milan. The United States Government agreed to provide 10 tons of heavy water for the reactor.[63]

Italian activity in the nuclear energy field was described by Giorgio Valerio, managing director, Societa Edison, before a meeting of the Atomic Industrial Forum in Washington, D. C., September 29, 1955.[64]

Netherlands.—It was reported that Netherlands' first experimental nuclear reactor would be ready for operation in about two years. The capacity of the reactor was to be 10,000 kilowatts of heat energy.[65]

Norway.—It was anticipated in 1955 that the Uranium Law of 1946 which gave the Government sole ownership of uranium deposits located in Norway would be repealed. Public lectures were given throughout the country instructing interested persons in the techniques for radioactive mineral prospecting.[66]

Some rock with a uranium content of 0.5 percent was found in the northern Province of Troms.[67]

The geology of two low-grade uranium occurrences, uranium-bearing alum shales, and the Rendalsvik graphite-mica schist, were described by the Norwegian delegate to the International Conference on the Peaceful Uses of Atomic Energy at Geneva, August 8–20, 1955.[68]

A nuclear powerplant was planned to provide heat for pulp and paper-milling operations at Halden on Oslo Fjord. The reactor may be located underground.[69]

Gunnar Randers, director, Norwegian Atomic Institute, prepared for submission to the Norwegian Parliament in 1955 a 5-year research

---

[59] Atomic Scientists Journal (London), vol. 4, No. 6, July 1955, p. 354.
[60] Nucleonics, vol. 13, No. 11, November 1955, p. 23.
[61] Ippolito, Felice, Present State of Uranium Surveys in Italy, Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 167–173.
[62] Mining World, vol. 17, No. 4, April 1955, p. 63.
[63] Atomic Energy Newsletter, vol. 13, No. 4, Apr. 5, 1955, p. 1.
South African Mining and Engineering Journal (Johannesburg), vol. 66, No. 3246, Apr. 30, 1955, p. 337.
[64] Valerio, Giorgio, Italian Situation in the Atomic Energy Field: Address before meeting of Atomic Ind. Forum, Sept. 29, 1955, 10 pp.
[65] Atomic Energy Newsletter, vol. 13, No. 7, May 17, 1955, p. 4.
[66] Engineering and Mining Journal, vol. 156, No. 9, September 1955, p. 210.
[67] Chemical and Engineering News, vol. 33, No. 46, Nov. 14, 1955, p. 4956.
[68] Siggerud, T., The Occurrence of Uranium and Thorium in Norway, Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 178–181.
[69] Chemical Week, vol. 77, No. 7, Aug. 13, 1955, p. 10.
Atomic Scientists Journal (London), vol. 4, No. 6, July 1955, pp. 358–359.

program with the primary aim of constructing a prototype atomic reactor for ship (marine) propulsion.[70]

Portugal.—The Nuclear Energy Board prepared to survey and prospect for uranium a 12,000-square-kilometer area south of the Douro River. The exploration program was expected to include airborne radiometric reconnaissance and ground investigations.[71]

Rumania.—Indications were that uranium was mined in Rumania under supervision of Soviet technicians. Operations were controlled by Sovromquartz Co. The most significant deposits were found near Capnic in the lead mining region of Baia Mare. Uranium was also known to occur at Beica, in the Banat region, near Oradea in western Transylvania, and at Turnu Severin.[72]

Spain.—Representatives of the United States Atomic Energy Commission visited Spain to assist Spanish engineers of the Junta de Energia Nuclear in investigations for radioactive minerals. The Spanish Government offered premium awards for discoveries of uranium and reserved the output of ore for itself.

On June 24, 1955, Gen. Eduardo Hernandez Videl was appointed president of the Junta de Energia Nuclear, succeeding the late Gen. Juan Vigon Suerodiaz.

The most significant deposits of uranium in Spain were described as having occurred in the Spanish Plateau. Pegmatitic, hydrothermal, metasomatic, and sedimentary mineralization was evident. The Hornachuelos deposit in the Sierra Morena represented an example of a pegmatite of significance that contained uraninite, brannerite, autunite, and some radioactive ochers. North of the Hornachuelos deposit hydrothermal uranium mineralization was uncovered, in which significant quantities of torbernite, autunite, and radioactive ochers were present. Average vein material contained 0.75 percent of U_3O_8. North of Leon on the plateau, in dolomitic masses in Namur limestone, uranium of metasomatic origin was investigated by Spanish geologists. Colloidal pitchblende was identified. It was not mentioned whether the deposit was being mined. In the Despenaperros region of the Plateau, graywacke horizons of Ordovician quartzites and slate were discovered to be radioactive. The uranium content in 2 different localities was determined at 0.035 percent of U_3O_8 and 0.07 percent of U_3O_8. Less abundant and less important radioactive occurrences were investigated in the Spanish mountain ranges of the Alpine cordilleran type.[73]

Sweden.—Joseph Eklund, chief state geologist, claimed that a high-grade uranium deposit had been discovered in the Billingen area of the Vaestergoetland Province of southwest Sweden.[74]

The Kvarntorp uranium mine and mill in central Sweden continued to operate successfully, using as raw material an alum shale containing 0.02 percent of uranium. The uranium-bearing shale and associated limestone were separated by a sink-float process, then the shale was ground and collected in filter basins through which sulfuric acid was

[70] Chemical and Engineering News, vol. 33, No. 17, Apr. 25, 1955, p. 1785.
[71] Mining World, vol. 17, No. 7, June 1955, p. 69.
[72] Mining World, vol. 17, No. 8, July 1955, p. 77.
[73] Alia, Manuel, Radioactive Deposits and Possibilities in Spain, Geology of Uranium and Thorium Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 196–199.
[74] Chemical Age (London), vol. 73, No. 1901, Dec. 17, 1955, p. 1334.
Mining World, vol. 17, No. 9, August 1955, p. 75.
Metal Bulletin (London), No. 4053, Dec. 16, 1955, p. 19.

passed. Uranium phosphate was precipitated from the resulting leach solution.[75]

Sweden prepared to construct 2 nuclear power plants; 1 reactor was to be a heating unit with a 75,000-kilowatt heat output, the other an electrical generator with a 10,000-kilowatt electrical capacity. The reactors were to be a joint project of the Swedish Board of Waterfalls, the Atomic Energy group, and the Asea Electric Co. The heating reactor was to be placed near the Asea factories in Vassteras, about 60 miles from Stockholm. The power reactor was to be underground in either central or southern Sweden.[76]

Switzerland.—On March 1, 1955, the Societe Reaktor Cie. was founded in Baden, Switzerland. The first company nuclear reactor will be built near Wuerenligen. The capital of the nuclear energy firm was raised by 151 industrial and banking concerns. The board of directors was to consist of 15 members, 3 of whom were to be representatives of the Swiss Government.[77]

The International Conference on the Peaceful Uses of Atomic Energy was held in Geneva, August 8 through 20, 1955, under the auspices of the United Nations. A swimming-pool-type nuclear research reactor was erected by the United States Atomic Energy Commission as an exhibit at the conference. The reactor was sold to the Swiss Government for approximately $300,000 on conclusion of the meeting.[78]

U. S. S. R.—A former Soviet prisoner reported uranium-mining activities at Norilsk in northern Siberia.[79]

On July 18, 1955, the Soviet Government announced that it would contribute fissionable materials to the international pool of nuclear materials proposed by President Eisenhower at an earlier date.[80]

The Soviet nuclear powerplant was described by scientists of that nation in technical journals, and 20 newspaper reporters from the Free World were shown the plant on a guided tour. The power reactor was completed in 1954 by the Soviet Academy of Sciences at Obrenskoge, 60 miles southwest of Moscow. The power output of the pressurized-water, graphite-moderated plant is 5,000 kilowatts.[81]

United Kingdom.—In August 1955 the Geological Survey of Great Britain published its "Summary of Progress" for 1954, which mentioned that previously unknown radioactive deposits, of no economic importance, were found in Cornwall.[82]

The United Kingdom Atomic Energy Authority continued construction of the nuclear power station at Calder Hall. The station was intended to produce additional supplies of plutonium, as well as deliver approximately 65,000 kilowatts of electricity into the Central Electrical Authority grid. Operation was expected to begin in 1956. Three similar power-production reactors were to be constructed, 1 at Calder Hall and 2 at Dumfriesshire, Scotland. Four additional

[75] Atomics and Atomic Technology (London), vol. 6, No. 11, November 1955, p. 326.
[76] Engineering News-Record, vol. 155, No. 23, Dec. 8, 1955, p. 74.
[77] U. S. Department of Commerce, Foreign Commerce Weekly: Vol. 53, No. 14, Apr. 4, 1955, p. 25.
U. S. Embassy, Bern, Switzerland, State Department Despatch 727: Apr. 4, 1955, p. 4.
[78] Mining World, vol. 17, No. 7, June 1955, p. 77.
Atomic Energy Newsletter, vol. 13, No. 7, May 17, 1955, p. 2.
[79] Mining World, vol. 17, No. 4, April 1955, pp. 64–65.
Metal Bulletin (London), No. 4017, Aug. 12, 1955, p. 22.
[80] Atomics and Atomic Technology (London), vol. 6, No. 9, September 1955, pp. 253–254.
[81] Engineering (London), The First Atomic Power Station in the Soviet Union, Heat Transfer by Water in Two Circuits: Vol. 18, No. 4673, Aug. 19, 1955, pp. 233–234.
Metal Bulletin (London), Russia's Atomic Power Station; Metals Play Their Part: No. 4023, Sept. 2, 1955, pp. 14–15.
Bulletin of the Atomic Scientists, vol. 11, No. 3, March 1955, p. 103.
[82] Mining Magazine (London), Geological Survey in 1954: Vol. 93, No. 2, August 1955, p. 68.

nuclear-power stations were to be constructed under the program. They would be of the Calder Hall type but would produce no plutonium. Eight more power-generating nuclear reactors were planned; but the types of reactors involved were to depend on the results of research, development, and operating experience with existing reactors. It was estimated that in England by 1956 the total installed capacity of nuclear powerplants would be nearly 2 million kilowatts, with nuclear energy substituting for 5 to 6 million tons of coal a year. By 1975 the installed nuclear capacity was expected to rise to between 10 million and 15 million kilowatts, with nuclear energy doing the work of at least 40 million tons of coal a year and providing 40 percent of the energy for electricity. The generating cost at the first stations under construction was estimated at 7 mills per kilowatt-hour.[83]

The Atomic Energy Authority announced construction of a plant at Windscale, Cumberland, for processing spent-fuel elements to recover the unused fissionable material. A newly developed process was believed to reduce fuel wastes nearly 10 percent.[84]

British radioisotope production in 1955 was estimated at 20,000 consignments, a third of which was exported. This compared with nearly 17,000 consignments in 1954.[85]

A 1,500-ton load of radioactive wastes, including contaminated equipment and strontium and cesium radioisotopes, was sealed in steel and concrete containers and dumped into the Atlantic Ocean by a British Naval unit. It was the largest amount of radioactive material so disposed of by the British Atomic Energy Authority.[86]

An agreement between the United Kingdom and Belgium was signed November 18, 1955, providing for mutual assistance in developing peaceful uses of atomic energy. The agreement covered a 10-year period.[87]

The First Annual Report of the United Kingdom Atomic Energy Authority was released on November 3, 1955.

Numerous articles published during the year described British achievements in developing nuclear power.[88]

Yugoslavia.—The power level of a reactor, under consideration at Vinca, near Belgrade, was expected to exceed 1,000 kilowatts.[89]

Press reports from Yugoslavia indicated that some 200 uranium deposits of various types had been discovered in that country during an active exploration program. The occurrences were inferred to be low grade. The uranium in Yugoslavia was described by Milan Ristic of the Institute for Geological, Mining, and Technological

[83] Cockcroft, Sir John, Nuclear Power Program in the U. K.: Address before meeting of the Atomic Ind. Forum, Sept. 29, 1955, 6 pp.
[84] Mining World, vol. 17, No. 9, August 1955, pp. 75, 77.
[85] Chemical and Engineering News, vol. 33, No. 5, Jan. 31, 1955, p. 424.
[86] Chemical and Engineering News, vol. 33, No. 6, Feb. 7, 1955, p. 477.
[87] U. S. Embassy, London, England, State Department Despatch 1165: Nov. 22, 1955, 1 p.
[88] Chemical and Engineering News, British Begin Atom Power Program: Vol. 33, No. 9, Feb. 28, 1955, pp. 868, 872.
Sorrell, Richard, British Industry in the Atom Age: South African Min. Eng. Jour. (Johannesburg), vol. 66, part I, No. 3259, July 30, 1955, pp. 895, 897.
Mining Journal, Future Fuel Supplies in the U. K.: Vol. 245, No. 6280, Dec. 30, 1955, pp. 772–773.
Cockcroft, Sir John, Atoms for Peace in Britain: South African Min. and Eng. Jour. (Johannesburg), vol. 66, part II, No. 3275, Nov. 19, 1955, pp. 437, 439.
Metal Industry, Atomic Story: Vol. 87, No. 8, Aug. 19, 1955, p. 143.
Metal Progress, Britain's Atomic Factories: Vol. 68, No. 5, November 1955, pp. 116, 117, 186, 188, 190, 192.
Mining and Industrial Magazine, Britain's Efforts to Develop New Nuclear Metals: Vol. 45, No. 9, September 1955, pp. 341, 343.
Chemical Engineering and Mining Review (Melbourne), Nuclear Powerplants—Britain's Extensive Program: Vol. 47, No. 6, Mar. 10, 1955, p. 227.
Mining Journal (London), Developing the Nuclear Metals: Vol. 245, No. 6255, July 8, 1955, p. 46.
[89] Atomic Scientists Journal (London), vol. 4, No. 6, July 1955, p. 355.

Research, Belgrade, in a paper before the International Conference on the Peaceful Uses of Atomic Energy, Geneva, Switzerland, August 1955.

ASIA

India.—Some uranium was mentioned by Indian Prime Minister Nehru as having been recovered from monazite sands of the Travancore-Cochin area.[90]

A processing plant for treating low-grade uranium ores was being erected in eastern India near Takshilla, Bihar State. Uranium-bearing material discovered in the States of Madras, Bihar, and Orissa, will be treated at the mill.[91]

The Indian Ministry for Natural Resources and Scientific Research supported a $40 million-exploration program to include investigations for radioactive minerals in the States of Rajasthan and Andhra.[92]

The Trombay uranium-thorium refinery began full-scale operation in August 1955, and the capacity of the plant was increased 30 percent in October 1955. The plant was expected to have an annual production of a few tons of uranium per year.

Construction of India's first nuclear reactor of a few megawatts capacity was begun at Trombay; it was to be fueled with domestic uranium from beach-sand occurrences.[93]

During the latter part of the year it was announced that the Indian Government would accept a Canadian offer of a NRX-type reactor under the Colombo plan.[94] The cost of the $15-million reactor was to be divided equally between the two countries, Canada paying for the machinery and equipment and India the buildings and construction work.

Monazite beach sands were estimated to contain 6,000 to 7,000 tons of available uranium and at least 3,000 to 4,000 tons was economically recoverable from the Singhbhum area, State of Bihar. A minimum of 3,000 tons of uranium was estimated in the Aravalli area, northern Rajputna.[95]

Indonesia.—The U. S. S. R. offered the Republic of Indonesia a 2,500-kilowatt nuclear powerplant.[96]

Iraq.—The Iraqi Government accepted a United States offer of assistance in applying peaceful uses of atomic energy.[97]

Israel.—The chairman of the Israel Atomic Energy Commission announced that scientists of that country had developed an economical method of extracting uranium from uraniferous phosphate deposits of the Negev Desert.[98]

Japan.—Pitchblende was found in an abandoned gold mine in the Tottori district by a Japanese Government survey group.[99]

---

[90] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 6, December 1955, p. 23.
[91] American Metal Market, vol. 62, No. 46, Mar. 8, 1955, p.1.
Journal of Metals, vol. 7, No. 4, April 1955, p. 515.
[92] Engineering and Mining Journal, vol. 156, No. 7, July 1955, p. 73.
South African Mining and Engineering Journal (Johannesburg), vol. 66, part 11, No. 3265, Sept. 10, 1955, p. 53.
[93] Mining World, vol. 17, No. 7, June 1955, p. 76.
[94] Atomic Energy Newsletter, vol. 14, No. 4, October 1955, p. 1.
Chemical and Engineering News, vol. 33, No. 46, Nov. 14, 1955, p. 4957.
[95] Wadia, D. N., Natural Occurrences of Uranium and Thorium in India, Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 163–166.
[96] Chemical and Engineering News, vol. 33, No. 49, Dec. 5, 1955, p. 5290.
[97] Chemical and Engineering News, vol. 33, No. 50, Dec. 12, 1955, p. 5398.
[98] Engineering and Mining Journal, vol. 156, No. 8, August 1955, p. 180.
Atomics and Atomic Technology (London), vol. 6, No. 5, May 1955, p. 122.
Nucleonics, vol. 13, No. 1, January 1955, p. 81.
Aschner, Ernest, Israel's Chemical Industry: Chem. Eng. News, vol. 33, No. 41, Oct. 10, 1955, p. 4323.
Chemical Age (London), vol. 73, No. 1887, Sept. 10, 1955, p. 534.
[99] Metal Bulletin (London), No. 4039, Oct. 28, 1955, p. 21.

A Japanese delegation of 14 men visited the United States and Europe to discuss initiation of a Japanese program of nuclear-energy research and development.

Plans were being made in Japan for forming an atomic energy commission to guide the nation on a formal investigation of nuclear research.

The United States Information Agency conducted an Atoms-for-Peace-Fair in Tokyo on November 1, 1955. The fair was to tour major Japanese cities.[1]

Japanese authorities planned to construct 5 reactors; 3 were probably to be purchased from other countries; and 2 were to be constructed at a later date by Japanese interests.[2]

Korea.—Radioactive minerals were found in the Kum-Wha district of Kankwon Province and in the Chonan district of South Choongchong Province.[3]

Lebanon.—Lebanese engineers stated that uranium ore was located near Dahr El Baidar Pass in the Beirut-Damascus road area. Assays of samples proved the existence of radioactive material.[4]

Malaya.—Uranium mineral in the form of torbernite was found near Frasers Hill in the jungle of central Malaya. The Geological Survey Department of the Malayan Federation indicated that it would investigate the torbernite showings and attempt to determine the potential of the area.[5]

Philippines.—The copper-molydenum-uranium ore discovered at the Larap property of the Philippine Iron Mines in 1954 was further investigated in 1955. Results of core drilling showed that enough copper and molybdenum existed to make the deposit minable and that the uranium could be recovered as a byproduct.[6]

A report was published on the joint program of preliminary reconnaissance for uranium in the Philippine Islands by Philippine Bureau of Mines and United States Atomic Energy Commission geologists in 1953. The report indicated that more comprehensive geologic investigations must be conducted before the potentialities of specific areas of interest can be determined.[7]

Thailand.—Euxenite and an unidentified mineral both with an appreciable uranium content were found in tailing samples of 40 percent of the tin-mining operations along the west coast of the peninsular Provinces from Ranong to Phuket. The economic potentialities of the uranium and associated elements in the tailings were to be investigated.[8]

Turkey.—A uranium occurrence, reported in the Antalya region, was being investigated.[9]

Representatives of Turkey and the United States signed an agreement during 1955 for lease by the latter nation to Turkey of 6 kilograms of enriched uranium that Turkey desired for a nuclear-research

---

[1] Chemical and Engineering News, vol. 33, No. 45, Oct. 31, 1955, p. 4674.
[2] Nucleonics, vol. 13, No. 11, November 1955, p. 23.
[3] Mining World, vol. 17, No. 8, July 1955, pp. 74–75.
[4] Engineering and Mining Journal, vol. 156, No. 9, September 1955, p. 212.
[5] Mining Journal (London), vol. 244, No. 6238, Mar. 11, 1955, p. 273.
Mining World, vol. 17, No. 12, November 1955, p. 67.
Engineering and Mining Journal, vol. 156, No. 9, September 1955, p. 214.
[6] Engineering and Mining Journal, vol. 156, No. 12, December 1955, p. 172.
[7] Puttack, H. E. and Stafford, H. S., Search for Uranium in the Philippines: Republic of the Philippines, Dept. of Agric. and Nat. Resources, Bureau of Mines, Rept. of Investigation 12, Manila, 1955, 19 pp.
[8] Delegation of Thailand, Natural Occurrence of Uranium and Thorium in Thailand; Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 201–203.
[9] Metal Bulletin, (London) No. 4036, Oct. 18, 1955, p. 25.

reactor. The agreement also called for exchange of unclassified information on reactor research and radioisotopes.[10]

AFRICA

Angola.—Radiometric surveys for radioactive minerals were conducted in geologically favorable areas by the Angola Government Mines and Geological Services in conjunction with the Portugese Atomic Energy Commission. A promising samarskite deposit was found. Future investigations were to include the granite highlands of Benguela, the asphalt-bearing formations north of the Cuanza River, and the Tertiary phosphate deposits of an area stretching from Landana to Ambriz.[11]

Belgian Congo.—Under agreements signed with the United States and Britain in 1955, Belgium agreed to give the Combined Development Agency, representing the United States, Canada, and Britain, an option to purchase 90 percent of Belgian Congo uranium ore in 1956 and 1957. For 1958, 1959, and 1960 the agency was given the authority to obtain as much as 75 percent of Congo production. Most of the uranium mined by the Union Miniére du Haut Katanga in the Congo has been shipped in the past to the United States.[12]

On July 18, 1955, a decree, published in the Bulletin official de Congo Belge, prohibited prospecting for uranium, thorium, or any substance containing radioactive minerals in the Belgian Congo and Ruanda-Urundi, except where approved in a special decree.[13]

Belgian delegates to the International Conference on the Peaceful Uses of Atomic Energy at Geneva, August 8–20, described the geology, mineralogy, and metallurgy of the Shinkolobwe mine of the Union Miniére du Haut Katanga, 20 miles west of Jadotville. It was reported that: Principal metals in order of importance were uranium, cobalt, and nickel; the deposit was the vein type and of magmatic origin; and nickel showed a special affinity for uranium.[14]

Egypt.—The Egyptian atomic-energy organization will be advised about the most effective way to utilize money and materials for an initial atomic-energy program. United States Atomic Energy Commission personnel will assist the Egyptian Government in planning an atomic-energy training program and making best use of a technical library being provided that country by the AEC.[15]

French Morocco.—Commercial-grade phosphate deposits of French Morocco were reported to contain an average of 0.0125 percent of uranium, which could be recovered as a byproduct of phosphate mining.[16]

Kenya.—Two prospectors found uranium and thorium in the Loldaiga Hills, 30 miles north of Nanyuki. An exclusive prospecting license was reported to have been issued to a syndicate for investigation of the occurrences.[17]

---

10 Atomic Energy Newsletter; vol. 13, No. 7, May 17, 1955, p. 2.
11 Mining World, vol. 17, No. 7, June 1955, p. 73.
12 Engineering and Mining Journal, vol. 156, No. 8, August 1955, p. 73. South African Mining and Engineering Journal (Johannesburg), vol. 96, Part 1, No. 3260, Aug. 6, 1955, p. 941.
13 U. S. Embassy, Leopoldville, Belgium, State Department Despatch 102: Sept. 19, 1955, p. 1.
14 Derriks, J. J. and Vaes, J. F., The Shinkolobwe Uranium Deposit; Current Status of Our Geological and Metallogenic Knowledge, Geology of Uranium and Thorium: Proc. Internat. Conf. on Peaceful Uses of Atomic Energy, vol. 6, 1956, pp. 94–128.
15 Chemical Engineering Progress, vol. 51, No. 10, October 1955, p. 102.
16 U. S. Embassy, Tangier, French Morocco, State Department Despatch 71: Aug. 10, 1955, p. 1.
17 Bureau of Mines, Mineral Trade Notes: Vol. 42, No. 1, Jan. 1956, p. 17.

Mozambique.—The Swedish company, Bolidens Gruv a. b. conducted a preliminary geological survey for uranium and certain other valuable elements in Mozambique in 1955. Several uranium ore claims were staked. A subsidiary, Companhia Boliden de Mocambique, Lda., was formed, which applied for exclusive mineral prospecting rights from the Portugese Government in a large part of the Tete district.[18]

Nigeria.—A uranium-columbium deposit was discovered at Kabba, in northern Nigeria.[19]

Rhodesia and Nyasaland, Federation of.—On the Livingstonia Plateau of Northern Nyasaland a 3-inch-thick seam of coal was found to contain 0.73 percent of uranium oxide. Detailed investigations were to be undertaken.[20]

The British Atomic Energy Authority opened an office in Salisbury to assist prospectors in their search for radioactive materials and to conduct investigations of promising areas. Most uranium exploration was centered in the Lomagundi district west of Salisbury.[21]

In Southern Rhodesia, the Mafungabusi Plateau, some 80 miles west of Gatooma, and an area in the Chinmanimani Range, about 15 miles east of Metsetter were explored. No indication of the results was announced.[22] Airborne radiometric surveys were made of an area consisting of about 88 square miles, some 35 miles northwest of Gatooma.[23]

In the copper belt of Northern Rhodesia, uranium occurred in conjunction with workable copper deposits. With one exception, however, the uranium content of the copper deposits was not sufficient to warrant its recovery. In the Mindola section of the Nkana copper mine, uranium-bearing shale was present in amounts that merited erection of a small treatment plant in 1955.[24]

The Chartered Exploration, Ltd., with authorized capital of £1 million began exploration for uranium and other valuable minerals in 1955. Three areas covering over 104,000 square miles in Northern Rhodesia were to be investigated.[25]

Union of South Africa.—Gold mines, authorized by early 1955 to engage in uranium recovery are listed in the accompanying table.

The uranium-production program, which was begun in 1950 and financed by the Combined Development Agency, neared completion in 1955. There were 19 mines participating in the program in 1955. It is estimated that, by the end of 1956, 4 more mines will be engaged and 1 in 1957.

An outline was published of (1) the basic process for extracting uranium oxide from the gold-bearing reefs of South Africa, (2) methods of protecting the usual materials of plant construction from corrosion

[18] Engineering and Mining Journal, vol. 156, No. 5, May 1955, p. 190.
[19] Metal Bulletin (London), No. 4024, Sept. 6, 1955, p. 19.
[20] Atomic Scientists Journal (London), vol. 4, No. 5, May 1955, p. 293.
[21] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 3, September 1955, p. 29.
Engineering and Mining Journal, vol. 156, No. 11, November 1955, p. 186.
Chemical Age (London), vol. 73, No. 1888, Sept. 17, 1955, p. 584.
Rhodesian Mining Journal (Salisbury), vol. 20, No. 9, September 1955, p. 19.
[22] Uranium Magazine, vol. 2, No. 7, July 1955, p. 45.
[23] Mining Journal (London), vol. 246, No. 6285, Feb. 3, 1956, p. 159.
[24] American Metal Market, British Firms Start Search for Uranium in Central Africa: Vol. 62, No. 158, Aug. 16, 1955, pp. 1, 5.
Metal Bulletin (London), No. 4024, Sept. 6, 1955, p. 20.
[25] U. S. Embassy, Salisbury, Southern Rhodesia, State Department Despatch 337: June 21, 1955, 2 pp.

and abrasion in the uranium process plant, and (3) major items of equipment used and the capital costs of a typical South African uranium recovery unit.[26]

TABLE 7.—Companies to produce uranium in Union of South Africa [1]

	Status	Capacity			
		Leaching, tons slimes/month	Flotation, tons ore/month	Acid, tons/months	Slimes pumped to plants
West Rand Cons	Producing	60,000		1,500	
Blyvooruitzicht	do	160,000		(2)	
Western Reefs	do	200,000	200,000	6,600	
Daggafontein:					
North plant	do	120,000	120,000	6,600	
South plant	do		[3] 300,000		
Stilfontein	do	168,000		1,200	
Ellaton	do				[4] 30,000
Babrosco	do				[4] 16,000
Afrikaner	do				[4] 21,000
New Klerksdorp	do				[4] 21,000
Randfontein	do	140,000		6,600	
East Champ d'Or	do				[5] 20,000
Luipaardsvlei	Trial run	50,000			
Virginia	Under construction	130,000	130,000	9,900	
Merriespruit			[6] 100,000		
Welkom:					
President Brand	do	100,000			
President Steyn	do	100,000			
Vogelstruisbult	do	40,500	190,500		
Harmony	do	80,000			
West Driefontein	do	80,000			
Doornfontein	do				[7] 30,000
Dominion Reefs	do	40,000			
Vaal Reefs		65,000			

[1] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 2, February 1955, p. 30.
[2] Applied for.
[3] Pre-leach. Flotation concentrate pumped to North plant.
[4] Current and accumulated slimes. Pumped to Stilfontein.
[5] Current slimes. Pumped to Randfontein.
[6] Pre-leach. Flotation concentrates pumped to Virginia.
[7] Pumped to West Driefontein.

Several descriptions of the uranium industry in Union of South Africa were noted during 1955.[27]

During 1955 the West Rand Consolidated Mines, Ltd., developed a special shaft solely for hoisting uranium ores from the Monarch reefs of the Bird reef series. It was the first such shaft purely for hoisitng uranium ore, sunk by a gold-mining concern.[28] Gold is recovered at Monarch reefs as a coproduct.

A mineralogical report of the association of uraninite and gold in the reefs of the Witwatersrand was made available.[29]

[26] Craib, S., Engineering Features of Uranium Plant Design, Part I: South African Min. and Eng. Jour. (Johannesburg), vol. 66, No. 3275, Nov. 26, 1955, pp. 457, 459, 461, 463, 465.
[27] Holz, Peter, Uranium Production in South Africa: Min. Eng., vol. 6, No. 5, May 1955, pp. 130-131.
Chemical Age (London), Uranium Industry in S. A.: Vol. 73, No. 1879, July 16, 1955, p. 133.
Young, Paul E., A Tour of the Gold-Uranium Mines in South Africa: Western Miner and Oil Review, vol. 38, No. 11, November 1955, pp. 35-38.
[28] Mining World and Engineering Record, Uranium-Ore Mining in South Africa: Vol. 169, No. 4416, Nov. 19, 1955, pp. 280, 287.
Mining Journal (London), Rapid Sinking of the First Uranium Shaft in South Africa: Vol. 245, No 6272, Nov. 4, 1955, p. 529.
[29] Sommerlatte, Herbert, S. A. Mineralogical Observations on Witwatersrand Ores: Min. Mag. (London), vol. 93, No. 3, September 1955, pp. 142-152.

OCEANIA

Australia.—Descriptions of the uranium deposits at Radium Hill, Crockers Well, Mount Painter, and Houghton, South Australia, were provided in a bulletin by the Geological Survey of South Australia.[30]

The uranium-exploration program in the Rum Jungle uranium province, Northern Territory, was outlined. Systematic regional prospecting of the province was underway, based on airphoto geological mapping and airborne scintillometer surveys. Territory Enterprises Pty., Ltd., continued to develop, mine, and concentrate uranium at Rum Jungle proper on behalf of the Commonwealth Government.[31]

In Queensland, results of diamond drilling on the Mary Kathleen uranium occurrence in the Mount Isa-Cloncurry district were encouraging. The Rio Tinto Co. and the Australasian Oil Exploration, Ltd., are jointly developing the prospect.[32]

It was indicated that ore from the Radium Hill mine was being concentrated, before shipment to a chemical plant, at the Port Pirie mill in 1955. Contracts were believed to have been made by the South Australian State Government with the Combined Development Agency of the United States and Great Britain for sale and export of concentrates to both countries.[33]

The Rum Jungle refinery shipped its first $450,000 consignment of uranium concentrate to the United States, in accordance with a contractual agreement between Australia and the United States and Great Britain, made through the Combined Development Agency. Such exports of uranium concentrate to the United States and Great Britain were to assist in repaying a $6.7 million loan made by the agency to help in developing the Rum Jungle deposits.[34]

The Australian Atomic Energy Commission prepared designs for a nuclear-research center to be located near Sydney. The installation was to include a 10,000-kilowatt-capacity reactor.[35]

New Zealand.—Uranium was discovered by two prospectors in Buller Gorge, South Island, but subsequent investigations by Government geologists proved the occurrences had less than economic significance.[36]

Plans were underway to construct a heavy-water production plant in the Wairakei district of North Island. The plant would utilize geothermal steam. Heavy water recovered would be used as a moderator in nuclear power reactors proposed for New Zealand.[37]

---

[30] Chemical Engineering and Mining Review (Melbourne), South Australia's Uranium Deposits: Vol. 47, No. 6, Mar. 10, 1955, pp. 219–227.
[31] Hungerford, T. A., Rum Jungle Begins Production of Uranium Concentrate: Eng. Min. Jour., vol. 156, No. 1, January 1955, pp. 96–97.
Fisher, N. H., Sullivan, C. J., Uranium Exploration in the Rum Jungle Province: South African Min. and Eng. Jour. (Johannesburg), vol. 66, part 1, No. 3241, Mar. 26, 1955, pp. 133, 135, 155.
[32] Mining Magazine (London), vol. 92, No. 5, May 1955, pp. 294–295; vol. 92, No. 6, June 1955, p. 355.
[33] Mining Journal (London), Australia: Vol. 245, No. 6264, Sept. 9, 1955, p. 288.
[34] American Metal Market, vol. 62, No. 57, Mar. 23, 1955, p. 2.
Mining World, vol. 17, No. 6, May 1955, p. 66.
Metal Bulletin (London), No. 3986, Apr. 19, 1955, p. 24.
Mining Magazine (London), vol. 92, No. 3, Mar. 19, 1955, pp. 165–166.
Metal Industry (London). vol. 86, No. 14, Apr. 8, 1955, p. 277.
[35] Chemical and Engineering News, vol. 33, No. 25, June 20, 1955, p. 2616, 2618.
[36] Chemical Age (London), vol. 73, No. 1897, Nov. 19, 1955, p. 1118.
Atomic Energy Newsletter, vol. 14, No. 9, Dec. 13, 1955, p. 2.
Metal Bulletin (London), No. 4048, Nov. 20, 1955, p. 24.
[37] Atomics and Atomic Technology (London), Heavy-Water Plant—New Zealand: Vol. 6, No. 4, April 1955, p. 108.
Atomic Scientists Journal (London), vol. 4, No. 5, May 1955, p. 293.

Vanadium

By Hubert W. Davis [1] and Phillip M. Busch [1 2]

SUPPLY of vanadium in 1955 again exceeded requirements, despite an increase in world and United States consumption. The chief source of vanadium continued to be the uranium ores of the Western States, from which it was extracted as a byproduct.

World production of vanadium totaled about 4,000 short tons, a 4-percent gain over 1954 and virtually the same as in the record year 1953.

Outputs of ferrovanadium and vanadium pentoxide in the United States were greater by 107 and 16 percent, respectively.

Consumption of vanadium products in the United States in 1955 was about 3.8 million pounds, of which 85 percent was consumed as ferrovanadium.

Imports of vanadium were limited to a relatively small quantity of concentrate from Peru.

TABLE 1.—Salient statistics of the vanadium industry in the United States, 1946–50 (average) and 1951–55

(Pounds of contained vanadium)

	1946–50 (average)	1951	1952	1953	1954	1955
Production (domestic):						
Recoverable vanadium in ore and concentrate [1]	1, 915, 456	4, 251, 278	5, 142, 799	6, 114, 851	6, 051, 784	6, 571, 655
Vanadium pentoxide	2, 474, 259	4, 456, 704	4, 328, 016	5, 012, 448	6, 302, 912	7, 338, 668
Imports:						
Ore and concentrate	966, 990	982, 878	1, 043, 797	716, 977	395, 287	184, 737
Vanadium-bearing flue dust	18, 711	----------	939	1, 010	----------	----------
Exports:						
Ferrovanadium and other vanadium alloying materials containing over 6 percent vanadium [2]	[3] 161, 437	[3] 122, 344	[3] 293, 162	[3] 156, 952	[3] 140, 510	[3] 439, 457
Vanadium pentoxide, vanadic oxide, vanadium oxide, and vanadates [4]	8, 197	2, 817	120, 367	12, 319	42, 935	1, 729, 103
Ore and concentrate processed	[5] 3,965, 450	7, 036, 317	6, 557, 691	[6] 7,890, 000	[6] 9,609, 000	11, 312, 000

[1] Measured by receipts at mills.
[2] Classified as ferrovanadium, 1946–52.
[3] Figure represents gross weight.
[4] Classified as "Ore and concentrates" in 1946–52 but probably included vanadium pentoxide.
[5] 1947–50 average.
[6] Revised figure.

[1] Commodity specialist.
[2] The assistance of Kathleen W. McNulty is acknowledged.

The inability of South-West Africa, the second largest producer of vanadium, to increase production, coupled with the greatly increased consumption of vanadium in Europe, resulted in a phenomenal export demand in the United States, and shipments to foreign countries were 11 times larger than in 1954.

Quotations on vanadium ore remained unchanged throughout 1955 but prices on ferrovanadium and vanadium pentoxide were advanced 10 to 5 cents a pound, respectively.

DOMESTIC PRODUCTION

ORE

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 northern Arizona and northern New Mexico. Vanadium production in these States was a byproduct or coproduct of uranium. For the first time since production was begun in 1941, there was no recovery of vanadium from phosphate-rock mining in Idaho in 1955.

Production of recoverable vanadium in ore and concentrate established a new high in 1955 and was 9 percent more than in 1954.

Colorado maintained its position as the largest vanadium-ore-producing State; the output of recoverable vanadium was 1.5 percent more than in 1954. Vanadium-recovery units were operated in 1955 by Climax Uranium Corp., at Grand Junction; Union Carbide Nuclear Co. (formerly United States Vanadium Co.) at Rifle and Uravan; and Vanadium Corp. of America at Durango and Naturita.

Production of recoverable vanadium in ore and concentrate in Utah was 73 percent more than in 1954. The ore-processing plant of Galigher Co. at Monticello was the only one recovering vanadium in Utah in 1955.

A small quantity of vanadium was recovered at the ore-processing plant near Shiprock, N. Mex., by the Navajo Uranium Division of Kerr-McGee Oil Industries, Inc., in 1955.

More detailed information on domestic production is contained in volume III of this series under Colorado, New Mexico, and Utah.

TABLE 2.—Recoverable vanadium in ore and concentrate produced in the United States, 1946–55, by States

(Pounds of contained vanadium)

State	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
Colorado	805, 011	1, 253, 261	768, 612	1, 746, 722	2, 239, 158	3, 168, 781	4, 197, 914	4, 530, 612	4, 528, 472	4, 595, 359
Utah	45, 015	32, 932	67, 206	151, 591	282, 179	381, 704	194, 532	385, 038	575, 884	995, 873
Other States [1]	170, 672	356, 785	504, 423	478, 359	675, 352	700, 793	750, 353	1, 199, 201	947, 428	980, 423
	1, 020, 698	1, 642, 978	1, 340, 241	2, 376, 672	3, 196, 689	4, 251, 278	5, 142, 799	6, 114, 851	6, 051, 784	6, 571, 655

[1] Includes Arizona; Idaho, 1946–54; New Mexico, 1947–48 and 1950–54; and South Dakota and Wyoming, 1954.

TABLE 3.—Vanadium content and recoverable vanadium in ore and concentrate produced in the United States, 1946–55, in pounds

Year	Mine production [1]	Recoverable vanadium	Year	Mine production [1]	Recoverable vanadium
1946	1,272,148	1,020,698	1951	[2] 6,079,854	4,251,278
1947	2,117,962	1,642,978	1952	[2] 7,176,861	5,142,799
1948	1,788,551	1,340,241	1953	9,285,898	6,114,851
1949	[2] 3,160,772	2,376,672	1954	9,860,028	6,051,784
1950	4,596,134	3,196,689	1955	9,965,205	6,571,655

[1] Measured by receipts at mills.
[2] Revised figure.

OXIDE

The first step in the processing of domestic vanadium-bearing ore and concentrate to marketable form is conversion of the vanadium to pentoxide, which contains 85 to 92 percent V_2O_5. Vanadium oxide output in 1955 was consumed largely as a raw material in the manufacture of ferrovanadium, which contains 38 to 80 percent vanadium. Production of vanadium pentoxide in the United States again established a new record in 1955 and was 16 percent more than in 1954. Vanadium pentoxide was produced at 8 plants in 1955 and 9 in 1954. The figures for 1946–55 in table 4 include the vanadium pentoxide produced from Peruvian concentrate and that recovered as a byproduct of foreign chrome ore, and those for 1946–54 include the vanadium oxide recovered as a byproduct of domestic phosphate rock.

TABLE 4.—Production of vanadium pentoxide in the United States, 1946–55, in pounds

Year	Gross weight	V_2O_5 content	Year	Gross weight	V_2O_5 content
1946	2,985,000	2,631,800	1951	8,939,300	7,958,400
1947	6,145,300	5,466,000	1952	8,710,900	7,728,600
1948	4,396,900	3,898,000	1953	10,140,900	8,950,800
1949	4,086,200	3,595,500	1954	12,735,000	11,255,200
1950	7,338,600	6,500,300	1955	14,851,000	13,104,800

FERROVANADIUM

Ferrovanadium was produced in the United States in 1954 and 1955 by two companies, Electro Metallurgical Co. and Vanadium Corp. of America. The Bureau of Mines is not at liberty to publish the output figures; however, production was 107 percent more than 1954.

CONSUMPTION

ORE AND CONCENTRATE

The quantity of domestic and foreign vanadium ore and concentrate consumed at domestic plants in making vanadium pentoxide and ferrovanadium again established a new record in 1955; it was 11.3 million pounds (vanadium content), an 18-percent increase over 1954.

VANADIUM PRODUCTS

In 1955, for the first time since 1946, the Bureau of Mines collected statistics on consumption and stocks of vanadium products. The data in tables 5 and 6 cover all the larger and most of the smaller users of vanadium and are believed to represent about 90 percent of the total consumption.

Of the reported consumption in 1955 about 85 percent was in the form of ferrovanadium, and 87 percent of the total consumption was used in high-speed and other alloy steels.

TABLE 5.—Vanadium consumed and in stock in the United States in 1955, by forms, in pounds of vanadium

Form	Stocks at consumers' plants Dec. 31, 1954	Consumption	Stocks at consumers' plants Dec. 31, 1955
Ferrovanadium	373,168	2,906,033	461,268
Oxide	18,394	256,573	29,210
Ammonium metavanadate	25,570	132,639	24,818
Other	10,493	104,488	49,790
Total	427,625	[1] 3,399,733	565,086

[1] Represents about 90 percent of total consumption, which was about 3.8 million pounds.

TABLE 6.—Vanadium consumed in the United States in 1955, by uses

Use	Pounds of vanadium	Use	Pounds of vanadium
High-speed steel	1,027,867	Chemicals	162,785
Other alloy steels	1,943,682	Other	87,167
Alloy cast iron	56,780		
Nonferrous alloys	121,452	Total	[1] 3,399,733

[1] Represents about 90 percent of total consumption, which was about 3.8 million pounds.

USES

About 85 percent of the vanadium was used as ferrovanadium in the manufacture of tool steels, engineering steels, high-strength structural steels, nonaging rimming steels, and special wear-resistant cast irons. Ferrovanadium was also used in welding-electrode coatings, as a deoxidizer, and in permanent-magnet alloys. Vanadium oxide was also utilized in welding-electrode coatings and employed for adding vanadium to steels under certain special conditions. Vanadium oxide and ammonium metavanadate were utilized as catalysts, in glass and ceramic glazes, for driers in paints and inks, and for laboratory research. The use of metallic vanadium was limited largely to alloying with gold in dental alloys, copper, and bronze (such as for aircraft propeller bushings), and with aluminum for airframe construction.

Vanadium continued to be used mainly in steel for its grain-refining and alloying effects; however, only small quantities are required to achieve these results. In high-speed steels the vanadium content ranges from about 0.50 to 2.50 percent, although still higher percentages are sometimes employed. 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 generally 0.10 to 0.25 percent. Most steels containing over 0.50 percent vanadium are for special purposes, such as reamers, roughing and finishing tools, die-casting dies, work dies, and twist drills. Vanadium can be used successfully alone in an alloy of carbon steel; but, in a wide variety of engineering and structural steels, it is more generally combined with chromium, nickel, manganese, boron, and tungsten. Aluminum alloyed with 2.5 to 10 percent vanadium was used to control thermal expansion, electrical resistivity, and grain size of aluminum alloys, both wrought and cast; and it improves high-temperature strength. Aluminum, titanium, and boron, alloyed with 25 percent vanadium, was employed in alloy steels to increase depth hardenability, as well as to impart fine grain structure to the resultant metal. It also improves hot-working characteristics of wrought stainless and heat-resisting steels and reduces heat checking of castings of these steels.

Vanadium additions of 0.10 to 0.15 percent increase the strength of cast iron 10 to 25 percent and add a considerable degree of toughness.

PRICES

Since March 8, 1951, vanadium ore has been quoted at 31 cents per pound of contained V_2O_5. This quotation, however, disregards penalties based on grade of the ore or the presence of objectionable impurities, such as lime—matters important to the refiners, inasmuch as impurities vitally affect recoveries. Effective October 1, 1955, the quotation on ferrovanadium was increased 10 cents a pound to $3.10 to $3.30 a pound of contained vanadium (depending upon the grade of the alloy); the price on vanadium pentoxide (technical grade) was advanced 5 cents a pound to $1.33 to $1.38 a pound of V_2O_5. Vanadium metal, in 100-pound lots, was quoted at $3.45 a pound in 1955.

FOREIGN TRADE [3]

Imports of vanadium concentrate (all from Peru) in 1955 were 53 percent less than in 1954 and the smallest since 1935.

Vanadium ore and concentrate entered the United States free of duty; however, the rate of duty on ferrovanadium was 12½ percent ad valorem and on vanadic oxide, anhydride, salts and compounds and mixtures of vanadium 40 percent ad valorem.

Exports of vanadium in various forms in 1955 were 11 times greater than in 1954. Exports of ferrovanadium tripled, those of vanadium flue dust and other vanadium waste materials were 3.6 times greater, but those of vanadium pentoxide, vanadium oxide, vanadic oxide, and vanadates rose spectacularly from 43,000 pounds in 1954 to 1,729,000 pounds (vanadium content) in 1955. Austria, France, West Germany, Netherlands, and Sweden were the chief foreign markets, taking 85 percent of the total exports.

---

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

TABLE 7.—Vanadium ore or concentrate, vanadium-bearing flue dust, and ferrovanadium[1] imported for consumption in the United States, 1946–50 (average) and 1951–55

[U. S. Department of Commerce]

Year	Vanadium ore or concentrate			Vanadium-bearing flue dust			Ferrovanadium	
	Pounds		Value	Pounds		Value	Pounds (gross weight)	Value
	Gross weight	Vanadium content		Gross weight	Vanadium content			
1946–50 (average)	3,446,558	966,990	$470,691	50,090	18,711	$6,288	26,004	$18,239
1951	3,893,900	982,878	526,941				123,050	100,261
1952	4,338,660	1,043,797	599,203	12,285	939	2,425	21,396	22,132
1953	2,959,600	716,977	421,091	9,822	1,010	2,237	17,364	12,584
1954	1,183,961	395,287	238,222					
1955	[2] 558,706	[2] 184,737	[2] 104,230					

[1] In addition to data shown "vanadic acid, anhydride, salts and compounds, and mixtures of vanadium" imported as follows: 1953: 3,090 pounds (gross weight), $2,368: 1954: 4,000 pounds (gross weight), $2.934.
[2] Includes 92,594 pounds of concentrate containing 29,804 pounds of vanadium, valued at $16,811, received but not reported by the U. S. Department of Commerce.

TABLE 8.—Exports of vanadium from the United States, 1946–50 (average) and 1951–55 by classes

[U. S. Department of Commerce]

Year	Vanadium pentoxide, vanadic oxide, vanadium oxide, and vanadates (except chemically pure grades)[1]		Ferrovanadium and other vanadium alloying materials containing over 6 percent vanadium[2]		Vanadium metal, alloys, and scrap		Vanadium-bearing flue dust and other vanadium waste materials	
	Pounds (vanadium content)	Value	Pounds (gross weight)	Value	Pounds (gross weight)	Value	Pounds (vanadium content)	Value
1946–50 (average)	8,197	$23,495	161,437	$270,324	6,980	$6,755	(3)	(3)
1951	2,817	6,581	122,344	190,346	1,712	6,481	(3)	(3)
1952	120,367	280,216	293,162	529,360	103,036	12,862	(3)	(3)
1953	12,319	32,141	156,952	296,157	(4)	(4)	54,211	$31,285
1954	42,935	120,311	140,510	237,333	(4)	(4)	23,953	13,609
1955	1,729,103	3,768,358	439,457	991,955	(4)	(4)	86,519	66,472

[1] Classified as "Ore and concentrates" in 1946–52 but probably includes vanadium pentoxide.
[2] Classified as ferrovanadium in 1946–52.
[3] Not separately classified before Jan. 1, 1953.
[4] Beginning Jan. 1, 1953, not separately classified.

TABLE 9.—Exports of vanadium from the United States, 1954–55, by countries, in pounds

[U. S. Department of Commerce]

Country	Ferrovanadium and other vanadium alloying materials containing over 6 percent vanadium (gross weight)		Vanadium pentoxide, vanadic oxide, vanadium oxide and vanadates (except chemically pure grade) (vanadium content)		Vanadium flue dust and other vanadium waste materials (vanadium content)	
	1954	1955	1954	1955	1954	1955
North America:						
Canada	116,335	110,200	1,120	1,120		
Mexico	17,000	1,100		840		
Total	133,335	111,300	1,120	1,960		
South America:						
Argentina				3,342		
Brazil	3,128	2,240	11,318	1,193		
Chile	742	2,000				
Colombia			2,660			
Total	3,870	4,240	13,978	4,535		
Europe:						
Austria				610,467		
Belgium-Luxembourg			2,256	6,525		42,108
France			4	327,094	9,036	
Germany, West		308,027		293,476	14,917	28,840
Italy				116,600		
Netherlands			560	157,713		12,744
Sweden				173,680		2,827
Switzerland		13,215				
United Kingdom				1,232		
Yugoslavia		2,205				
Total		323,447	2,820	1,686,787	23,953	86,519
Asia:						
Japan	3,305		25,017	35,821		
Taiwan		470				
Total	3,305	470	25,017	35,821		
Grand total	140,510	439,457	42,935	1,729,103	23,953	86,519

TECHNOLOGY

During 1955 Bureau of Mines research on vanadium was primarily of an experimental nature; it involved evaluating current and new techniques for recovering vanadium oxide, production and testing of high-purity vanadium metal, and determination of the physical and metallurgical properties of vanadium.

Lack of information concerning the effect of trace amounts of impurities on the properties of ultra-high-purity vanadium metal led the Vanadium Corp. of America to institute a new research program to investigate the behavior of high-purity vanadium metal. The iodide vanadium process appeared to show some industrial promise. The production of high-purity metal by this process has been described in an article.[4] Briefly, the method involves:

The reaction between iodine vapor and impure vanadium metal at an elevated temperature, followed by the volatilization of the vanadium triiodide. When the vanadium iodide comes in contact with a hot wire, it is thermally decomposed

[4] Rathman, H. W., and Grady, H. R., Ultra-High-Purity Vanadium by the Iodide Method: Vancoram Rev., vol. 10, No. 2, 1955, pp. 6–7, 17.

into vanadium and iodine. Thus, the hot wire grows in size as metallic vanadium is deposited thereon.

The results of a study of vanadium oxides to provide a basis for the development of oxidation catalysts [5] and the results of an exploratory investigation made of the possibilities of using V_2O_4 and V_2O_5, and some of their binary compounds for new and useful ceramics [6] were described.

A patent was issued for hot-working metallic vanadium and vanadium-base alloys.[7]

WORLD REVIEW

World production of vanadium ore in 1955 was again limited almost entirely to Peru, South-West Africa, and the United States; production increased 4 percent over 1954. The United States contributed about 82 percent of the total in 1955. In addition to ore, other sources of vanadium have been 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 a byproduct of iron ore and other materials is lacking, it is not possible to determine world production of vanadium from all sources. Consequently, table 10 reflects only the production of

TABLE 10.—World production of vanadium in ores and concentrates, 1946–55, in short tons

[Compiled by Pearl J. Thompson]

	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
North America: United States (Recoverable vanadium in shipments) [1]	510	821	670	1,188	1,598	2,126	2,571	3,057	3,026	3,286
South America:										
Argentina	7	8	[2] 8	[2] 8	[2] 8	[2] 8	[2] 8	[2] 8	[2] 8	[2] 8
Peru (content of concentrate)	355	480	563	503	481	495	482	349	195	78
Total	362	488	571	511	489	503	490	357	203	86
Africa:										
Rhodesia and Nyasaland, Federation of:										
Northern Rhodesia (recovered vanadium)	75	62	191	169	------	96	47	------	------	------
South-West Africa (recoverable vanadium)	474	311	206	180	325	583	688	596	633	632
Total	549	373	397	349	325	679	735	596	633	632
World total (estimate) [3]	1,421	1,682	1,638	2,048	2,412	3,308	3,796	4,010	3,862	4,004

[1] Includes vanadium recovered as a byproduct of phosphate-rock mining, 1946–54.
[2] Estimate.
[3] 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 table also excludes quantities of vanadium recovered as byproducts from other ores and raw materials.

[5] Simard, G. L., and others, Vanadium Oxides as Oxidation Catalysts: Ind. Eng. Chem., vol. 47, No. 7, July 1955, pp. 1424–1430.
[6] King, B. W., and Suber, L. L., Some Properties of the Oxides of Vanadium and Their Compounds: Jour. Am. Ceram. Soc., vol. 38, No. 9, September 1955, pp. 306–311.
[7] Brown, C. M., and Shrubsall, A. E. (assigned to Union Carbide & Carbon Corp.), Hot-Working Vanadium: U. S. Patent 2,715,765, Aug. 23, 1955.

vanadium in ore and concentrate for the countries listed, plus the quantity recovered in the United States as a byproduct of phosphate rock in 1946–54.

The figures for the United States for 1946–55 represent recoverable vanadium and consequently are not strictly comparable with those for preceding years, which represented the vanadium content in ore and concentrate produced.

SOUTH AMERICA

Argentina.—Vanadium occurs in small deposits widely scattered in the Provinces of Cordoba, Mendoza, and San Luis. A small quantity of ore has been mined to produce 3 to 8 short tons of vanadium pentoxide annually.

Peru.—Production of vanadium at the well-known Mina Ragra mine of the Vanadium Corp. of America in the Andes near Ricran, Department of Junin, continued its downtrend for the fourth successive year. Output was 78 short tons (vanadium content) in 1955, a 60-percent decrease from 1954 and the smallest since 1935. Output was suspended in August 1955, when the mine and plant were put on an indefinite standby basis. The mine has been an important source of vanadium since 1907, when production was begun.

EUROPE

Finland.—It is reported [8] that construction of a plant to recover the vanadium contained in the titaniferous iron ore of the Otanmäki mine in central Finland was begun in the spring of 1955 and that production of vanadium pentoxide was expected to begin by mid–1956.

The ore contains about 35 percent Fe, 12 to 15 percent TiO_2, 0.6 percent S, 0.3 percent V, and small quantities of P and Ni. The ore is converted into a magnetite concentrate which contains about 0.6 percent V, and an ilmenite concentrate which contains about 0.25 percent V. Vanadium will be recovered from the magnetite concentrates by chemical methods. The plant will have capacity to produce about 500 metric tons of pentoxide annually.

AFRICA

Rhodesia and Nyasaland, Federation of.—The zinc-vanadium mine at Broken Hill of Rhodesia Broken Hill Development Co., Ltd., was a source of vanadium from 1931 through 1952. During this period production of vanadium in oxide was 4,970 short tons. There has been no output of oxide since 1952; meanwhile, all vanadium ore produced by the mine has been stockpiled with the mixed fines tailings, pending final development of a process for recovering both the zinc and vanadium.

South-West Africa.—The South West Africa Co., Ltd., again was the only producer of vanadium in South-West Africa. The vanadium occurs with lead in the Abenad West and Berg Aukas mines. Output of vanadium in lead concentrate (in terms of recoverable V_2O_5) comprised 1,091 short tons from the Abenab West mine and 38 tons

[8] Mining World, vol. 18, No. 5, Apr. 16, 1956, p. 121.

from the Berg Aukas mine in 1955 compared with 1,130 tons in 1954. Exports were 1,022 short tons in 1955 compared with 969 tons in 1954. The 1955 exports comprised 1,020 tons to West Germany and 2 tons to the Union of South Africa.

The Berg Aukas mine was reopened in 1955; underground development disclosed small quantities of high-grade vanadium ore. The company experienced increasing difficulty in maintaining a large enough supply of ore to the mill from that section of the Abenab West mine being worked, and a substantial tonnage was drawn from old tailings. Work was resumed at Harasib III mine to explore the lead-vanadium ore body at greater depth; some lead-vanadium was exposed by continued underground development at the Baltika mine; and a geological examination of the old Nosib lead-vanadium-copper mine gave encouraging results, which will be investigated further.

OCEANIA

New Zealand.[9]—Hitherto found to be unusable in blast furnaces because of the presence of titanium, the vast deposits of iron sands extending from Patea to the Waikato in New Zealand, estimated to contain 700 million tons or more of recoverable iron, may become the basis of a large new industry as a result of experiments at the Victoria University College. Titanium might be a premium material that would make processing economical, since magnetic separation yielded a product containing 0.3 percent vanadium and 8 percent titanium.

[9] Mining Journal (London), Titanium and Vanadium From New Zealand Iron Sands: Vol. 245, No. 6269 Oct. 14, 1955, pp. 436–437.

Vermiculite

By L. M. Otis[1] and Nan C. Jensen[2]

CRUDE vermiculite production nearly regained the high output established in 1951–52; and, for the fourth year in statistical recording by the Bureau of Mines, over 200,000 tons was marketed or used by producers. The Union of South Africa was again the only important foreign producer, its output rising almost 30 percent over that in 1954.

DOMESTIC PRODUCTION

Crude Vermiculite.—Seven firms operating 8 mines in 3 States reported output of crude vermiculite in 1955. Of the firms, 4 sold their entire production as screened and cleaned crude to be exfoliated in plants belonging to others, 1 produced only for its own use, and 2 utilized part of their production for their own exfoliating facilities and sold the remainder in the open market.

The greatest production of crude continued to come from the mines of the Zonolite Co. near Libby, Mont., and Lanford, S. C. Alabama Vermiculite Co., near Lanford, produced the second largest company total. Output was reported in North Carolina, but none from Arizona or Colorado during 1955.

TABLE 1.—Screened and cleaned crude vermiculite sold or used by producers in the United States, 1946–50 (average) and 1951–55

Year	Short tons	Value	Year	Short tons	Value
1946–50 (average)	146,665	$1,480,525	1953	189,535	$2,445,381
1951	209,008	2,679,148	1954	195,538	2,537,577
1952	208,906	2,657,826	1955	204,040	2,702,225

Exfoliated Vermiculite.—In 1955, 28 companies operated 54 plants in 32 States and Hawaii. North Carolina and Texas each had 4 exfoliating plants, with 3 plants in California, Illinois, Minnesota, Florida, New Jersey, and Pennsylvania and 2 plants in Montana, Missouri, and Massachusetts. All other States concerned contained one vermiculite-exfoliating plant each.

A total of 158,000 short tons of exfoliated vermiculite, valued at nearly $10 million, was sold or used in 1955.

[1] Commodity specialist.
[2] Statistical assistant.

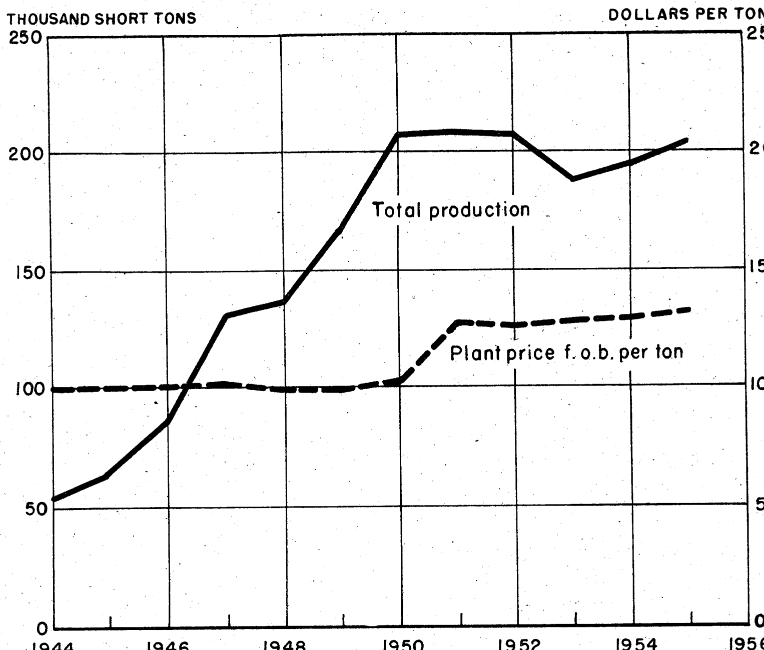

FIGURE 1.—Screened and cleaned crude vermiculite sold or used by producers in the United States and average value per ton, at their plants, 1944–55.

TABLE 2.—Exfoliated vermiculite sold or used by producers in the United States,[1] 1954–55

Year	Operators	Plants	Short tons	Value	
				Total	Average per ton
1954	27	50	144,964	$10,807,023	$74.55
1955	28	54	157,952	9,999,634	63.31

[1] 32 States and Hawaii.

Mine and Plant Developments.—Zonolite Co. had a new mill under construction in South Carolina in 1955. The mill was to be fully equipped with the most effective machines including froth-flotation applied directly to shaking tables for removing impurities from vermiculite. With its completion, vermiculite mining north of Greenville will be discontinued, and the older mill at Travelers Rest, though idle, will be maintained in standby condition. Active mining was underway at several deposits south of Greenville. The new mill at Enoree, Spartansburg County, is not only centrally located with respect to the mines but is adjacent to two streams which are adequate to insure water supply.

Southern Vermiculite Co. of Franklin, N. C., was purchased by Roy M. Biddle of Franklin. Crude vermiculite will be produced from this mine.[3]

[3] Engineering and Mining Journal, vol. 156, No. 5, May 1955, p. 148.

CONSUMPTION AND USES

A new application for vermiculite as an insecticide and herbicide was reported.[4] For these purposes it may be mixed with fertilizer or drilled into the ground separately. Other subjects discussed were the machine application of vermiculite concrete and plaster for floors, ceilings, roofs, spandrels, fireproofing steel beams, and acoustical treatment.

The use of vermiculite in machine-applied acoustical plasters was the subject of a meeting of architects, plastering contractors, and Zonolite Co. officials in Minneapolis, Minn. Buildings in which vermiculite had been machine-applied for acoustical and fire-retardant purposes were inspected by the group. Exploratory vermiculite-plaster fire tests at the University of Ohio and full-scale tests at Underwriters' Laboratories also were discussed. The tests were sponsored by the Vermiculite Institute of Chicago.[5]

The Bureau of Mines did not canvass producers concerning uses, as in many instances the exfoliators are not aware of the end uses. However, the largest vermiculite producer, the Zonolite Co., prepared a data book listing over 40 industrial uses for its product.[6] Besides describing these uses in terms of absorption, resiliency, and thermal expansion, and characteristics as a filler, lubricant, catalyst, dielectric, and insulator, the book includes a selected bibliography on vermiculite.

The relatively small quantity of vermiculite used in the unexfoliated state included the following applications: A catalyst in the preparation of petroleum hydrocarbons and other organic compounds; an ingredient in acid-resistant etching powder; an additive to molten nonferrous metals and gray iron to improve grain structure and machinability; in compounding briquets of ferrosilicon used to disperse additives in ladles of molten metal.

The construction industries consume most of the exfoliated vermiculite. Agriculture used a substantial tonnage, and many relatively minor miscellaneous purposes constituted the remainder.

PRICES

The average value of crude screened and cleaned vermiculite at the mine in 1955 was $13.24 per short ton, a 2-percent increase over 1954. The average value of the exfoliated product f. o. b. producers' plant was $63.31 per ton, a decline of 15 percent compared with the previous year. These prices are from a Bureau of Mines canvass. Market quotations are seldom found in the trade journals.

FOREIGN TRADE

The Union of South Africa was the only important exporter of crude vermiculite to the United States. The quantity, value and destination of its exports are shown in table 4.

About 80 percent of Canadian requirements of crude vermiculite were supplied by the United States and the remainder by the Union of South Africa.

[4] Rock Products, New Applications for Vermiculite: Vol. 58, No. 7, July 1955, p. 88.
[5] Plastering Industries, Contractors, Western Mineral Cosponsor Architect Meet: September 1955, pp. 47-48.
[6] Zonolite Co., Zonolite Brand Vermiculite, Chemical and Physical Properties: Chicago, Ill. 16 pp.

TECHNOLOGY

Patents.—A new type of bonding material for use in molding compositions was patented. The mixture from which molded products are formed contains exfoliated vermiculite, asbestos, and talc.[7]

A patented lightweight concrete includes, among its aggregates, exfoliated vermiculite and various other materials of low specific gravity.[8]

A new type of insulation for underground pipe employs exfoliated vermiculite with asbestos-board or mineral-wool jackets.[9]

A patent was granted covering the use of vermiculite in a mixture of sodium silicate solution, metal oxides, and kaolin, as a protective coating. It is claimed that this mixture applied to steel, aluminum, and other metals prevents corrosion under moist or dry heat conditions and makes them resistant to chemical reactions. Recommended coatings contain 10 percent of expanded vermiculite.[10]

A patent was issued for a new type of plaster aggregate comprised largely of exfoliated vermiculite and granulated blast-furnace slag.[11]

In a new separation process, exfoliated vermiculite can be used as a support for urea or thiourea in the chemical reaction.[12]

Exfoliated vermiculite is the preferred rooting medium in a patented packaged plant-growing box designed for rapid germination of plants.[13]

A patented surfacing material for walls and ceilings contains exfoliated vermiculite, lime, and portland cement together with small quantities of a plasticizing agent such as barite, chalk, whiting, or kaolin.[14]

Research.—A graduate fellowship was established by the Zonolite Co. at Clemson College. The initial study will deal with the relationship of the physical and chemical properties of vermiculite to its geological origin.[15]

At a joint symposium of the Institute of Marine Engineers and the Institution of Naval Architects, it was stated that research indicated effective use of vermiculite as an additive in powdered form to fuel oil used in steam turbines. With the addition of vermiculite, cheap residual oil can be used without fouling the machine with combustion waste.[16]

Utilization.—The manufacture of precast vermiculite insulating concrete roof tile in a modern Pittsburgh plant outlined with illustrations was described. The tile is 3 by 18 by 36 inches long, with 12-gage galvanized steel mesh bent into 2- by 4-inch basket-shape reinforcing members.[17]

---

7 Thompson, J. S. (assigned to Parker Rust Proof Co.), Bonding Materials and Method of Making the Same: U. S. Patent 2,702,425, Feb. 22, 1955.

8 Willson, C. D., Cement-Bound Lightweight Aggregate Masses: U. S. Patent 2,703,289, Mar. 1, 1955.

9 Coff, D. C. (assigned to Zonolite Co., Chicago, Ill.), Method of Insulating Underground Pipe: U. S. Patent 2,707,984, May 10, 1955.

10 Happe, Arthur H., Coating for Metals: U. S. Patent 2,711,974, June 28, 1955.

11 Ziegler, C. F. (assigned to Zonolite Co., Chicago, Ill.), Aggregate Composition of Granulated Slag and Expanded Vermiculite: U. S. Patent 2,715,583, Aug. 16, 1955.

12 Axe, W. M. (assigned to Phillips Petroleum Co.), Separation Process: U. S. Patent 2,716,113, Aug. 23, 1955.

13 Peerless, S. A., Miniature Greenhouse: U. S. Patent 2,720,725, Oct. 18, 1955.

14 Clipson, S., Composition for Surfacing Walls, Ceilings, and the Like: U. S. Patent 2,728,681, Dec. 27, 1955.

15 Chemical and Engineering News, vol. 33, No. 9, Feb. 28, 1955, p. 854.

16 Mine and Quarry Engineering (London), Talc and Vermiculite: Vol. 21, No. 8, August 1955, p. 351.

17 Pit and Quarry, Pipe Firm Adds Precast Concrete Roof-Tile Plant: Vol. 48, No. 3, September 1955, pp. 226, 228, 252.

A magazine article called attention to the fire resistance of vermiculite used as a plaster and in concrete slabs under actual fire conditions. A 3-hour fire in a laboratory of a high school indicated that vermiculite plaster over metal lath is effective in protecting steel supports and ceiling and that vermiculite-concrete roof slabs are advantageous under these fire conditions.[18]

Vermiculite is one ingredient in a patented mixture used by various licensees to manufacture lightweight wall panels. These panels have good insulation qualities and high resistance to moisture and can be sawed, nailed, and otherwise worked like lumber. Standard panels are 8 feet long, 16 inches wide, and 2 to 5¼ inches thick. They are strong enough for walls in 1 story and 1½-story residences and are especially adapted for fireproof demountable partitions in industrial buildings.[19]

WORLD REVIEW

NORTH AMERICA

Canada.—Four companies produced exfoliated vermiculite at 9 plants in Canada during 1955. The value of crude vermiculite imported into Canada was Can$355,411, $284,152 from the United States and the remainder from the Union of South Africa. Consumption in 1954 was 21,964 short tons, 13 percent less than 1953.[20]

TABLE 3.—World production of vermiculite, by countries [1] 1946–50 (average) and 1951–55 in short tons [2]

[Compiled by Helen L. Hunt]

Country [1]	1946–50 (average)	1951	1952	1953	1954	1955
Argentina	------	------	------	------	------	551
Australia	161	62	69	32	------	------
Egypt	------	702	66	[3] 100	------	------
India	[4] 58	260	24	------	3	138
Japan	------	------	------	------	882	[3] 1,300
Kenya	2	3	------	82	807	380
Rhodesia and Nyasaland, Federation of:						
Southern Rhodesia	[5] 621	553	------	------	------	------
Tanganyika	11	------	------	------	------	------
Union of South Africa	21,050	27,014	39,918	33,844	45,633	57,482
United States (sold or used by producers)	146,665	209,008	208,906	189,535	195,538	204,040
World total [1]	168,568	237,602	248,983	223,593	242,863	263,891

[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] This table incorporates a number of revisions of data published in previous Vermiculite chapters.
[3] Estimate.
[4] Average for 1 year only, as 1950 was first year of commercial production.
[5] Average for 1948–50.

ASIA

India.—Vermiculite of satisfactory commercial quality is reported from Mysore by the Geological Department. Although vermiculite is used to a limited extent in various industries, India is not at present a large consumer.[21]

[18] Plastering Industries, Fire Protection in Action: September 1955, p. 35.
[19] Pit and Quarry, Concrete Wall Panels: Vol. 48, No. 3, September 1955, pp. 230, 232.
[20] Canada Department of Mines and Technical Survey, Vermiculite in Canada, 1955 (Prelim.): Ottawa, 3 pp.
[21] Bureau of Mines, Mineral Trade Notes: Vol. 40, No. 5, May 1955, p. 67.

457676—58——80

AFRICA

Mozambique.—The Transvaal Ore Co., Ltd., of Johannesburg investigated vermiculite deposits of Panzo at the Zambezi River in the Tete district.[22]

Rhodesia and Nyasaland, Federation of.—A detailed account of the geology of the Middle Shire Valley, Southern Nyasaland, mentions the existence of vermiculite ore resulting from the hydrothermal alteration of biotitite-rich rocks of the Basement complex.[23]

South Africa.—The Transvaal Ore Co., Ltd., reported its 1955 shipments of crude vermiculite ore from Palabora, northeastern Transvaal.[24] This company purchased competitive properties in the Palabora district, northeastern Transvaal, and was the sole exporter of South African vermiculite ore. It reports over 6 million tons of hydrophlogopite vermiculite and a substantially larger tonnage of hydrobiotitic vermiculite indicated. None of the latter was mined in 1955. Processing capacity was said to be 80,000 tons of crude annually. American Vermiculite Corp. was the only representative of Transvaal Ore Co., Ltd., in the United States and Canada.

TABLE 4.—Exports of crude vermiculite from Union of South Africa, 1954–55 [1]

Country of destination	1954			1955		
	Short tons	Value [2]		Short tons	Value [2]	
		Total	Average		Total	Average
United Kingdom	8,363	$151,155	$18.07	11,711	$217,414	$18.56
United States	7,553	117,426	15.55	10,637	164,257	15.44
Italy	5,036	88,455	17.56	5,748	103,869	18.07
France	5,209	97,443	18.71	4,341	80,421	18.53
Canada	5,160	79,811	15.47	3,168	49,689	15.68
Germany	2,668	46,953	17.60	2,926	54,127	18.50
Denmark	2,491	45,021	18.07	1,439	27,139	18.86
Netherlands	1,163	19,659	16.90	1,024	17,573	17.16
Australia	578	10,158	17.57	685	12,617	18.42
Sweden	1,097	19,541	17.81	366	6,660	18.20
Cuba				349	4,702	13.47
Rhodesia	116	2,167	18.68	304	5,854	19.26
Morocco	114	2,355	20.66	282	7,102	25.18
Belgium	391	6,812	17.42	280	5,417	19.35
Venezuela	130	2,248	17.29	197	3,493	17.73
Iraq				197	3,468	17.60
Uruguay				181	3,192	17.64
French West Africa	54	1,204	22.30	159	3,167	19.92
Jersey				135	4,316	31.97
Egypt	70	1,263	18.04	130	2,336	17.97
Finland				88	1,732	19.68
Japan	186	3,186	17.13	88	1,527	17.35
Malaya	56	1,092	19.50	59	1,121	19.00
New Zealand	170	3,217	18.92	57	1,171	20.54
Switzerland	116	2,075	17.89	55	912	16.58
Norway				50	834	16.68
Arabia	52	874	16.81	28	534	19.07
Austria				22	373	16.95
Chile	48	890	18.54	19	359	18.89
Kenya				15	275	18.33
Lebanon	101	1,823	18.05			
Total	40,922	704,828	17.22	44,740	785,651	17.56

1 Source: Union of South Africa Mines Department Quarterly Reports.
2 Converted to United States currency at the rate of SA£ 1=US$2.80 (1954); SA£ 1=US$2.7809 (1955).

22 Mining World, vol. 17, No. 3, March 1955, p. 71.
23 Morel, S. W., Biotitite in the Basement Complex of Southern Nyasaland: Geol. Magazine (Hertford, England), vol. 92, No. 3, May–June 1955, pp. 241–254.
24 South African Mining and Engineering Journal, vol. 66, Part 1, No. 3244, Apr. 16 1955, p. 265.

Water

By Robert T. MacMillan [1]

ALTHOUGH estimated water requirements of the United States reached a new high in 1955, the supply situation was eased in most areas by drought-breaking rains. Runoff was in the normal range for about 75 percent of the Nation and excess in less than 5 percent. Areas of deficiency were less than for the previous year, and most drought areas had received some rainfall by the end of the year.

TABLE 1.—Percent of average annual precipitation, by States, 1950–55 [1]

State	1950	1951	1952	1953	1954	1955
Alabama	98	100	89	111	65	90
Arizona	54	115	112	62	95	92
Arkansas	122	109	88	89	78	86
California	124	111	132	72	100	98
Colorado	74	99	80	86	71	80
Connecticut	97	114	111	119	108	125
Delaware	92	102	116	109	85	91
Florida	91	90	91	128	86	80
Georgia	89	91	91	117	63	83
Idaho	115	112	78	100	89	110
Illinois	117	119	92	76	96	94
Indiana	138	109	98	79	96	108
Iowa	93	135	95	82	110	73
Kansas	101	156	70	79	75	79
Kentucky	139	119	91	80	90	99
Louisiana	101	87	88	119	70	99
Maine	107	126	95	120	142	86
Maryland	102	102	122	104	82	99
Massachusetts	93	112	97	124	123	116
Michigan	114	122	97	97	115	94
Minnesota	103	123	89	122	98	99
Mississippi	112	104	77	106	75	95
Missouri	102	125	81	63	87	82
Montana	107	110	74	112	102	115
Nebraska	100	137	91	89	86	74
Nevada	95	95	107	62	74	103
New Hampshire	106	125	106	114	137	97
New Jersey	97	109	120	107	91	92
New Mexico	74	69	78	69	80	91
New York	104	108	98	97	109	102
North Carolina	92	83	100	93	86	100
North Dakota	106	97	72	117	109	96
Ohio	126	110	93	76	97	96
Oklahoma	104	106	71	94	67	82
Oregon	135	114	83	133	98	122
Pennsylvania	113	105	111	97	96	95
Rhode Island	93	106	98	136	125	111
South Carolina	88	82	98	100	70	90
South Dakota	94	116	73	114	90	87
Tennessee	127	116	84	91	91	99
Texas	83	76	83	86	66	80
Utah	78	110	92	82	85	92
Vermont	99	114	102	100	122	100
Virginia	100	91	110	89	93	98
Washington	118	109	67	123	109	124
West Virginia	118	107	97	82	106	92
Wisconsin	101	126	95	99	119	89
Wyoming	96	98	78	83	70	102

[1] U. S. Department of Commerce, Climatological Data: National Summary, vol. 6, No. 13, Annual 1955, p. 5.

[1] Commodity specialist.

DOMESTIC SUPPLY

The water supply for the Nation is based largely on precipitation. For the Nation as a whole, the average annual precipitation is about 30 inches. In 1955 the eastern and far northwestern sections received more than the average annual precipitation, while in the West and Southwest precipitation was much below average. Table 1 shows precipitation as a percentage of average annual precipitation for each State.

According to the Water Resources Review of the Federal Geological Survey,[2] the average flow of the Mississippi River for the water year ended September 30, 1955, was about 80 percent of normal. The percentage of normal flow in several other major continental rivers was as follows: Missouri—67, Ohio—94, Colorado—57, St. Lawrence—119, and Columbia—111. Although less than in the previous year, deficiencies of normal flow persisted in most southern areas, while moderate excess was noted in northeast and northwest sections.

Water stored in most major power reservoirs in the Northeast was about average, while in the Southeast it continued to be below average. In the West storage was above average in some sections and average in others. Individual reservoirs varied greatly.

Storage in most irrigation reservoirs was much below average in the West; on the other hand, storage in four major municipal-industrial systems in the Northeast was average or above.

Ground-water levels followed normal seasonal trends in most areas. Accumulated deficits of several years were replenished in some areas of North Carolina, while in several Midwestern States and New Mexico the water tables continued to fall, especially in areas where water was pumped for irrigation.

Artificial recharge of aquifers by spreading storm runoff on natural recharge areas and by pumping surface or clean waste water into recharge wells aided in maintaining water tables in many heavily pumped areas.

Artificial recharge has increased notably in recent years, amounting to approximately 700 million gallons per day in 1955. Although practiced to some extent in most areas of the Nation, over 60 percent of the known artificial recharging was practiced in California.

Other areas where artificial recharge was important were the Delaware-Hudson drainage basin and the Pacific slope north of California, which accounted for 16 and 12 percent, respectively, of known recharge in 1955.

A report of the Presidential Advisory Committee on Water Resources Policy became available in December 1955.[3] One major recommendation of the Committee was the establishment in the Executive Office of the President of an Office of Coordinator of Water Resources. The Committee felt that, because of the current and increasing importance of water-resource problems, some avenue of Presidential direction was desirable.

It was also recommended that a permanent Interagency Committee on Water Resources be established. This Committee would consist

[2] Geological Survey (in collaboration with Canada Department of Northern Affairs and National Resources), Water Resources Review; Annual Summary, Water Year 1954: Oct. 19, 1955, 10 pp.

[3] Presidential Advisory Committee on Water Resources Policy, Report: U. S. Gov't. Printing Office, Dec. 22, 1955, 35 pp.

of the principal policymaking officials of the Departments of Agriculture, Army, Commerce, Health, Education and Welfare, and Interior and the Federal Power Commission. The Coordinator of Water Resources would be permanent chairman of this committee.

CONSUMPTION AND USES

Uses of water are classed as withdrawal and nonwithdrawal, depending on whether the water is withdrawn from its source or applied to nonwithdrawal uses, such as navigation, dilution and removal of many wastes, conservation of wildlife, or recreation. Nonwithdrawal uses are not considered herein.

Withdrawal uses of water are classified as: Waterpower, irrigation, industrial (self-supplied), public municipal, and farm and rural.

Waterpower was by far the greatest user of water, requiring an estimated 1,740 billion gallons per day in 1955. In generating power water often is reused many times, as is evidenced by the fact that the withdrawal for waterpower in 1955 was nearly 1.5 times the average annual runoff of the entire United States. As water for generating power is returned immediately to the waterway and is not degraded, it is usually excluded in calculating requirements.

TABLE 2.—Estimated use of water in United States, million gallons per day [1]

Year	Irrigation [2]	Public municipal	Farm [3] and rural	Industrial (self-supplied) [4]	Total
1930	60, 200	8, 000	2, 900	39, 400	110, 500
1940	71, 030	10, 100	3, 100	51, 200	135, 430
1944	80, 650	12, 000	3, 180	91, 900	187, 730
1945	83, 060	12, 000	3, 200	76, 800	175, 060
1946	86, 440	12, 000	3, 500	65, 900	167, 840
1950	100, 000	14, 100	4, 600	84, 400	203, 100
1955	119, 800	17, 000	5, 400	119, 800	262, 000

[1] SOURCE: Water and Sewerage Industry and Utilities Division, B. D. S. A., U. S. Department of Commerce.
[2] Total includes delivery losses but not including reservoir evaporation.
[3] Farm domestic, nonfarm domestic, and farm stock use.
[4] Manufacturing industry, mineral industry, air conditioning, resorts, motels, steam-electric power military, and miscellaneous.

In 1955 about equal quantities of water were withdrawn for irrigation and for self-supplied industrial use. Together these 2 categories represented more than 90 percent of the Nation's total withdrawal, excluding the water used in generating hydroelectric power. Public municipal and farm rural made up the remaining 10 percent.

Water evaporated or incorporated in a product is said to be consumed, whereas most of the water that passes through an industrial plant or through a municipal water system emerges as industrial waste water or sewage effluent, which may be purified and reused.

It is estimated that only about one-fourth of all withdrawn water is consumed. Climate, season, and the use of water affect the percentage of water consumed. Irrigation usually is the largest consumer of water, although it is estimated that, in general, crops consume only about 60 percent of the water delivered to the farm; 40 percent seeps back to streams and aquifers.[4]

[4] Blaney, H. F., Climate as an Index of Irrigation Needs: Water, The Yearbook of Agriculture, U. S. Dept. of Agriculture, 1955, p. 341.

Comparatively little of the water supplied for public municipal purposes was actually consumed. It was estimated that 90 percent of the water withdrawn for municipal use eventually reaches downstream watercourses in more or less contaminated condition.[5]

Public water systems served almost 115 million people in 1955, supplying about 17,000 million gallons per day or an average of 148 gallons per day per person. This water included that used for fire protection, street flushing, watering lawns and gardens and certain commercial and industrial establishments. Nearly one-third of the total municipal supply was used by commercial establishments that had no private water supply.

The use of water in the mineral industries was varied, and the quality requirements depend upon the use. Water was injected into salt deposits, dissolving the salt and producing brine that is used by industry. Sulfur was mined by injecting hot water into the deposit, melting the sulfur, which was removed in molten form.

Most mineral-beneficiation processes involving grinding, classification, and flotation used large quantities of water, and water was also employed extensively in washing sand and gravel and crushed stone. Large amounts of water were used in hydraulic stripping of soil overburden at mines and quarries and for conveying (by pipeline) slurries of sand, phosphate rock, or other mineral products. A notable example of the extensive use of water in stripping was the removal of silt from the basin of Black Lake, Quebec, which was begun in 1955 in preparation for asbestos mining. The silt was pumped as a slurry through a large pipeline at a rate of 1 million cubic yards per month. The project involves removing 25 million cubic yards of silt.[6]

The increased recovery of petroleum from oilfields that no longer flow spontaneously has been made possible by waterflooding programs. Water or brine, injected into oil sands, increases the flow of oil toward producing wells. One of the largest waterflooding projects was reported to be underway in the North Burbank field of Oklahoma.[7] An additional 140 million barrels of oil was expected to be added to the output of this field, which already had produced 170 million barrels.

PRICES

Water is one of the least expensive commodities required for daily living. Costs of municipal supplies varied in different regions, depending on the availability of supply and the treatment necessary. Assuming an average price of $0.30 per 1,000 gallons, the cost of water delivered to the tap was about 7 cents per ton.

Estimated cost-consumption relations for water in the United States appeared in a recent issue of a technical journal.[8] These are listed in table 3.

---

[5] Jordan, H. E., The Problems That Face Our Cities: Water, Yearbook of Agriculture, U. S. Dept. of Agriculture, 1955, p. 649.

[6] Canadian Mining and Metallurgy Bulletin, vol. 48, No. 519, July 1955, p. 456.

[7] Vivian, C. H., Swapping Water for Oil: Compressed Air Mag., vol. 60, No. 7, July 1955, pp. 192–199.

[8] Gilliland, E. R., Fresh Water for the Future: Ind. Eng. Chem., vol. 47, No. 12, December 1955, pp. 2410–2422.

TABLE 3.—Estimated range of costs per thousand gallons of water for various uses at 3 daily capacity levels

Uses	Daily capacity (1,000 gal.)		
	Below 50	500	5,000
Agriculture	$0.10	$0.03	$0.005–0.03
Industrial	.10–5.00	.02–1.00	.02– .08
Household (delivered)	.30–5.00	.30–1.00	.20– .60

TECHNOLOGY

Water has the property of dissolving or entraining many substances with which it comes in contact; for this reason, its quality varies widely. Most uses of water have specific quality requirements, and for this reason water treatment usually is necessary.

Treatment of water for municipal uses generally consisted of settling and filtration to remove suspended matter, chlorination to kill residual micro-organisms, and aeration for odor control. In some States water treatment included the addition of small quantities of fluorine compounds, the presence of which in drinking water has been associated with lowered incidence of tooth decay.

Water was also treated for reducing its hardness. This treatment removes a high proportion of the calcium and magnesium ions, which increase soap and detergent requirements and cause scaling in boilers.

Water for certain industrial uses must meet extreme purity requirements attained through distillation or ion-exchange methods. Boiler water for generating steam must be of high purity, not only to reduce scale deposits on heat-transfer surfaces but also to control corrosion in boilers and associated piping. Bureau of Mines research was continued in boiler-water treatment, which has resulted in developing equipment and methods for testing and treating boiler water and in discovering additives for controlling corrosion in steam condensate return lines.

Treatment of water-borne wastes was becoming increasingly complex, not only because of increasing quantities of waste but also because many new types of industrial and mineral wastes were being produced.

Most organic sewage wastes were treated by time-honored biological oxidation methods through which the organic material is ponded and attacked by biological organisms and reduced largely to gases, water, and sludge. Chemical and mineral substances, on the other hand, often require special chemical techniques to neutralize, precipitate, collect, or drive off the waste substances. Each industry has its own waste-disposal problem. Wider dissemination of knowledge and techniques in handling chemical and mineral wastes would be valuable not only in controlling chemical wastes but also in recovering valuable mineral and chemical substances otherwise lost.

Wastes of the mineral industry were a special problem in many areas. Acid-water drainage from coal mines and brines from oil wells presented difficult disposal problems. All wastes, however, should be examined closely for values that may readily be recovered. The recovery of iodine from oil-well brines is one example.

In many instances information is lacking on the exact quality requirements of water used for specific purposes. It is only natural to use the best water obtainable for any and all uses. However, water of inferior quality may be used for certain purposes, conserving higher quality water for use where quality requirements are more exacting.

The impurities in various lakes and rivers used for water supplies were described in an article.[9] The list of soluble impurities included the following substances:

Cations: Ca, Mg, Na, K, Al, Fe, Mn, H.
Anions: HCO_3, SO_4, Cl, SiO_3, CO_3, F, S, OH.
Gases: CO_2, H_2S, CH_4.

A second article described in detail the main types of water-conditioning processes.[10] These included (1) sodium cation exchange, (2) hydrogen cation exchange, (3) ion-exchange demineralization using both cation and anion exchangers, (4) cold lime soda, (5) hot lime soda, (6) coagulation, settling and filtration, (7) aeration, (8) deaeration, and (9) iron and manganese removal.

The theory, operation, and equipment used in the disposal of organic waterborne wastes by the process known as bio-oxidation was described in a technical journal.[11] Both sewage and organic industrial wastes have been successfully treated by the activated sludge process wherein a portion of the biologically active sludge from a previous batch is thoroughly mixed with the incoming waste stream and aerated vigorously. Approximately 60 percent of the dissolved and colloidal organic matter in the waste stream goes into the growth of additional microorganisms or sludge, while 40 percent is oxidized to CO_2 and water to provide energy for the life process. The excess sludge is removed, leaving a sewage effluent from which 90-95 percent of the BOD (biological oxygen demand) has been removed.

The steady increase in demand for water together with the increased pollution and high cost of developing additional fresh water sources turned attention to sea water as an inexhaustible potential source of fresh water. The U. S. Department of the Interior, Office of Saline Water Conversion, has sponsored research and development of low-cost saline water conversion processes. The Saline Water Act of 1952 was amended in 1955,[12] increasing the scope of the program from 5 years to 11, with a limited extension for 3 additional years. Ten million dollars was authorized to be spent in this period, with $2½ million authorized in Federal scientific laboratories.

Twenty-five projects were in progress in 1955, involving processes of thermal distillation, solar distillation, electric membrane separation, osmotic processes, solvent extraction, separation by freezing, and other processes.[13]

Outstanding progress was reported in vapor-compression distillation and electro-osmotic membrane separation. A vapor compression unit of 25,000 gallons per day was in the development stage. An electric membrane process was also in the pilot-plant stage. As this type of process removes salt rather than water from brine, it is particularly applicable to waters of low salinity because of the reduced energy requirements.

---

[9] Nordell, Eskel, Water—What It Contains: Chem. Eng., vol. 62, No. 9, September 1955, pp. 183–188.
[10] Nordell, Eskel, Water—How It's Treated: Chem. Eng., vol. 62, No. 10, October 1955, pp. 175–184.
[11] Eckenfelder, W. W., and Moore, T. L., Bio-Oxidation: Chem. Eng., vol. 62, No. 9, September 1955, pp. 189–202.
[12] Public Law 111, 84th Cong., 1st sess.: Chap. 227, H. R. 2126, approved June 29, 1955.
[13] Secretary of the Interior, Saline Water Conversion: Annual Report, 1955, 82 pp.

Zinc

By O. M. Bishop,[1] A. J. Martin,[1] and Esther B. Miller[2]

THE ZINC INDUSTRY participated in the general rise of industrial activity in the United States in 1955. Production and consumption of slab zinc reached alltime highs, and mine output of recoverable zinc increased moderately. An upward trend in the price of zinc, which began in March 1954, continued through 1955. Increased consumption coupled with sustained Government purchases for the National Stockpile reduced smelter stocks of slab zinc to the lowest level since June 1952 despite an increase in general imports of zinc. Consumers' stocks increased moderately.

Production of slab zinc increased 18 percent over 1954, exceeding 1 million tons for the first time. Of the total, 57 percent was derived from domestic ore and 37 percent from foreign ore; 6 percent was redistilled secondary metal from scrap. Pigments and salts produced directly from domestic and foreign ores contained more than 108,400 tons of additional primary metal, compared with about 99,000 tons in 1954.

Consumption of slab zinc, keeping pace with the upward trend of industrial production, increased 27 percent to a record 1.1 million tons. Zinc used in zinc-base alloys, mostly for die casting, increased 48 percent over 1954 largely owing to record automobile production and increased use of zinc die castings per car. Slab zinc used for galvanizing rose 12 percent owing to the 13-percent increase in private and public construction; galvanized products made from continuous process galvanized sheet found increased acceptance. These 2 uses furnished 79 percent of the slab zinc supplied to industry in 1955. The zinc content of alloys, zinc dust, chemicals, and pigments made from zinc-bearing scrap increased 17 percent to 231,000 tons.

Stocks of slab zinc at smelters dropped from 123,400 tons at the beginning of the year to 39,300 tons at the end of 1955, but stocks at consumers' plants increased from 103,700 tons to 123,500 tons.

The price of Prime Western slab zinc, East St. Louis, was 11.50 cents a pound at the beginning of the year, advancing slowly to 13 cents on September 6, where it remained through December. Purchases for the National Stockpile helped sustain the price in the face of the continued excess of overall zinc supply over commercial demand although the quantity of zinc offered monthly for stockpiling declined as industrial demand improved during the year.

Domestic mine production, at 514,700 tons of recoverable zinc, was 9 percent more than in 1954 but 14 percent less than the average of the 5-year period 1950–54. Some mines, closed during the period of declining prices between June 1952 and February 1954, had not reopened by the end of 1955; prolonged strikes in Idaho and New Jersey caused the loss of much production during the year. Output from reopened mines and from two new mines supplied most of the moderate production gain over 1954. New Mexico, which produced 15,300 tons of recoverable zinc in 1955 compared with only 6 tons

[1] Commodity specialist.
[2] Statistical assistant.

in 1954, recorded the largest gain, as 3 of the 6 large mines that had suspended work because of the low price of zinc resumed production. Of the 16 important producing States, only Idaho, Missouri, New Jersey, New York, and Oklahoma reported declines from 1954.

Output of secondary zinc, recovered chiefly from zinc- and copper-base scrap, increased 12 percent over 1954 to 305,000 tons, considerably more than half the quantity produced from domestic ores.

Imports of zinc contained in ore and concentrate increased 5 percent and those of slab zinc 25 percent; the 674,000 tons imported in both forms was 10 percent more than in 1954 but considerably below the 1953 alltime record of 748,000 tons. By far the largest quantity came from Mexico, Canada, and Peru. Exports of slab zinc totaled 18,000 tons.

Outside the United States, zinc demand and prices also increased in 1955. The rate of gain in total consumption in foreign countries was about half that in the United States alone, but mine production was nearly the same as in the United States. The principal countries gaining more than 10 percent over 1954 in mine output were Canada, Mexico, Italy, and French Morocco; the only substantial decreases were 21 percent in Belgian Congo and 11 percent in South-West Africa. Smelter output of zinc increased in all producing countries except Belgium and Australia.

TABLE 1.—Salient statistics of the zinc industry in the United States, 1946–50 (average) and 1951–55

	1946–50 (average)	1951	1952	1953	1954	1955
Production of slab zinc:						
By sources:						
From domestic ores.....short tons..	537,395	621,826	575,828	495,436	380,312	582,913
From foreign ores..........do....	257,959	259,807	328,651	420,669	422,113	380,591
Total primary..........do....	795,354	881,633	904,479	916,105	802,425	963,504
From scrap..........do....	57,678	48,657	55,111	52,875	68,013	66,042
Total production..........do....	853,032	930,290	959,590	968,980	870,438	1,029,546
Stocks on hand at producers' plants:						
At primary plants..........short tons..	72,079	21,343	81,344	176,725	[1] 121,847	37,322
At secondary plants..........do....	1,695	637	3,677	3,268	1,549	1,938
Total..........do....	73,774	21,980	85,021	179,993	[1] 123,396	39,260
Imports (general):						
Ores (zinc content)..........do....	269,535	302,777	449,636	513,724	[1] 455,427	478,044
Slab zinc..........do....	110,647	88,043	115,705	234,576	156,858	195,696
Mine production of recoverable zinc..do....	611,799	681,189	666,001	547,430	473,471	514,671
Consumption:						
Slab zinc..........do....	816,862	933,971	852,783	985,927	884,299	1,119,812
Ores (recoverable zinc content)...do....	127,029	133,845	109,277	118,244	99,247	108,395
Zinc-base scrap [2] (recoverable zinc content)..........short tons..	87,624	91,808	72,435	73,936	62,166	74,547
Copper-base scrap (recoverable zinc content)..........short tons..	143,926	165,403	175,937	160,499	132,051	149,630
Aluminum-and magnesium-base scrap (recoverable zinc content) short tons..	795	1,055	1,216	3,783	2,929	6,956
Total..........do....	1,176,236	1,326,082	1,211,648	1,342,389	1,180,692	1,459,340
Exports:						
Slab zinc..........do....	58,211	36,510	57,714	17,969	24,994	17,904
Price, Prime Western grade:						
East St. Louis..........cents per pound..	11.77	17.99	16.21	10.86	10.69	12.30
London..........do....	12.80	21.46	18.53	9.47	9.78	11.30
World mine production..........short tons..	2,050,000	[1] 2,600,000	[1] 2,870,000	[1] 2,980,000	[1] 2,960,000	3,200,000
World smelter production..........do....	1,880,000	[1] 2,360,000	[1] 2,470,000	[1] 2,640,000	[1] 2,710,000	2,990,000

[1] Revised figure.
[2] Excludes redistilled slab and by remelting.

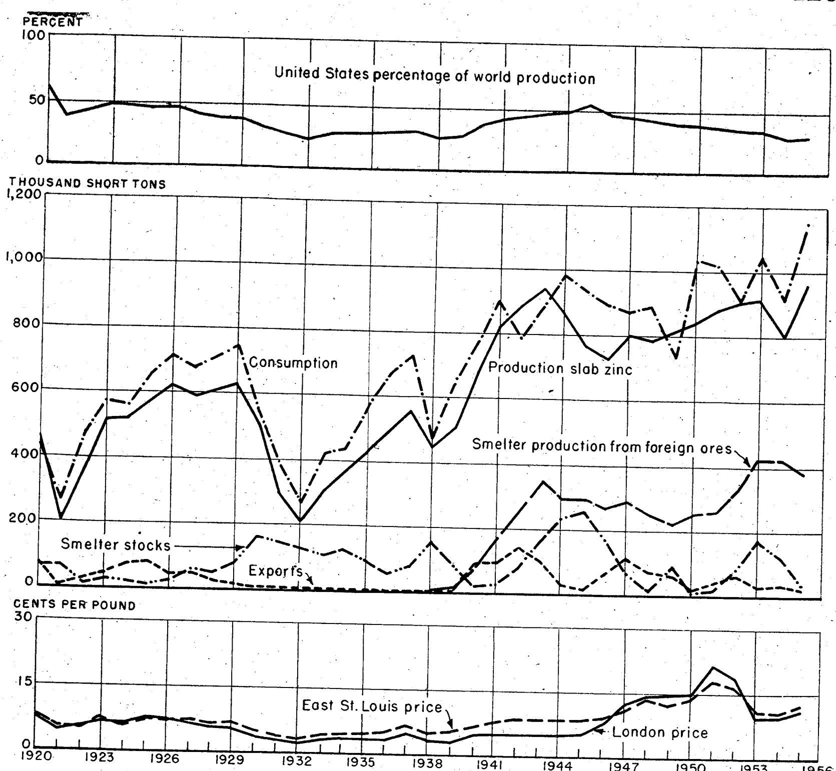

FIGURE 1.—Trends in the zinc industry in the United States, 1920–55. Consumption figures represent primary slab zinc plus zinc contained in pigments made directly from ore.

GOVERNMENT REGULATIONS

Legislation extending the Reciprocal Trade Agreements Act for another 3 years was signed by President Eisenhower, June 21, 1955. The law gave the President authority to cut tariffs a maximum of 5 percent a year in each of the 3 years and allowed an industry showing adverse effects to petition for an increase. The tariff on zinc was not changed during the year.

The Defense Production Act of 1950 with amendments was extended to June 30, 1956.

The Export Control Act of 1949, still in effect in 1955, required licenses for exports to all countries except Canada.

Defense Mobilization Order OD–LS 416, dated August 11, 1955, closed expansion goals and hence the issuance of certificates of necessity for a number of minerals, including lead and zinc.

DEFENSE MINERALS EXPLORATION ADMINISTRATION

The DMEA program to encourage exploration of strategic and critical minerals and metals was continued throughout 1955. On exploration contracts for lead and zinc, the Government provided 50 percent of the approved cost of projects. The number of such contracts made in 1955 was 23, authorizing a maximum Government participation of $691,972, matched by an equal amount of private capital for an anticipated expenditure of $1,383,944, an average of $60,172 per project. From the beginning of the program in 1951 through December 1955, 220 contracts involving lead and zinc were executed, which authorized Government participation of $9,719,243 [3] and total expenditures (combined Government and private capital) of $19,445,191. Lead-zinc and lead-zinc-copper exploration contracts in 1955 furnished 15 percent of all DMEA contracts executed and

TABLE 2.—Defense Minerals Exploration Administration contracts involving lead and zinc, by States, executed in 1955

State and contractor	Property	County	Date approved	Total amount [1]
CALIFORNIA				
Shasta Copper & Uranium Co., Inc.	Shasta King	Shasta	May 24, 1955	$104,572
COLORADO				
Buckskin Joe Mines, Ltd	Gold Ridge-Denver-France claims.	Park	Jan. 3, 1955	44,875
Hurst Majors	Mineral Farm group	Ouray	Sept. 21, 1955	2,200
IDAHO				
Copper Mountain Mine	Copper Mountain	Butte	Oct. 13, 1955	14,250
Highland Surprise Consolidated Mining Co.	Deer Trail	Custer	June 17, 1955	59,570
Idaho Consolidated Mines, Inc	Twin Peak	Lemhi	Nov. 10, 1955	17,370
Shirts, Fred H. and Earl W	Mountain King mine	Custer	Oct. 8, 1954	31,304
Sunset Mines, Inc	Liberal King	Shoshone	Nov. 22, 1954	101,125
MISSOURI				
McLaren, Lucy A	McLaren, Lucy A	St. Francois	Dec. 23, 1954	7,050
MONTANA				
Boss Mines, Inc	Boss & Atlantus	Cascade	Dec. 7, 1954	24,146
Elkhorn Consolidated, Inc	Dunstone mine	Jefferson	Nov. 22, 1954	26,110
Hogan, Howard R. and Pohl, E	Silver Saddle	Broadwater	June 6, 1955	16,460
NEVADA				
Combined Metals Reduction Co	Black Prince	Lincoln	Mar. 2, 1955	98,200
Mt. Wheeler Mines, Inc	Mount Wheeler	White Pine	Mar. 15, 1955	303,200
Nelson, A. C., et al	Four Aces	Esmeralda	Mar. 30, 1955	8,436
Ogle Swingle	Leadville mining claims	Washoe	June 21, 1955	15,300
Yuba Dike Mines, Inc	Yuba Dike	Lincoln	May 17, 1955	21,750
NEW MEXICO				
Western Development Co	Bottom Dollar—Black Hornet Teresa.	Santa Fe	Sept. 29, 1955	16,710
UTAH				
McFarland & Hullinger	Ophir	Tooele	Sept. 15, 1955	104,700
U. S. Smelting, Refining & Mining Co.	United States and Lark mine.	Salt Lake	Aug. 15, 1955	301,930
VIRGINIA				
Bellville Gold Mines, Ltd	Dillwyn area	Buckingham	Jan. 6, 1955	25,500
Do	New Canton area	do	Dec. 13, 1954	14,340
WISCONSIN				
Gille, Paul	Lindsay and Dawson Lease.	Lafayette	Jan. 6, 1955	24,846
Total				1,383,944

[1] Government participation was 50 percent in exploration projects for lead and zinc in 1955.

[3] Includes sums provided through amendments to contracts and also funds for participation in exploration contracts, which were subsequently canceled or terminated upon completion.

20 percent of all Government funds obligated. From the beginning through 1955, these contracts furnished 26 percent of all contracts and 40 percent of the Government funds obligated.

GENERAL SERVICES ADMINISTRATION

The General Services Administration (GSA) conducted stockpile procurement and administration, procurement under foreign-aid programs (as agent of the former Foreign Operations Administration and the new International Cooperation Administration), and administration of Defense Production Act programs, including domestic purchase programs. Purchases of zinc produced from domestically mined ores were made against the long-term stockpile objective in each month of 1955, but the quantity tendered decreased sharply after March. The program for the barter of surplus agricultural commodities in exchange for strategic and critical materials, pursuant to the provisions of the Agricultural Trade Development and Assistance Act of July 1954, was carried on with respect to a number of materials, but no zinc was acquired under the program during 1955. No new contracts with foreign producers for obtaining zinc under the Defense Production Act of 1950 were executed in 1955; some zinc produced under contracts negotiated in preceding years was delivered.

DOMESTIC PRODUCTION

Statistics on zinc production are compiled both on a mine and on a smelter basis. Zinc content of ore and concentrate production (adjusted to account for average smelting losses) forms a measure of domestic zinc output from year to year. Smelter production of slab zinc from domestic ores represents an accurate figure of zinc-metal recovery but differs from the mine-recovery figures because of a time lag between mine or mill shipments and smelter production and because considerable zinc ore and concentrate are not smelted but utilized directly in making zinc pigments and chemicals. Secondary zinc recovered at smelters treating zinc-bearing scrap metals constituted a large part of the domestic production of zinc in all forms.

Zinc-production data for 1954 were collected jointly with the Bureau of the Census (U. S. Department of Commerce). Comparison of final data reported by each agency shows only minor differences. The Bureau of Mines figure (473,471 short tons) representing recoverable domestic mine production of zinc in 1954, was slightly larger than the Census figure (455,740 tons). The difference is due to slightly broader coverage by the Bureau of Mines through inclusion of output of metal contained in old slag and mill clean-up material and by mines with production valued at less than $500. Some State totals reported by the two agencies also differ because the metal derived from ores transported across State lines for milling was credited by the Bureau of Mines to the production of the State in which the ore was mined, while the Bureau of the Census credited such production to the State in which the ore was milled.

MINE PRODUCTION

Domestic mine production of recoverable zinc rose to 514,700 tons in 1955 from 473,500 tons in 1954 but was 17 percent less than the average of the 5 years 1949–53. Some mines that had shut down because of low zinc prices prevailing since the latter part of 1952 resumed production in 1955. Two important newly developed mines—at Crested Butte, Colo., and at Friends Station, Tenn.—began producing ore during the year. The production gain from these sources was partly offset by losses resulting from strikes, particularly those of unusually long duration at some mines in the Coeur d'Alene region of Idaho and one mine each in Montana and New Jersey.

The producing zinc mines of the United States were widely dispersed in 50 mining districts in 7 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; Southern Illinois and Kentucky; and the Western States (in order of 1955 output—Montana, Idaho, Utah, Colorado, Washington, Arizona, New Mexico, California and Nevada).

The Western States output of recoverable zinc, at 277,800 tons, was 17 percent larger than in 1954, despite a strike which closed 15 mines in Idaho and 1 in Montana from August 23, 1955, to January 31, 1956.

Idaho output in 1955 dropped 13 percent to 53,300 tons, the smallest quantity since 1939. Important zinc producers affected by the strike, all in the Coeur d'Alene region, Shoshone County, included the Frisco, Page, Tamarack, and Sidney mines. The Star mine, active throughout the entire year, continued to be the leading zinc producer in the State; other important producers included the Bunker Hill mine and Morning mine salvage. The only substantial Idaho producer outside the Coeur d'Alene region was the Triumph mine in Blaine County.

Montana was the leading State in mine production of zinc in 1955, but its output (13 percent more than 1954) was well under that in 1951–53. Most zinc in the State was mined at Butte, Silver Bow County, by Anaconda Co.; Anselmo, Lexington, and Orphan Girl lead-zinc mines and the Emma manganese-zinc mine supplied most of the production. Output from the Jack Waite mine on the Montana-Idaho State line in Sanders County, Mont., decreased as this mine was among those of the Coeur d'Alene region that were closed by the prolonged strike.

Production of recoverable zinc in Utah increased 9,500 tons (28 percent) to 43,600 tons in 1955. The gain resulted mainly from the full year of Park City mines production, and from increased output at the United States and Lark mines. Output from other mines varied only slightly from 1954.

Colorado zinc production increased slightly (200 tons) over 1954. Some zinc production was lost through destruction by fire of the Emperius Mining Co. mill at Creede in August. The newly developed Kaystone zinc-lead mine of American Smelting & Refining Co. at Crested Butte began producing in June. The Eagle mine (New Jersey Zinc Co.) at Gilman was by far the leading zinc producer in the State; Idarado mine in San Miguel County ranked second. Other important producers included the Rico-Argentine mine at Rico, Camp Bird (King Lease) near Ouray, Resurrection Mining Co. properties at Leadville, and Wellington mine at Breckenridge.

In Washington, mine output of zinc increased 32 percent over 1954; each of the four mines supplying nearly all the zinc and lead in the State increased production. The Van Stone open-pit mine continued as the leading producer, followed by the Pend Oreille, Deep Creek, and Grandview underground mines. Of the 4 mines, 3 were predominately zinc producers and 1, the Pend Oreille, yielded approximately equal tonnages of zinc and lead.

Mine production of zinc in Arizona increased 6 percent over 1954. Important producers included the Iron King mine in Yavapai County, Flux in Santa Cruz County, Athletic in Graham County, San Xavier in Pima County, and Shannon in Cochise County.

In New Mexico, output of recoverable zinc was 15,300 tons in 1955 compared with only 6 tons (all recovered from lead ore) in 1954. Zinc and zinc-lead mining, which had stopped by October 1953 because of low zinc prices, was resumed in March 1955 at the Ground Hog mine of American Smelting & Refining Co. in the Central district, Grant County. In the latter part of the year the Hanover mine and mill (New Jersey Zinc Co.) and the Kearney mine and Peru mill (Peru Mining Co.) also were reopened.

Zinc production in California rose to 6,800 tons from 1,400 tons in 1954. The increase was due mainly to the reopening by The Anaconda Co. of its Darwin mine group, Inyo County, which was idle most of 1954.

Nevada production of recoverable zinc (2,700 tons) was small compared with the 5-year annual average of 19,000 tons from 1948–52. The low production was due mainly to curtailment by Combined Metals Reduction Co. of the milling of lead-zinc ore and manganese ore, containing lead and zinc, at Pioche. Part of the output in 1955 was contained in zinc ore drawn from a stockpile at Jean and shipped to smelter-fuming plants outside Nevada.

In the West Central States—Kansas, Missouri, and Oklahoma—mine production of zinc increased 9 percent over 1954. Arkansas has had no mine output of zinc since 1952.

The Tri-State or Joplin district produced 68,300 tons of recoverable zinc and 19,700 tons of lead from 4,140,300 tons of crude ore milled; an additional 1,400 tons of zinc was recovered from remilled tailings. The mines and the Central and Bird Dog mills of Eagle-Picher Co., leading producer in the district, ran continuously except during a few days in July, when union workers were on strike. Besides ore from company mines in the Oklahoma and Kansas parts of the district, the Central mill treated custom ore from many other Kansas and Oklahoma mines. The Barbara J. and Lawyers mines and mills of the Nellie B. Division, American Zinc, Lead & Smelting Co., produced steadily until December 22, when they were closed; the mines and Barbara J. mill resumed reduced production on January 3, 1956. The Ballard mill of National Lead Co. operated a full year in 1955 compared with only 8 months in 1954. Sooner Milling Co. treated old tailings in Oklahoma.

In Southeastern Missouri zinc concentrate was recovered as a byproduct from lead ores at some mills of St. Joseph Lead Co.

In the States east of the Mississippi River the mine production of zinc decreased 3 percent from 1954. The permanent shutdown on September 30, 1954, of the famous Franklin mine at Franklin, N. J.,

TABLE 3.—Mine production of recoverable zinc in the United States, 1946–50 (average) and 1951–55, by States, in short tons

State	1946–50 (average)	1951	1952	1953	1954	1955
Western States and Alaska:						
Alaska	11	1	------	------	------	------
Arizona	56,785	52,999	47,143	27,530	21,461	22,684
California	6,475	9,602	9,419	5,358	1,415	6,836
Colorado	42,707	55,714	53,203	37,809	35,150	35,350
Idaho	81,058	78,121	74,317	72,153	61,528	53,314
Montana	48,683	85,551	82,185	80,271	60,952	68,588
Nevada	20,391	17,443	15,357	5,812	1,035	2,670
New Mexico	36,063	45,419	50,975	13,373	6	15,277
Oregon	6	3	1	------	------	------
South Dakota	10	------	------	------	------	------
Texas	13	24	3	------	------	------
Utah	37,161	34,317	32,947	29,184	34,031	43,556
Washington	12,663	18,189	20,102	32,786	22,304	29,536
Total	342,026	397,383	385,652	304,276	237,882	277,811
West Central States:						
Arkansas	29	50	26	------	------	------
Kansas	36,277	28,904	25,482	15,515	19,110	27,611
Missouri	11,974	11,476	13,986	9,981	5,210	4,476
Oklahoma	51,041	53,450	54,916	33,413	43,171	41,543
Total	99,321	93,880	94,410	58,909	67,491	73,630
States east of the Mississippi River:						
Illinois	15,398	21,776	18,816	14,556	14,427	21,700
Kentucky	625	3,457	3,280	489	458	------
New Jersey	64,734	62,917	59,190	45,700	37,416	11,643
New York	35,498	40,051	32,636	51,529	53,199	53,016
Tennessee	30,093	38,639	38,020	38,465	30,326	40,216
Virginia	15,028	7,332	13,409	16,676	16,738	18,329
Wisconsin	9,076	15,754	20,588	16,830	15,534	18,326
Total	170,452	189,926	185,939	184,245	168,098	163,230
Grand total	611,799	681,189	666,001	547,430	473,471	514,671

and the strike, which closed the Sterling mine at Ogdensburg from August 23, 1955, to the end of the year caused a 69-percent decline in New Jersey production. New York output decreased slightly. These declines were offset to a large extent by increases of 50 percent in Illinois, 33 percent in Tennessee, 10 percent in Virginia, and 18 percent in Wisconsin. New York was the principal zinc-producing State east of the Mississippi River; Tennessee ranked second.

The Balmat and Edwards mines of St. Joseph Lead Co., St. Lawrence County, N. Y., produced continuously in 1955. In New Jersey, at the Sterling mine of New Jersey Zinc Co., a new 2,700-foot shaft was completed, the expanded mine-development program was continued, and new crushing, ore-conveying, and other improved facilities were installed.[4]

In Tennessee six zinc mines, all in the Mascot-Jefferson City area, Knox and Jefferson Counties, produced during 1955. American Zinc Co. of Tennessee ran its Mascot No. 2, Grasselli, Athletic, and North Friends Station mines (also productive in other recent years); at the end of July, it began producing ore from the newly developed Young mine. The other producer in the Jefferson City area was the Davis-Bible mine of the Tennessee Coal & Iron Division, United States Steel Corp. At the new Jefferson City mine of New Jersey Zinc Co. (scheduled to reach full production in 1956) underground development

[4] Mining Engineering, New Jersey Zinc Rejuvenates Sterling Zinc Producer: Vol. 7, No. 5, May 1955, pp. 442–443.

was continued, ore hoisting and ventilating shafts were completed, and a 1,000-ton flotation mill and other surface buildings were under construction. The company also began developing its Flat Gap property at Treadwell, 25 miles from the Jefferson City mine. The Tennessee Copper Co. mines in Polk County produced sulfide ore yielding copper, zinc concentrates, and pyrite.

In Virginia the New Jersey Zinc Co. Austinville mine and concentration mill in Wythe County, producing throughout the year, continued a 13,300-foot transportation drift to connect the Ivanhoe mine with the Austinville workings; ore produced from the new Ivanhoe mine will be treated in the Austinville mill.

In Illinois and Wisconsin the mines and mills of Tri-State Zinc, Inc., and Eagle-Picher Co. near Galena in Illinois, and Eagle-Picher Co. mine and mill in the Schullsburg district in Southern Wisconsin were large producers. In August, Vinegar Hill Zinc Co., a longtime major producer in Wisconsin, sold its 800-ton mill and mining leases and equipment to American Zinc, Lead & Smelting Co., which worked the properties the remainder of the year. American Zinc also acquired leases from Cuba City Mining Co. on 370 acres (Thompson and Temperly properties) in Wisconsin and announced that development work would begin immediately and that production could be expected by mid-1956. In Southern Illinois, production of zinc concentrate increased at the fluorspar-zinc-lead mills of Ozark Mahoning Co. and Minerva Oil Co.

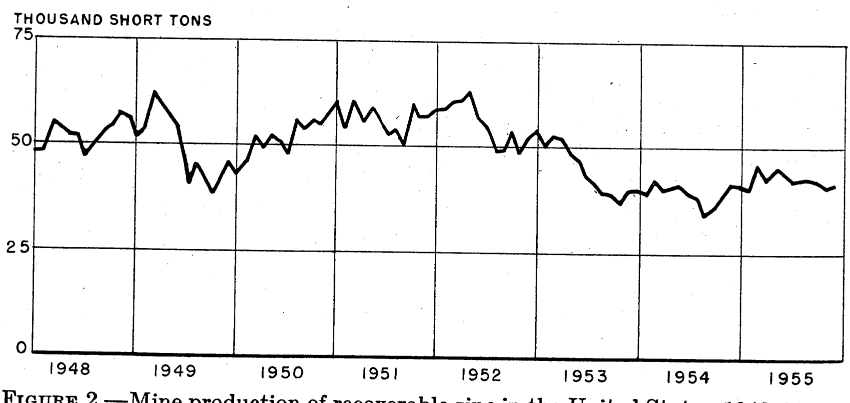

FIGURE 2.—Mine production of recoverable zinc in the United States, 1948–55, by months, in short tons.

TABLE 4.—Mine production of recoverable zinc in the United States,[1] 1954–55, by months, in short tons

Month	1954	1955	Month	1954	1955
January	40,148	41,005	August	38,808	43,555
February	39,508	40,101	September	34,833	43,080
March	42,706	46,286	October	35,957	42,700
April	40,357	43,721	November	39,375	41,083
May	40,510	45,351	December	41,305	41,963
June	40,936	43,972			
July	39,028	41,854	Total	473,471	514,671

[1] Includes Alaska.

TABLE 5.—Twenty-five leading zinc-producing mines [1] in the United States in 1955, in order of output

Rank	Mine	District	State	Operator	Type of ore.
1	Butte Mines	Summit Valley (Butte)	Montana	Anaconda Co.	Lead-zinc.
2	Balmat	St. Lawrence County	New York	St. Joseph Lead Co.	Do.
3	United States and Lark	West Mountain (Bingham)	Utah	U. S. Smelting, Refining & Mining Co.	Do.
4	Eagle	Red Cliff (Battle Mountain)	Colorado	New Jersey Zinc Co.	Zinc.
5	Austinville	Austinville	Virginia	do	Lead-zinc.
(2)	Ground Hog	Central	New Mexico	American Smelting & Refining Co.	Do.
(2)	Van Stone	Northport	Washington	do	Do.
(2)	Mascot No. 2	Eastern Tennessee	Tennessee	American Zinc Co. of Tennessee	Zinc.
(2)	Star	Hunter	Idaho	Sullivan Mining Co.	Do.
(2)	Davis-Bible group	Eastern Tennessee	Tennessee	United States Steel Corp., Tennessee Coal & Iron Division	Do.
11	Sterling	New Jersey	New Jersey	New Jersey Zinc Co.	Do.
12	Iron King	Big Bug	Arizona	Shattuck Denn Mining Co.	Lead-zinc.
13	Edwards	St. Lawrence County	New York	St. Joseph Lead Co.	Zinc.
14	Shullsburg	Wisconsin	Wisconsin	Eagle-Picher Co.	Do.
15	Bunker Hill	Yreka	Idaho	Bunker Hill Co.	Lead, lead-zinc.
16	Gray	Northern Illinois	Illinois	Tri-State Zinc Co., Inc.	Lead-zinc.
17	Barbara J.	Tri-State	Oklahoma	American Zinc, Lead Smelting Co.	Zinc.
18	Pend Oreille	Metaline	Washington	Pend Oreille Mines & Metals Co.	Lead-zinc.
19	Ontario-Park Utah	Park City region	Utah	United Park City Mines Co.	Do.
20	Darwin Group	Coso	California	Anaconda Co.	Do.
21	Treasury Tunnel-Black Bear	Upper San Miguel	Colorado	Idarado Mining Co.	Copper-lead-zinc.
22	Deardorff	Southern Illinois	Illinois	Ozark Mahoning Co.	Fluorspar-lead-zinc.
23	Page	Yreka	Idaho	American Smelting & Refining Co.	Lead-zinc.
24	Lawyers	Tri-State	Oklahoma	American Zinc, Lead Smelting Co.	Zinc.
25	Graham and Snyder	Northern Illinois	Illinois	Eagle-Picher Co.	Do.

[1] Excludes old slag dump of Bunker Hill Co. at Kellogg, Idaho. [2] Not listed in order of rank.

In the United States in 1955, the 25 leading zinc-producing mines, listed in table 5, yielded 68 percent of the domestic zinc output; the 3 leading mines, 25 percent; and the 10 leading mines, 46 percent.

TABLE 6.—Mine production of zinc in the principal districts [1] of the United States, 1946–50 (average) and 1951–55, in terms of recoverable zinc, in short tons

District	State	1946–50 (average)	1951	1952	1953	1954	1955
Tri-State (Joplin region)	Kansas, Southwestern Missouri, Oklahoma.	98, 480	91, 553	90, 512	55, 729	64, 322	69, 696
Summit Valley (Butte)	Montana	42, 388	80, 500	75, 968	75, 170	53, 527	62, 588
St. Lawrence County	New York	35, 498	40, 051	32, 636	51, 529	53, 199	53, 016
Coeur d'Alene	Idaho	78, 191	74, 989	70, 316	68, 650	58, 736	50, 527
Eastern Tennessee [2]	Tennessee	30, 093	38, 639	38, 020	38, 465	30, 326	40, 216
Upper Mississippi Valley	Northern Illinois, Iowa,[3] Wisconsin.	18, 824	31, 403	34, 716	26, 286	25, 441	31, 411
West Mountain (Bingham)	Utah	17, 709	18, 286	20, 395	19, 669	20, 489	21, 864
Red Cliff (Battle Mt.)	Colorado	17, 515	29, 200	26, 000	16, 850	18, 604	21, 322
Austinville	Virginia	15, 027	7, 332	13, 409	16, 676	16, 738	18, 329
Central	New Mexico	31, 769	41, 884	48, 043	12, 743	--------	15, 104
Park City region	Utah	9, 187	10, 209	7, 746	4, 848	6, 650	12, 295
New Jersey	New Jersey	64, 734	62, 917	59, 190	45, 700	37, 416	11, 643
Big Bug	Arizona	7, 054	9, 688	10, 862	10, 476	10, 453	11, 234
Kentucky-Southern Illinois	Kentucky, Southern Illinois.	6, 275	9, 584	7, 968	5, 589	4, 978	8, 615
Upper San Miguel	Colorado	4, 480	9, 228	9, 811	10, 414	7, 899	6, 532
Smelter (Lewis and Clark County).	Montana	2, 596	2, 428	2, 807	2, 924	5, 301	4, 077
Tintic	Utah	4, 685	3, 410	2, 951	2, 433	4, 335	4, 018
Cochise	Arizona	2, 336	3, 243	4, 266	3, 893	3, 566	3, 295
Smelter (Salt Lake County)	Utah	26	--------	--------	--------	--------	3, 148
Warm Springs	Idaho	1, 874	1, 860	2, 142	3, 026	2, 584	1, 833
California (Leadville)	Colorado	6, 076	8, 144	8, 487	3, 945	2, 437	1, 621
Aravaipa	Arizona	595	1, 404	1, 315	1, 732	1, 366	1, 670
Rush Valley and Smelter (Tooele County).	Utah	3, 793	1, 608	916	1, 528	1, 738	1, 434
Flint Creek	Montana	55	392	1, 084	[4]	1, 290	1, 400
Pima (Sierritas, Papago, Twin Buttes).	Arizona	5, 482	5, 414	3, 472	11	--------	1, 310
Creede	Colorado	328	892	1, 024	858	1, 111	745
Yellow Pine (Goodsprings)	Nevada	609	1, 332	1, 464	--------	--------	716
Breckenridge	Colorado	670	366	620	1, 200	1, 186	615
Eureka (Bagdad)	Arizona	1, 337	2, 504	3, 520	2, 594	1, 126	444
Patagonia (Duquesne)	do	484	601	1, 049	257	54	273
Animas	Colorado	1, 128	1, 183	986	541	15	212
Magdalena	New Mexico	3, 457	2, 276	2, 122	512	--------	98
Heddleston	Montana	1, 471	1, 395	1, 066	--------	[4]	47
Tomichi	Colorado	1, 305	1, 011	874	--------	--------	6
Cow Creek (Ingot)	California	--------	[4]	[4]	--------	--------	
Chelan Lake [5]	Washington	2, 235	1, 879	[4]	[4]	[4]	[4]
Coso [5]	California	3, 051	4, 720	5, 479	[4]	[4]	[4]
Elk Mountain [5]	Colorado	16	244	303	--------	--------	[4]
Harshaw [5]	Arizona	2, 630	4, 076	3, 924	4, 186	4, 193	[4]
Metaline [5]	Washington	8, 190	12, 753	[4]	[4]	[4]	[4]
Northport [5]	do	2, 113	3, 496	[4]	[4]	[4]	[4]
Pioche [5]	Nevada	17, 409	14, 350	12, 493	[4]	[4]	[4]
Pioneer (Rico) [5]	Colorado	2, 553	2, 527	2, 734	2, 634	2, 896	[4]
Silver Bell [5]	Arizona	48	--------	364	1, 324	[4]	[4]
Sneffels [5]	Colorado	702	1, 094	931	[4]	712	[4]
Old Hat (Oracle)	Arizona	4, 251	3, 583	3, 368	--------	1	--------
Pioneer (Superior)	do	519	6, 240	4, 175	--------	--------	--------
Verde (Jerome)	do	2, 522	10, 155	4, 360	959	--------	--------
Warren (Bisbee)	do	27, 738	4, 511	4, 791	1, 182	--------	--------

[1] Districts producing 1,000 short tons or more in any year of the period 1951–55.
[2] Includes zinc recovered from copper-zinc-pyrite ore in Polk County.
[3] No production in Iowa since 1917.
[4] Figure withheld to avoid disclosing individual company confidential data.
[5] This district not listed in order of 1955 output.

SMELTER PRODUCTION

Seventeen domestic primary zinc-reduction plants continued producing slab zinc mostly at capacity rates throughout 1955. In the third quarter of the year a new electrothermic zinc-slag furnace produced primary slab zinc directly from lead slags at the Herculaneum, Mo., lead smelter. The unit replaced a smaller one which had been used experimentally in previous years. Eight of the other 17 reduction plants used horizontal retorts exclusively, 4 used continuous smelting vertical retorts exclusively (1 plant wholly electrothermic and 1 partly so), and 5 employed the electrolytic-zinc process. The retort furnaces of American Zinc Co. of Illinois Fairmont City plant at East St. Louis remained idle, but the roasting and sintering units, cadmium plant, and sulfuric-acid plant were active.

Horizontal-Retort Plants.—Retorts at active horizontal-retort primary plants in 1955 numbered 54,576, compared with 54,496 in 1954. Of the total retorts, 46,468 (85 percent) were in use at the end of 1955, compared with 34,488 (63 percent) at the close of 1954. No substantial expansion of retort-smelting-plant capacity was reported during the year. The smelting companies continued their progressive practice of adding new facilities to meet changes in quality requirements in consuming industries, to obtain increased efficiency, better metallurgy, and lower costs. At the Blackwell, Okla., plant of Blackwell Zinc Co. (subsidiary of American Metal Co., Ltd.), the largest horizontal-retort smelter and melting and casting facilities were added to produce uniform metal of specified composition, and improvements in smelting practice enabled the plant to produce slab zinc of reduced lead content, when desired.[5]

Vertical-Retort Plants.—During 1955 three of the vertical-retort continuous distilling plants used New Jersey Zinc Co. externally gas fired vertical retorts; the fourth used the St. Joseph Lead Co. electrothermically heated vertical retorts. In the latter vertical retort and in the St. Joseph Lead Co. new electrothermic zinc-slag furnace at the Herculaneum lead smelter, the charge forms the resistance. One of the retorts used by New Jersey Zinc Co. plant, Palmerton, Pa., was a Sterling arc-type electric furnace, first used experimentally in 1951. Vertical retort of all types, at the end of 1955 numbered 91; 81 were in use at the end of the year.

Electrolytic Plants.—Five electrolytic zinc-reduction plants with a total of 3,720 electrolytic cells were producing in 1955; 3,492 cells were in use at the end of the year. Of 3,720 cells, in 1954, 3,317 were in use at the end of the year.

Smelting Capacity.—Owing to changes in metallurgical practice in the various plants, statistics on domestic smelting capacity vary from year to year, irrespective of additions or subtractions of smelter-recovery units. The active zinc-reduction plants in the United States, as of the end of 1955, had an annual capacity of 1,164,000 short tons of slab zinc. Smelter output was 88 percent of capacity. In 1954 smelter production was 76 percent of the reported capacity (1,150,600 tons). Horizontal- and vertical-retort primary plants produced 89 percent of the 669,400-ton reported capacity (78 percent of a 668,700-ton reported capacity in 1954), electrolytic plants at 89 per-

[5] American Metal Co., Ltd., Annual Report for the 68th Year: 1955.

cent of a 436,100-ton reported capacity (73 percent of a 425,500-ton capacity in 1954), and secondary smelters at 71 percent of a 58,500-ton reported capacity (64 percent of a 56,400-ton capacity in 1954.)

Waelz Kilns.—In 1955 Waelz kilns were available or in use at the following places:

Illinois:
- Fairmont City—American Zinc Co. of Illinois.[6]
- LaSalle—Matthiessen & Hegeler Zinc Co.

Kansas: Cherryvale—National Zinc Co., Inc.[7]
Oklahoma: Henryetta—Eagle-Picher Co.
Pennsylvania:
- Donora—American Steel & Wire Division of United States Steel Corp.
- Palmerton—New Jersey Zinc Co.

Slag-Fuming Plants.—The following slag-fuming plants produced impure zinc oxide, which was further treated to recover slab zinc:

California: Selby—American Smelting & Refining Co.
Idaho: Kellogg—Bunker Hill & Sullivan Mining & Concentrating Co.
Montana: East Helena—The Anaconda Co.
Texas: El Paso—American Smelting & Refining Co.
Utah: Tooele—International Smelting & Refining Co.

During 1955 these 5 plants, treating 753,300 tons of hot and cold slag, produced 125,400 tons of oxide fume containing 85,700 tons of recoverable zinc. Corresponding figures for 1954 were 728,200, 116,800, and 80,600 tons, respectively.

Active Zinc-Reduction Plants.—All but two of the reduction plants producing primary-slab zinc in 1955 increased output over 1954. Facilities for raising the capacity of some plants were in the planning stage or being installed. According to the annual report of American Smelting & Refining Co., the capacity for production of Special High-Grade zinc from densified zinc oxide fume at the company Corpus Christi, Tex., electrolytic plant was being doubled. With this expansion, scheduled for completion in 1956, the plant will have a total capacity of approximately 100,000 tons per year of Special High-Grade zinc. Late in 1955, plans for enlarging by 50 percent the annual capacity of the Sullivan electrolytic zinc plant at Kellogg, Idaho, were announced. Full control of the plant was acquired by Bunker Hill & Sullivan Mining & Concentrating Co. in 1955 in an exchange of stock with Hecla Mining Co. According to the annual report of New Jersey Zinc Co., the Palmerton, Pa., plant produced on a reduced basis at the beginning of 1955; by July, metal-producing facilities were at capacity; and during the year production of metal increased 21 percent over 1954. Output of American process and French process zinc oxide rose 18 percent. The new and improved mechanical oxide furnaces readily produced the required additional tonnage of American process zinc oxide. The Josephtown smelter of St. Joseph Lead Co., on a full-time basis throughout 1955, increased its output of slab-zinc equivalent of oxide and metal by 22 percent. Other plants recording large increases in slab-zinc production included the horizontal-retort smelters at Fort Smith, Ark.; La Salle, Ill.; and Amarillo, Tex.; and the electrolytic plants at East St. Louis, Ill., and Anaconda and Great Falls, Mont.

---

[6] Plant idle entire year.
[7] See footnote 6.

Zinc-reduction plants in the United States in 1955 are listed as follows:

Primary Zinc Distillers

Horizontal-retort plants

Arkansas: Fort Smith—Athletic Mining & Smelting Co.
Illinois:
 Fairmont City—American Zinc Co. of Illinois.[8]
 LaSalle—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 the 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—The Anaconda Co.
 Great Falls—The Anaconda Co.
Texas: Corpus Christi—American Smelting & Refining Co.

Secondary Zinc Smelters.—Zinc-base scrap, which includes skimmings and drosses, die-cast alloys, old zinc, engravers' plates, new clippings, and chemical residues, was chiefly smelted at 11 secondary smelters.

Primary and secondary smelting, based on zinc-base scrap, produced 66,000 tons of redistilled zinc, 5,000 tons of remelt zinc, and 30,100 tons of zinc dust.

In addition to the secondary zinc and zinc products recovered from zinc-base scrap at primary and secondary smelters and other plants, 149,600 tons of zinc was recovered from copper-base scrap, chiefly in the form of brass and bronze. Additional details on the secondary zinc phase of the industry may be obtained in the Secondary Metals—Nonferrous chapter of this volume.

Secondary Zinc Distillers

Alabama: Fairfield—W. J. Bullock, Inc
California:
 Los Angeles—American Smelting & Refining Co., Federated Metals Division.
 Torrance—Pacific Smelting Co.

[8] Roasting and sintering, cadmium, and germanium units operated; furnaces idle entire year, and therefore no slab zinc was produced.

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.
- Mars—Beal Brothers.[9]
- Philadelphia—General Smelting Co.

West Virginia: Wheeling—Wheeling Steel Corp.

SLAB ZINC

Primary slab-zinc output in 1955 reached a record 964,000 tons compared with 802,000 tons in 1954 and the previous peak of 942,000 tons in 1943. Tonnage derived from domestic ores increased 53 percent; that from foreign ores declined 10 percent.

Production of redistilled slab zinc decreased 3 percent to 66,000 tons; the quantity redistilled at secondary smelters increased 14 percent, but that redistilled at primary smelters declined 22 percent. Primary smelters supplied 37 percent of the total redistilled. In addition to primary distilled zinc and redistilled secondary zinc, 5,000 tons of remelted secondary slab zinc was recovered by remelting purchased scrap (4,500 tons in 1954). Zinc rolling mills and other large consumers of slab zinc recovered large quantities of slab zinc from "runaround" scrap generated in their own plants.

Sixty percent of primary slab zinc was distilled and 40 percent was produced electrolytically. Output of Special High Grade rose 40 percent over 1954 and that of High Grade increased 4 percent. The combined output of Intermediate, Brass Special, and Select increased 47 percent, and that of Prime Western, 3 percent. Prime Western constituted 39 percent of the total in 1955 (nearly 46 percent in 1954); Special High Grade, 37 percent (31 percent in 1954); High Grade, 14 percent (15); Brass Special, 8 percent (6 percent); Intermediate, more than 2 percent (2); and Select, less than 1 percent in both years.

TABLE 7.—Primary and redistilled secondary slab zinc produced in the United States, 1946–50 (average) and 1951–55, in short tons

Year	Primary			Redistilled secondary	Total (excludes zinc recovered by remelting)
	From domestic ores	From foreign ores	Total		
1946–50 (average)	537,395	[1] 257,959	795,354	57,678	853,032
1951	621,826	259,807	881,633	48,657	930,290
1952	575,828	[1] 328,651	904,479	55,111	959,590
1953	[1] 495,436	[1] 420,669	916,105	52,875	968,980
1954	[1] 380,312	[1] 422,113	802,425	68,013	870,438
1955	582,913	[1] 380,591	963,504	66,042	1,029,546

[1] Includes a small tonnage of slab zinc further refined into high-grade metal.

[9] Plant closed in October 1955.

TABLE 8.—Distilled and electrolytic zinc, primary and secondary, produced in the United States, 1946–50 (average) and 1951–55, in short tons

CLASSIFIED ACCORDING TO METHOD OF REDUCTION

Year	Electrolytic primary	Distilled	Redistilled secondary [1]		Total
			At primary smelters	At secondary smelters	
1946–50 (average)	311, 506	483, 848	23, 953	33, 725	853, 032
1951	336, 087	545, 546	16, 251	32, 406	930, 290
1952	351, 106	553, 373	18, 861	36, 250	959, 590
1953	370, 870	545, 235	17, 645	35, 230	968, 980
1954	311, 237	491, 188	31, 658	36, 355	870, 438
1955	389, 891	573, 613	24, 747	41, 295	1, 029, 546

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)	High Grade (Ordinary)		Brass Special	Select		
1946–50 (average)	245, 212	193, 201	30, 216	57, 093	7, 570	319, 740	853, 032
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
1953	312, 810	180, 188	14, 720	56, 219	1, 930	403, 113	968, 980
1954	270, 159	132, 980	19, 284	52, 662	1, 233	394, 120	870, 438
1955	378, 215	138, 597	23, 792	80, 209	3, 904	404, 829	1, 029, 546

[1] For total production of secondary zinc see chapter on Secondary Metals—Nonferrous.

TABLE 9.—Primary slab zinc produced in the United States, by States where smelted, 1946–50 (average) and 1951–55, in short tons

Year	Arkansas	Idaho	Illinois	Montana	Oklahoma	Pennsylvania	Texas and West Virginia [1]	Total	
								Short tons	Value
1946–50 (average)	17, 854	42, 894	101, 109	204, 903	134, 627	172, 614	121, 353	795, 354	$190, 765, 590
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
1953	20, 379	54, 037	129, 904	222, 354	134, 918	192, 279	162, 234	916, 105	210, 154, 487
1954	8, 576	47, 404	92, 262	154, 024	153, 846	180, 706	165, 607	802, 425	173, 805, 255
1955	21, 481	56, 625	102, 808	207, 366	160, 961	218, 469	195, 794	963, 504	236, 829, 283

[1] Includes Missouri, 1947–53 and 1955.

Pennsylvania led, Montana ranked second, and Oklahoma third among the States in producing primary slab zinc in 1955 as in 1954. All slab zinc produced in Montana and Idaho was electrolytic, that in Illinois and Texas was in part electrolytic and in part distilled, but all of that produced in other States was distilled.

BYPRODUCT SULFURIC ACID

Sulfuric acid was made from sulfur dioxide gases produced in roasting zinc-blende (sphalerite) concentrate at zinc smelters where the demand for sulfuric acid warranted. At several plants, quantities of elemental sulfur were also burned to increase acid-making capacity. The production of sulfuric acid at zinc plants from 1951 through 1955 is shown in table 10.

TABLE 10.—Sulfuric acid (basis, 100 percent) made at zinc blende roasting plants in the United States, 1946–50 (average) and 1950–55

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[2]	Average per ton
1946–50 (average)	551,842	$7,685,547	206,885	$2,878,625	758,727	$10,564,172	$10.84
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
1953	636,864	11,397,458	229,951	4,115,262	866,815	15,512,720	13.90
1954	612,250	11,642,763	156,984	2,985,268	769,234	14,628,031	14.77
1955	782,938	14,687,012	153,622	2,881,771	936,560	17,568,783	14.57

[1] Includes acid from foreign blende.
[2] At average of sales of 60° B. acid.

ZINC DUST

The output of zinc dust increased 13 percent to 30,100 tons. 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 content of the dust produced in 1955 ranged from 94.1 percent to 99.8 and averaged 98.0 percent. Shipments of zinc dust were 29,300 tons, of which 28,900 tons was domestic shipments, and 400 tons was for foreign consignees. Producers' stocks of zinc dust declined from 2,100 tons at the beginning of the year to 1,600 tons at the end of 1955.

The average price of all zinc dust shipped was 15.3 cents, compared with 13.6 cents in 1954 and 13.3 cents in 1953. Most of the production was from zinc scrap (principally galvanizers' dross), but some was recovered from zinc ore and as a byproduct of zinc refining. The secondary raw materials used to manufacture zinc dust are reviewed in the Secondary Metals—Nonferrous chapter of this volume.

TABLE 11.—Zinc dust[1] produced in the United States, 1946–50 (average) and 1951–55

Year	Short tons	Value		Year	Short tons	Value	
		Total	Average per pound			Total	Average per pound
1946–50 (average)	28,618	$7,899,173	$0.138	1953	25,297	$6,729,002	$0.133
1951	31,695	13,438,680	.212	1954	26,714	7,266,208	.136
1952	25,113	9,794,070	.195	1955	30,118	9,216,108	.153

[1] All produced by distillation.

ZINC PIGMENTS AND SALTS

The principal zinc pigments were zinc oxide and lithopone, and the principal salts were chloride and sulfate. These products were manufactured from various zinc-bearing materials, including ore, metal, scrap, and residues. In 1955, 183,000 tons of zinc was consumed in these products. 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 830 plants, consumption of slab zinc reached a record high of 1,120,000 tons in 1955 compared with 884,300 tons in 1954 and the previous record of 986,000 tons in 1953. In the last quarter of 1955, consumption exceeded 97,000 tons monthly and totaled 293,000 tons—12 percent more than in the first quarter.

The principal uses of zinc continued to be in galvanizing and for making zinc-base alloys (chiefly die castings), which utilized 40 and 38 percent, respectively. The quantity used for galvanizing increased 12 percent and for zinc-base alloys 48 percent over 1954. The expanded use of zinc-base die castings for functional and decorative trim parts of automobiles (of which a record number were manufactured in 1955) was an important factor in bringing about the record overall consumption of slab zinc during the year. Slab zinc used in making brass increased 35 percent over 1954 but was still 18 percent below the quantity consumed in 1953. In addition to the slab zinc used in brassmaking in 1955, 149,600 tons of secondary zinc in copper-base scrap was consumed in making brass and bronze ingots at secondary smelters.

TABLE 12.—Consumption of slab zinc in the United States, 1946–50 (average) and 1951–55, by industries, in short tons [1]

Industry and product	1946–50 (average)	1951	1952	1953	1954	1955
Galvanizing: [2]						
Sheet and strip	136, 931	144, 329	145, 875	164, 601	181, 558	200, 403
Wire and wire rope	45, 969	51, 792	48, 645	44, 100	44, 882	48, 171
Tubes and pipe	78, 296	79, 221	82, 043	88, 428	76, 891	98, 206
Fittings	12, 506	21, 186	10, 366	10, 330	10, 513	10, 586
Other	95, 222	103, 751	90, 759	99, 529	89, 619	93, 775
Total galvanizing	368, 924	400, 279	377, 688	406, 988	403, 463	451, 141
Brass products:						
Sheet, strip, and plate	56, 009	67, 815	71, 706	94, 826	52, 284	67, 550
Rod and wire	37, 436	46, 056	49, 831	47, 312	30, 899	46, 830
Tube	16, 150	15, 927	17, 057	18, 136	12, 097	15, 363
Castings and billets	3, 790	7, 098	7, 262	8, 145	5, 499	7, 518
Copper-base ingots	4, 401	5, 743	8, 223	7, 659	6, 594	8, 062
Other copper-base products	1, 313	653	1, 529	2, 104	895	920
Total brass products	119, 099	143, 292	155, 608	178, 182	108, 268	146, 243
Zinc-base alloy:						
Die castings	226, 426	282, 812	225, 877	297, 280	279, 676	417, 333
Alloy dies and rod	3, 448	11, 135	9, 235	7, 140	8, 857	11, 754
Slush and sand castings	729	2, 487	1, 577	3, 025	2, 313	1, 720
Total zinc-base alloy	230, 603	296, 434	236, 689	307, 445	290, 846	430, 807
Rolled zinc	72, 679	64, 085	51, 318	54, 649	47, 486	51, 589
Zinc oxide	16, 336	18, 223	17, 205	20, 675	18, 701	22, 433
Other uses:						
Wet batteries	1, 470	1, 749	1, 396	1, 417	1, 264	1, 420
Desilverizing lead	2, 503	2, 186	2, 370	2, 425	2, 740	2, 676
Light-metal alloys	939	3, 132	3, 266	5, 939	3, 526	3, 484
Other [3]	4, 309	4, 591	7, 243	8, 207	8, 005	10, 019
Total other uses	9, 221	11, 658	14, 275	17, 988	15, 535	17, 599
Total consumption [4]	816, 862	933, 971	852, 783	985, 927	884, 299	1, 119, 812

[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 4,505 tons of remelt zinc in 1951, 4,144 tons in 1952, 3,710 tons in 1953, 3,589 tons in 1954, and 2,997 tons in 1955.

Slab zinc used in rolled-zinc products rose to 51,600 tons, 9 percent above the 47,500 tons consumed in 1954. In addition to slab zinc, the rolling mills remelt and reroll the metallic scrap (home scrap) produced from associated fabricating processes. The scrap treated in 1955 totaled 8,100 tons, 12,300 tons in 1954, and 13,100 tons in 1953. Purchased zinc scrap, in the form of zinc clippings, old zinc, and engravers' plates, totaling 3,500 tons, was melted and rolled.

Production of rolled zinc from both slab zinc and purchased scrap was 53,100 tons compared with 49,000 tons produced in 1954. Inventories of rolled zinc at the beginning and end of 1955 were 1,500 and 1,900 tons, respectively. In addition to shipments of 37,700 tons of rolled zinc, the rolling mills processed 23,200 tons of rolled zinc in manufacturing 15,500 tons of semifabricated and finished products.

TABLE 13.—Rolled zinc produced and quantity available for consumption in the United States, 1954–55

	1954			1955		
	Short tons	Value		Short tons	Value	
		Total	Average per pound		Total	Average per pound
Production:						
Sheet zinc not over 0.1 inch thick	12,786	$6,985,291	$0.273	13,339	$7,640,582	$0.286
Boiler plate and sheets over 0.1 inch thick	1,117	477,697	.214	1,046	439,854	.210
Strip and ribbon zinc [1]	33,492	12,040,429	.180	36,926	13,401,954	.181
Foil, rod, and wire	1,640	839,564	.256	1,766	981,052	.278
Total rolled zinc	49,035	20,342,981	.207	53,077	22,463,442	.212
Imports	259	88,010	.170	431	148,389	.172
Exports	2,960	1,443,995	.244	2,604	1,317,756	.253
Available for consumption	46,404			50,462		
Value of slab zinc (all grades)			.108			.123
Value added by rolling			.099			.089

[1] Figures represent net production. In addition 12,280 tons of strip and ribbon zinc in 1954 and 8,134 tons in 1955 were rerolled from scrap originating in fabricating plants operated in connection with zinc rolling mills.

Consumption of six commercial grades of refined zinc and purchased remelt spelter by the various industries is shown in table 19. Of the 1.1 million tons of slab zinc consumed, 44 percent was Special High Grade; 37 percent, Prime Western; 9 percent, High Grade; 7 percent, Brass Special; 2 percent, Intermediate; and 1 percent, combined Select and Remelt. Record production of automobiles together with increased use of zinc die castings per car, were contributing factors to the new record established in the use of Special High Grade. Although all grades of zinc were used in galvanizing, the increasing number of continuous galvanizing lines in use has led to a gradual change to the higher grades. Of the 146,200 tons of slab zinc used in brass products, nearly 49 percent was High Grade, 25 percent Special High Grade, and 17 percent Prime Western.

TABLE 14.—Consumption of slab zinc in the United States in 1955, by grades and industries, in short tons

Industry	Special High Grade	High Grade	Intermediate	Brass Special	Select	Prime Western	Remelt	Total
Galvanizers	21,086	18,486	9,932	49,856	300	349,990	1,491	451,141
Brass mills [1]	36,553	71,027	1,328	8,154	3,800	24,628	753	146,243
Die casters [2]	423,233	104	33			7,346	91	430,807
Zinc rolling mills	8,356	13,571	13,204	15,090	1,266	102		51,589
Oxide plants	754	1,067		7		20,605		22,433
Other	4,484	1,385	621	474		9,973	662	17,599
Total	494,466	105,640	25,118	73,581	5,366	412,644	2,997	1,119,812

[1] Includes brass mills, brass ingotmakers, and brass foundries.
[2] Includes producers of zinc-base die castings, zinc-alloy dies, and zinc-alloy rods.

Consumption of Slab Zinc for All Uses.—The region comprising Illinois, Indiana, Michigan, Ohio, and Wisconsin led in zinc consumption, with over 50 percent of the total for the United States. The Mountain States group, the region of least consumption, (Arizona, Colorado, Idaho, Montana, and Utah) used less than one-half of one percent. Ohio consumed 204,600 tons in 1955, displacing Illinois as the leading consuming State in 1954. Pennsylvania ranked third in 1955, followed by Michigan and Indiana.

Consumption of Slab Zinc for Galvanizing.—The iron and steel industry continued to be the leading consumer of slab zinc, for manufacturing coat steel sheets, wire, tube, pipe, cable, chain, bolts, railway-signal equipment, building and poleline hardware, and numerous other items. Fabricators of sheet steel and job galvanizers also used quantities of zinc in zinc-coating many products. Zinc consumed in coating sheet and strip increased 10 percent over 1954 to 200,400 tons, surpassing the previous record yearly high of 188,400 tons in 1950. Additional continuous galvanizing lines began production, raising the total number in production in the United States from 22 at the end of 1954 to 26 at the end of 1955. Two more lines were under construction, and 9 were in the planning stage. Shipments of galvanized-steel sheets in 1955 reported by American Iron and Steel Institute totaled 2,864,500 short tons, an alltime high compared with the previous high of 2,362,600 tons established in 1954. The principal iron- and steel-producing States are the chief consumers of zinc for galvanizing. Among the 34 States consuming zinc for galvanizing, Ohio ranked first in 1955, Pennsylvania second, Illinois third, and Indiana fourth. Ohio, Pennsylvania, Illinois, and Indiana used 61 percent of the slab zinc consumed for galvanizing in 1955 and 57 percent in 1954.

Consumption of Slab Zinc for Brass Products.—Slab zinc used in making brass products increased 35 percent over 1954 despite widespread flood damage to brass mills in the Connecticut Valley. Mills in Connecticut took 37 percent of the total zinc used in brassmaking in the United States in 1955 and 36 percent in 1954. For many years Connecticut has ranked first among the States in consumption of zinc for brassmaking; Illinois ranked second in 1955, Michigan third, Ohio fourth, and Pennsylvania fifth.

TABLE 15.—Consumption of slab zinc in the United States, 1948–52 (average) and 1953–55, by geographic divisions and States [1]

Geographic division and State	1948–52 (average)		1953		1954		1955	
	Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
I. New England:								
Connecticut	60, 668	4	73, 197	6	46, 955	7	61, 172	7
Maine	90	34	(2)	34	(2)	34	(2)	38
Massachusetts	9, 411	15	9, 395	15	8, 355	16	8, 963	16
New Hampshire	14	38	(2)	38	(2)	38	(2)	40
Rhode Island	395	29	610	30	590	31	732	29
Total	70, 578	3	83, 476	3	56, 082	4	70, 904	3
II. Middle Atlantic:								
New Jersey	21, 550	12	27, 565	10	24, 890	11	33, 575	10
New York	50, 500	6	67, 081	7	56, 971	6	74, 239	6
Pennsylvania	127, 752	3	135, 850	3	124, 841	3	147, 776	3
Total	199, 802	2	230, 496	2	206, 702	2	255, 590	2
III. South Atlantic:								
Delaware	122	32	(2)	28	(2)	26	(2)	22
District of Columbia	36	37	(2)	37	(2)	37	(2)	37
Florida	108	33	(2)	33	(2)	32	(2)	30
Georgia	1, 955	21	1, 556	24	1, 498	24	1, 534	25
Maryland	29, 219	9	36, 850	9	33, 985	9	41, 217	9
North Carolina	4	40	----	----	----	----	(2)	32
South Carolina	41	36	(2)	35	(2)	36	----	----
Virginia	290	30	702	29	441	33	500	31
West Virginia	25, 696	11	21, 340	12	20, 501	12	18, 208	13
Total	57, 471	4	61, 810	4	58, 253	3	64, 652	4
IV. East North Central:								
Illinois	155, 616	1	157, 765	2	146, 453	1	179, 136	2
Indiana	58, 655	5	74, 329	4	68, 642	5	86, 422	5
Michigan	48, 105	7	73, 241	5	68, 888	4	104, 564	4
Ohio	141, 998	2	165, 062	1	141, 668	2	204, 594	1
Wisconsin	12, 180	14	13, 859	14	10, 370	15	14, 013	14
Total	416, 554	1	484, 256	1	436, 021	1	588, 729	1
V. East South Central:								
Alabama	26, 844	10	25, 420	11	30, 106	10	31, 350	11
Kentucky	9, 084	16	8, 291	16	11, 697	14	(2)	20
Mississippi	----	----	----	----	----	----	(2)	39
Tennessee	1, 257	25	1, 865	23	1, 421	25	1, 747	23
Total	37, 185	5	35, 576	6	43, 224	5	35, 900	6
VI. West North Central:								
Iowa	5, 160	17	5, 452	18	4, 547	18	3, 929	17
Kansas	162	31	(2)	32	593	30	(2)	33
Minnesota	3, 606	18	3, 005	19	2, 413	20	2, 939	18
Missouri	16, 288	13	14, 858	13	14, 233	13	19, 392	12
Nebraska	1, 544	23	(2)	25	1, 664	23	(2)	24
Total	26, 760	7	25, 363	7	23, 450	7	28, 167	7
VII. West South Central:								
Arkansas	1	41	(2)	40	(2)	40	(2)	41
Louisiana	564	26	(2)	26	818	27	(2)	27
Oklahoma	1, 456	24	2, 229	22	(2)	21	(2)	26
Texas	3, 408	19	6, 641	17	7, 822	17	9, 737	15
Total	5, 429	8	9, 936	8	10, 576	8	12, 250	8
VIII. Mountain:								
Arizona	60	35	(2)	36	(2)	35	(2)	35
Colorado	2, 095	20	2, 250	21	2, 583	19	2, 908	19
Idaho	485	28	(2)	31	(2)	29	(2)	34
Montana	----	----	----	----	(2)	41	(2)	42
Utah	8	39	(2)	39	(2)	39	(2)	36
Total	2, 648	9	2, 844	9	3, 284	9	3, 492	9
IX. Pacific:								
California	34, 726	8	45, 104	8	40, 375	8	53, 775	8
Oregon	533	27	835	27	811	28	933	28
Washington	1, 563	22	2, 521	20	1, 932	22	2, 423	21
Total	36, 822	6	48, 460	5	43, 118	6	57, 131	5
Grand total [1]	853, 249	----	982, 217	----	880, 710	----	1, 116, 815	----

[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 16.—Consumption of slab zinc for galvanizing in the United States, 1948–52 (average) and 1953–55, by States [1]

State	Geographic division	1948–52 (average)		1953		1954		1955	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	26,308	6	24,524	7	29,425	6	30,299	6
California	IX	19,204	8	27,116	6	25,462	7	26,941	7
Colorado	VIII	1,966	19	(2)	20	(2)	17	(2)	17
Connecticut	I	2,955	17	3,001	16	3,169	16	3,454	15
Florida	III	108	30	(2)	27	(2)	27	(2)	25
Georgia	III	1,948	20	(2)	22	(2)	22	(2)	22
Illinois	IV	47,902	3	46,605	3	49,412	3	54,076	3
Indiana	IV	29,876	4	35,196	5	39,265	4	45,634	4
Iowa	VI	148	29	242	30	172	30	242	29
Kentucky	V	8,948	9	7,854	9	11,308	9	(2)	18
Louisiana	VII	563	24	(2)	24	818	24	(2)	24
Maine	I	88	31	(2)	29	(2)	31	(2)	33
Maryland	III	28,779	5	36,261	4	33,694	5	40,722	5
Massachusetts	I	5,233	11	4,703	14	5,035	13	5,250	13
Michigan	IV	4,422	14	6,810	10	(2)	11	6,279	11
Minnesota	VI	3,604	15	2,944	17	(2)	18	(2)	16
Mississippi	V							(2)	32
Missouri	VI	4,472	13	4,234	15	4,108	15	4,287	14
Nebraska	VI	315	26	528	26	566	26	(2)	27
New Jersey	II	5,026	12	6,041	12	4,995	14	5,437	12
New York	II	5,846	10	6,356	11	5,854	10	6,949	10
Ohio	IV	81,406	1	83,772	1	74,283	1	100,580	1
Oklahoma	VII	1,453	21	(2)	19	(2)	20	(2)	21
Oregon	IX	260	27	197	31	246	28	262	28
Pennsylvania	II	71,937	2	67,829	2	67,774	2	74,256	2
Rhode Island	I	388	25	(2)	25	(2)	25	(2)	26
South Carolina	III	40	33	(2)	32	(2)	32		
Tennessee	V	922	23	1,305	23	1,185	23	1,385	23
Texas	VII	3,055	16	5,170	13	5,440	12	7,354	9
Utah	VIII	48	32					(2)	31
Virginia	III	189	28	(2)	28	(2)	29	(2)	30
Washington	IX	1,261	22	1,908	21	1,499	21	(2)	20
West Virginia	III	24,839	7	21,069	8	(2)	8	(2)	8
Wisconsin	IV	2,504	18	2,897	18	(2)	19	2,238	19
Total [1]		386,013		[3] 405,068		[3] 401,583		[3] 449,650	

[1] Excludes remelt zinc. Includes zinc used in electrogalvanizing and electroplating, but excludes sherardizing.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Includes States not individually shown (footnote reference 2).

Consumption of Slab Zinc for Zinc-Base Alloys.—Slab zinc used in zinc-base alloys established a new record high of 430,700 tons in 1955, a 48-percent increase over 1954 and a 40-percent rise above the former record attained in 1953. Large quantities of zinc were consumed in die castings used by automobile manufacturers. A study by the American Die Casting Institute [10] showed that 62 percent (a record number) of the 1955 automobiles used zinc die-cast grilles. The quantity of zinc alloy used per grille ranged from 6 pounds on lighter cars to 25 pounds on heavier models. According to the report, zinc alloy was preferred for automotive grilles, primarily because of its high-quality appearance when chrome-plated and the ease with which plating is accomplished. High impact strenght, low die cost, ability to achieve a high degree of dimensional accuracy without machining, and ability to produce shapes of extreme complexity were among other important factors favoring the use of die-cast zinc. Passenger-car and truck production in 1955 totaled 9.2 million units, compared with 6.6 million units in 1954. Zinc die castings were extensively

[10] American Metal Market, Record use of Zinc Die-cast Grilles in 1955 Model Automobiles: Vol. 62, No. 41, Mar. 1, 1955, p. 1.

TABLE 17.—Consumption of slab zinc for brass products in the United States, 1948–52 (average) and 1953–55, by States [1]

State	Geographic division	1948–52 (average)		1953		1954		1955	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	494	12	[2]	12	[2]	12	[2]	12
California	IX	1,622	11	3,067	11	1,840	11	2,451	10
Colorado	VIII	95	16	[2]	16	88	18	[2]	16
Connecticut	I	51,577	1	63,127	1	38,970	1	53,104	1
Delaware	III	122	14	[2]	14	[2]	16	[2]	21
District of Columbia	III	36	19	[2]	24	[2]	23	[2]	24
Georgia	III	7	27	[2]	25	[2]	25	[2]	25
Illinois	IV	15,427	2	23,944	2	14,130	2	17,650	2
Indiana	IV	3,817	9	13,347	4	4,844	9	7,184	7
Iowa	VI	1	31	------	------	------	------	------	------
Kansas	VI	28	20	[2]	20	[2]	17	[2]	20
Kentucky	V	72	18	[2]	19	[2]	15	[2]	14
Maine	I	2	29	[2]	29	[2]	29	[2]	30
Maryland	III	432	13	[2]	13	[2]	13	[2]	13
Massachusetts	I	2,863	10	3,504	10	1,926	10	[2]	11
Michigan	IV	13,295	3	19,259	3	11,263	3	15,851	3
Minnesota	VI	2	30	[2]	23	[2]	21	[2]	22
Missouri	VI	76	17	[2]	15	[2]	14	[2]	15
Nebraska	VI	1	32	[2]	30	[2]	28	[2]	31
New Hampshire	I	14	22	[2]	27	[2]	26	[2]	26
New Jersey	II	5,118	8	6,652	9	5,011	8	6,135	9
New York	II	8,952	5	12,655	6	6,614	6	9,661	6
North Carolina	III	------	------	------	------	------	------	[2]	28
Ohio	IV	8,991	4	13,013	5	8,694	4	10,895	4
Oregon	IX	12	23	[2]	22	[2]	22	[2]	23
Pennsylvania	II	6,307	7	[2]	7	6,884	5	9,682	5
Rhode Island	I	7	28	[2]	26	[2]	27	[2]	27
Tennessee	V	8	26	[2]	31	------	------	------	------
Texas	VII	28	21	[2]	21	[2]	19	[2]	18
Utah	VIII	1	33	[2]	32	[2]	30	[2]	32
Virginia	III	12	24	[2]	17	[2]	20	[2]	17
Washington	IX	12	25	[2]	28	[2]	31	[2]	29
West Virginia	III	101	15	[2]	18	[2]	24	[2]	19
Wisconsin	IV	6,429	6	7,305	8	5,043	7	7,157	8
Total [1]	------	125,961	------	[3] 177,308	------	[3] 107,392	------	[3] 145,490	------

[1] Excludes remelt zinc.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Includes States not individually shown (footnote reference 2).

used in manufacturing home appliances, office machines, builders' hardware, scientific communications, and photographic equipment. Six States, manufacturing large quantities of automotive parts and home appliances—Illinois, Ohio, Michigan, New York, Pennsylvania, and Indiana—consumed 83 percent of the slab zinc used in zinc-base alloys.

Consumption of Slab Zinc for Rolled Zinc.—Zinc rolling mills consumed 51,600 tons of slab zinc in making sheet, strip, plates, ribbon, foil, rod, and wire in 1955, a 9-percent increase over 1954. Unalloyed zinc had many uses, such as in producing dry-cell-battery cases; weather-stripping, roof valleys, and flashing in building construction; photo-engraving plates; and heavy plates installed on steam boilers and on ship hulls to protect them from corrosion. Rolled zinc was consumed in the same geographic areas each year from 1940 through 1955, but the quantity rolled ranged from a low of 47,500 tons in 1954 to a high of 98,000 tons in 1945; the average for the 5 years—1951–55—was 53,800 tons. Illinois led in 1955, with 22,400 tons, followed in order by Pennsylvania, Indiana, and New York.

TABLE 18.—Consumption of slab zinc for zinc-base alloys in the United States, 1948–52 (average) and 1953–55, by States [1]

State	Geographic division	1948–52 (average)		1953		1954		1955	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	11	18	------	------	------	------	------	------
California	IX	13,499	6	14,399	7	12,683	8	23,941	7
Colorado	VIII	34	16	------	------	------	------	------	------
Connecticut	I	4,748	10	5,737	10	3,549	10	3,707	11
Delaware	III	------	------	(2)	15	(2)	13	(2)	13
Illinois	IV	60,160	1	60,613	2	58,953	1	79,979	3
Indiana	IV	13,059	7	15,476	6	16,686	6	24,248	6
Iowa	VI	------	------	(2)	17	------	------	------	------
Kansas	VI	123	14	(2)	14	(2)	15	(2)	16
Kentucky	V	64	15	(2)	16	(2)	16	------	------
Massachusetts	I	9	19	(2)	19	------	------	------	------
Michigan	IV	30,154	3	46,977	3	52,109	3	82,352	2
Missouri	VI	11,340	8	9,499	9	9,106	9	13,683	9
New Jersey	II	9,671	9	13,531	8	13,882	7	20,869	8
New York	II	30,141	4	41,620	4	38,548	4	51,663	4
North Carolina	III	4	20	------	------	------	------	(2)	15
Ohio	IV	51,276	2	67,094	1	57,844	2	92,306	1
Oregon	IX	259	13	(2)	13	(2)	14	(2)	14
Pennsylvania	II	23,448	5	25,615	5	19,542	5	27,701	5
Rhode Island	I	------	------	------	------	------	------	(2)	18
Tennessee	V	------	------	------	------	(2)	17	(2)	17
Texas	VII	310	12	(2)	12	2,291	12	(2)	12
Virginia	III	16	17	(2)	18	------	------	------	------
Wisconsin	IV	3,245	11	(2)	11	(2)	11	4,618	10
Total [1]	------	251,571	------	[3] 307,203	------	[3] 290,680	------	[3] 430,716	------

[1] Excludes remelt zinc.
[2] Figure withheld to avoid disclosing individual company confidential data.
[3] Includes States not individually shown (footnote reference 2).

TABLE 19.—Consumption of slab zinc for rolled zinc in the United States, 1948–52 (average) and 1953–55, by States

State	Geographic division	1948–52 (average)		1953		1954		1955	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Connecticut	I	1,127	7	(1)	7	(1)	7	(1)	7
Illinois	IV	30,892	1	23,066	1	19,310	1	22,371	1
Indiana	IV	11,306	2	(1)	2	(1)	3	(1)	3
Iowa	VI	4,853	5	(1)	5	(1)	5	(1)	5
Massachusetts	I	1,277	6	(1)	6	(1)	6	(1)	6
New York	II	4,957	4	(1)	4	(1)	4	(1)	4
Pennsylvania	II	8,019	3	(1)	3	(1)	2	(1)	2
West Virginia	III	713	8	(1)	8	------	------	------	------
Total	------	63,144	------	54,649	------	47,486	------	51,589	------

[1] Figure withheld to avoid disclosing individual company confidential data.

Consumption of Slab Zinc for Other Uses.—Table 20 shows the distribution, by States, of the quantity of slab zinc consumed in slush castings, wet batteries, desilverizing lead, light-metal alloys, zinc dust, chemicals, bronze powders, and zinc oxide and part of the zinc used for cathodic protection. The increase in yearly totals beginning with 1952 is in large measure due to the inclusion of slab zinc consumed for zinc oxide.

TABLE 20.—Consumption of slab zinc for other uses in the United States, 1948–52 (average) and 1953–55, by States [1]

State	Geographic division	1948–52 (average)		1953 [2]		1954 [2]		1955 [2]	
		Short tons	Rank	Short tons	Rank	Short tons	Rank	Short tons	Rank
Alabama	V	30	18	(3)	25	(3)	21	(3)	19
Arizona	VIII	60	16	(3)	19	(3)	16	(3)	15
Arkansas	VII	1	27	(3)	28	(3)	24	(3)	27
California	IX	401	7	522	12	390	11	442	10
Colorado	VIII	----	----	(3)	27	(3)	19	(3)	23
Connecticut	I	262	12	(3)	14	(3)	12	(3)	12
Idaho	VIII	485	6	(3)	11	(3)	8	(3)	11
Illinois	IV	652	4	3,537	2	4,648	2	5,060	2
Indiana	IV	154	15	(3)	13	(3)	13	(3)	13
Iowa	VI	158	14	(3)	8	(3)	9	(3)	9
Kansas	VI	10	22	(3)	22	(3)	28	(3)	20
Kentucky	V	----	----	----	----	----	----	(3)	28
Louisiana	VII	1	28	(3)	23	----	----	----	----
Maryland	III	7	23	(3)	18	(3)	18	(3)	18
Massachusetts	I	28	19	(3)	20	(3)	22	(3)	29
Michigan	IV	234	13	(3)	15	(3)	17	82	17
Minnesota	VI	1	29	(3)	29	----	----	(3)	25
Missouri	VI	401	8	(3)	7	745	6	(3)	4
Montana	VIII	----	----	----	----	(3)	26	(3)	30
Nebraska	VI	1,228	3	(3)	6	(3)	3	(3)	5
New Jersey	II	1,736	2	1,341	3	1,002	4	1,134	3
New York	II	605	5	(3)	4	(3)	7	(3)	8
Ohio	IV	325	10	1,183	5	847	5	813	6
Oklahoma	VII	3	25	(3)	30	(3)	27	(3)	26
Oregon	IX	2	26	(3)	24	(3)	20	(3)	21
Pennsylvania	II	3,169	1	24,863	1	21,658	1	26,596	1
Tennessee	V	327	9	(3)	10	(3)	14	(3)	14
Texas	VII	15	21	(3)	17	(3)	25	(3)	22
Utah	VIII	7	24	(3)	26	(3)	23	(3)	24
Virginia	III	26	20	(3)	16	(3)	15	(3)	16
Washington	IX	290	11	(3)	9	(3)	10	(3)	7
West Virginia	III	43	17	----	----	----	----	----	----
Wisconsin	IV	1	30	(3)	21	----	----	----	----
Total [1]	----	10,662	----	[4] 37,989	----	[4] 33,569	----	[4] 39,370	----

[1] Excludes remelt zinc.
[2] Includes slab zinc used for zinc oxide.
[3] Figure withheld to avoid disclosing individual company confidential data.
[4] Includes States not individually shown (footnote reference 3).

STOCKS

National Strategic Stockpile.—The General Services Administration purchased zinc each month, in accordance with purchase directives from the Office of Defense Mobilization. According to an ODM stockpile report,[11] the minimum objectives for lead and zinc were completed for the 6 months ended December 31, 1955. Newly mined domestic lead and zinc continued to be purchased in 1955 for the long-term stockpile to support the domestic industry as a component of the mobilization base.

Producers' Stocks.—Slab-zinc stocks at producers' plants at the end of 1955 totaled 39,000 tons, compared with 123,000 tons at the end of 1954 and 177,000 tons at the end of 1953. Average year-end inventories for the period 1940–52 were 97,000 tons and ranged from a high of 256,000 tons in 1945 to a low of 9,000 tons in 1950. Continued monthly Government purchases of zinc for the National Stockpile were an important factor in the 1955 decrease in

[11] Stockpile Report to the Congress, July–December 1955, Executive Office of the President, Office of Defense Mobilization, p. 2.

smelter stocks, as the total supply of slab zinc (domestic smelter production of primary and secondary slab zinc plus imports of metal minus exports) exceeded consumption by almost 90,000 tons.

TABLE 21.—Stocks of zinc at zinc-reduction plants in the United States at end of year, 1951–55, in short tons

	1951	1952	1953	1954	1955
At primary reduction plants	21, 343	81, 344	176, 725	[1] 121, 847	37, 322
At secondary distilling plants	637	3, 677	3, 268	1, 549	1, 938
Total	21, 980	85, 021	179, 993	[1] 123, 396	39, 260

[1] Revised figure.

Consumers' Stocks.—Slab-zinc stocks held by consumers on December 31, 1955, totaled 123,500 tons, a 19-percent increase over the 103,700 tons held at the beginning of the year. At the average consumption rate of 93,318 tons a month in 1955, stocks on hand at the end of the year plus 16,300 tons of metal in transit to consumers' plants represented a 7-week supply.

TABLE 22.—Consumers' stocks of slab zinc at plants at the beginning and end of 1955, by industries, in short tons

Date	Galvanizers	Brass mills [1]	Die casters [2]	Zinc rolling mills	Oxide plants	Others	Total
Dec. 31, 1954 [3]	56, 393	16, 188	24, 711	4, 816	235	1, 363	[4] 103, 706
Dec. 31, 1955	65, 886	16, 012	33, 731	5, 765	301	1, 783	[4] 123, 478

[1] Includes brass mills, brass ingotmakers, and brass foundries.
[2] Includes producers of zinc-base die castings, zinc-alloy dies, and zinc-alloy rods.
[3] Revised figures.
[4] Stocks on Dec. 31, 1954 and 1955, exclude 476 tons (revised figure) and 595 tons, respectively, of remelt spelter.

PRICES

All the industry-wide changes in zinc-metal prices in 1955 were upward. The quoted price of Prime Western slab zinc, East St. Louis, was 11.50 cents a pound at the beginning of the year and rose to 12.00 cents on April 6, to 12.50 cents on June 16, and to 13.00 cents on September 6. On October 17 several companies raised their selling price to 13.50 cents a pound but canceled the ½-cent increase 2 days later. The price remained at 13.00 cents through December but rose to 13.50 cents on January 6, 1956. The average of the quoted price for the year was 12.30 cents compared with 10.69 cents in 1954. The average weighted yearly price of all grades sold was 12.3 cents a pound in 1955 and 10.8 cents in 1954.

On the London Metal Exchange the monthly mean of the buyers' and sellers' quotations at the close of the morning sessions in 1955 ranged from £85 16s. 9d. per long ton in January to £98 8s. 9d. in December and averaged £90 13s. 9d. for the year as compared with £82 0s. 5d. in 1954. The equivalent of the yearly average in United States money was 11.30 cents per pound (computed at an exchange rate of $2.7913 to the pound sterling).

TABLE 23.—Price of zinc concentrate and zinc, 1951–55

	1951	1952	1953	1954	1955
Joplin 60-percent zinc concentrate: [1]					
Price per short ton____dollars__	120.00	116.10	64.65	65.72	77.50
Average price common zinc at—					
St. Louis (spot)[1]____cents per pound__	17.99	16.21	10.86	10.69	12.30
New York [1]____do____	18.75	17.03	11.53	11.19	12.80
London [2]____do____	21.46	18.53	9.47	9.78	11.30
Price indexes [3] (1947–49 average=100):					
Zinc (New York)	148	135	91	88	101
Lead (New York)	109	102	84	88	94
Copper (New York)	117	117	138	142	177
Straits tin (New York)	138	130	103	100	103
Nonferrous metals	124	124	125	124	143
All commodities	115	112	110	110	111

[1] Metal Statistics, 1956.
[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 24.—Average monthly quoted prices of 60-percent zinc concentrates at Joplin, and of common zinc (prompt delivery or spot) St. Louis and London 1954–55 [1]

Month	1954			1955		
	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] [3]		St. Louis	London [2] [3]
January	54.61	9.75	9.23	68.00	11.50	10.64
February	51.33	9.37	9.10	68.00	11.50	11.09
March	52.52	9.66	9.36	68.00	11.50	11.03
April	57.85	10.25	10.04	70.92	11.93	11.13
May	58.23	10.29	10.02	72.00	12.00	11.21
June	62.54	10.96	10.07	73.70	12.25	11.42
July	64.00	11.00	9.77	76.00	12.50	11.31
August	64.00	11.00	9.49	76.00	12.50	11.12
September	67.69	11.44	10.16	78.77	12.96	11.39
October	68.00	11.50	10.40	80.00	13.02	11.36
November	68.00	11.50	10.23	80.00	13.00	11.55
December	68.00	11.50	10.42	80.00	13.00	12.30
Average for year	65.72	10.69	9.78	77.50	12.30	11.30

[1] Joplin: Metal Statistics, 1956, p. 585. St. Louis: Metal Statistics, 1956, p. 582. 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] Average of daily mean of bid and asked quotations at morning session of London Metal Exchange.

TABLE 25.—Average price received by producers of zinc, 1951–55, by grades, in cents per pound

Grade	1951	1952	1953	1954	1955
Grade A:					
Special High Grade	18.79	17.04	11.81	11.46	12.79
High Grade	18.48	16.42	11.40	11.05	12.59
Grade B: Intermediate	18.57	17.76	11.38	11.36	12.30
Grades C and D:					
Brass Special	18.20	17.07	11.72	10.93	12.21
Select	18.00	16.73	11.59	10.02	11.13
Grade E: Prime Western	17.92	16.33	11.21	10.39	11.74
All grades	18.24	16.63	11.47	10.83	12.29
Prime Western; spot quotation at St. Louis [1]	17.99	16.21	10.86	10.69	12.30

Metal Statistics, 1956, p. 582.

FOREIGN TRADE [12]

Imports.—Imports (general imports) of zinc in ores and concentrates and as refined metal totaled 674,000 tons in 1955, or 10 percent more than in 1954. Of the 478,000 tons imported in ores and concentrates in 1955, Mexico supplied 39 percent; Canada, 36 percent; and Peru, 18 percent. The remaining 7 percent came mostly from Guatemala, Australia, Union of South Africa (South-West Africa), and Chile.

Of the imports of slab zinc (196,000 tons), Canada supplied 58 percent; Belgian Congo, 8 percent; Mexico, 10 percent; Belgium-Luxembourg, 9 percent; and Peru, 5 percent. The remaining 10 percent came largely from Germany, Italy, Australia (Oceania), French Morocco, and the Netherlands.

TABLE 26.—Zinc imported into the United States, in ores, blocks, pigs, or slabs, by countries, 1946–50 (average) and 1951–55, in short tons [1]

[U. S. Department of Commerce]

Country	1946–50 (average)	1951	1952	1953	1954	1955
Ores (zinc content):						
North America:						
Canada-Newfoundland-Labrador	62,608	96,470	149,130	165,910	[2] 156,830	173,157
Guatemala		6,539	9,744	6,477	3,755	8,353
Honduras	70	154	316	637	792	1,433
Mexico	144,871	143,769	200,647	169,124	[2] 175,692	186,461
Other North America	11	62	171	(3)	(3)	3,704
Total	207,560	246,994	360,008	342,148	[2] 337,069	373,108
South America:						
Argentina	1,676	5,546	603			
Bolivia	11,494	7,849	14,603	22,528	11,440	1,833
Chile	8	1,088	33	3,247	1,797	4,858
Peru	30,621	29,136	44,337	84,365	93,216	83,915
Other South America	126	380	320	389	31	142
Total	43,925	43,999	59,896	110,529	106,484	90,748
Europe:						
Belgium-Luxembourg						1,546
Italy	4,580			8,738		
Netherlands				3,009		
Spain	7,008	4,392	16,647	8,617		
United Kingdom						1,497
Yugoslavia		1,756	2,512	10,820	4,871	
Other Europe	(3)			1	15	
Total	11,588	6,148	19,159	31,185	4,886	3,043
Asia:						
Japan	1,004		1,389			
Philippines	8	86	1,664	2,104	444	465
Other Asia	477	70	7	778		
Total	1,489	156	3,060	2,882	444	465
Africa:						
Algeria				2,804		
Union of South Africa	2,480	2,655	4,917	13,356	4,183	5,050
Other Africa	(3)	(3)	198			
Total	2,480	2,655	5,115	16,160	4,183	5,050
Oceania:						
Australia	2,493	2,825	2,398	10,820	2,361	5,630
Total	2,493	2,825	2,398	10,820	2,361	5,630
Grand total: Ores	269,535	302,777	449,636	513,724	[2] 455,427	478,044

See footnotes at end of table.

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

TABLE 26.—Zinc imported into the United States, in ores, blocks, pigs, or slabs, by countries, 1946–50 (average) and 1951–55, in short tons [1]—Continued

Country	1946–50 (average)	1951	1952	1953	1954	1955
Blocks, pigs, or slabs:						
North America:						
Canada	87,301	85,066	69,775	107,925	105,154	113,402
Mexico	12,466	760	18,686	33,878	9,726	19,480
Total	99,767	85,826	88,461	141,803	114,880	132,882
South America: Peru	241	26	1,600	8,406	6,757	9,767
Europe:						
Belgium-Luxembourg	1,339	612	6,854	21,549	7,540	17,748
Germany	327		[4] 7,619	[4] 13,906	[4] 3,109	[4] 6,642
Italy	852		4,063	23,972	5,285	6,190
Netherlands	401	254	3,976	4,338	1,461	1,079
Norway	2,228	882	110	6,323	717	504
United Kingdom	111			6,317	22	79
Yugoslavia	97		2,788	1,900		
Other Europe	256	3	12	165		
Total	5,611	1,751	25,422	78,470	18,134	32,242
Asia:						
Japan	4,323		222			
Other Asia	25					
Total	4,348		222			
Africa:						
Belgian Congo				882	13,895	15,228
Federation of Rhodesia and Nyasaland				[5] 1,064		280
French Morocco		440				1,264
Mozambique					112	
Total		440		1,946	14,007	16,772
Oceania: Australia	680			3,951	3,080	4,033
Grand total: Blocks, pigs, or slabs	110,647	88,043	115,705	234,576	156,858	195,696

[1] Data include zinc imported for immediate consumption plus material entering country under bond.
[2] Revised figure.
[3] Less than 1 ton.
[4] West Germany.
[5] Northern Rhodesia.

Exports.—Exports of zinc in zinc ore, concentrate, dross, and slab zinc, sheet, scrap, and dust totaled 43,600 tons valued at $8,732,000 compared with 46,200 tons valued at $9,751,000 in 1954. In addition to the export items listed in tables 28 and 29, considerable zinc was exported (as in other years) in brass, pigments, chemicals, die-cast alloy and as zinc coatings on steel products. Export data on zinc pigments and chemicals are given in the Lead and Zinc Pigments and Zinc Salts chapter of this volume.

Of the 18,000 tons of exported slab zinc, the United Kingdom received 42 percent, Argentina, 34 percent; Belgium-Luxembourg, 18 percent; Mexico, 4 percent; and other countries, 2 percent. The 3,700 tons of sheets, plates, strips, or other forms not otherwise specified were shipped to Canada, Mexico, Cuba, Colombia, and other countries as listed in table 28.

Tariff.—The duty on slab zinc (gross weight) remained 0.7 cent per pound and that on ores and concentrates (zinc content) 0.6 cent per pound throughout 1955. The rates of duty imposed on zinc articles under the Tariff Act of 1930, in specific years, 1930–54, are given in the 1953 Minerals Yearbook, Zinc, chapter (vol. I).

TABLE 27.—Zinc imported for consumption in the United States, 1946–50 (average) and 1951–55, by classes [1]

[U. S. Department of Commerce]

Year	Ore (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	
1946–50 (average)	168,524	$13,617,416	109,904	$24,863,164	73	$26,869	9,157	$1,018,345	121	$19,055	$39,544,849
1951	197,995	27,043,611	88,043	31,109,279	149	84,044	6,603	284,030	154	74,362	58,595,326
1952	542,314	105,428,691	113,053	36,219,619	47	23,557	3,489	535,426	133	38,932	142,246,225
1953	449,732	47,918,150	227,654	50,281,745	196	76,507	5,915	556,592	1,045	161,612	98,994,606
1954	[4] 480,918	[4 5] 52,481,723	160,138	[4 5] 33,714,309	259	88,010	1,087	103,486	----	----	[4 5] 86,387,528
1955	384,648	36,810,856	195,059	46,452,269	431	[5] 148,389	284	31,529	72	[5] 17,994	[5] 83,461,037

[1] Excludes imports for manufacture in bond and export, which are classified as "imports for consumption" by U. S. Department of Commerce.

[2] Includes dross and skimmings as follows: 1946–50 (average)—3,945 tons ($386,093); 1951—6,457 tons ($242,998); 1952—3,019 tons ($389,361); 1953—2,925 tons ($250,544); 1954—316 tons ($33,181); 1955—108 tons ($3,060).

[3] In addition, manufactures of zinc were imported as follows: 1946–50 (average)—$33,473; 1951—$51,700; 1952—$11,719; 1953—$5,855; 1954 [5]—$41,454; 1955 [5]—$190,076.

[4] Revised figure.

[5] Owing to changes in tabulating procedures by U. S. Department of Commerce, data known to be not comparable with earlier years.

TABLE 28.—Slab and sheet zinc exported from the United States, by destinations, 1952–55, in short tons

[U. S. Department of Commerce]

Destination	Slabs, pigs, and blocks				Sheets, plates, strips, or other forms, n. e. s.			
	1952	1953	1954	1955	1952	1953	1954	1955
North America:								
Canada	171	7	9	8	1,686	2,322	1,704	2,062
Cuba	33	12		11	73	99	96	132
Mexico	351	457	517	796	532	545	637	583
Other North America	3	5		4	70	47	58	43
Total	558	481	526	819	2,361	3,013	2,495	2,820
South America:								
Argentina	661		2,205	6,062	305	2		9
Brazil	4,089	1,687	2,900	35	621	697	952	71
Chile	365	141	230	6	66	31	9	8
Colombia	1	23		2	147	136	219	270
Other South America	73	32	14	14	97	84	119	76
Total	5,189	1,883	5,349	6,119	1,236	950	1,299	434
Europe:								
Austria	986							
Belgium-Luxembourg		840	3,136	3,219	(1)	1	10	2
Denmark				84				
France	6,689	56	56					1
Germany, West	607		2,777		21			30
Italy			224					12
Switzerland	498		1,064		23	13	17	30
United Kingdom	40,423	13,859	10,052	7,504	41	9	34	50
Other Europe	67	34	673	5	67	8	26	83
Total	49,270	14,789	17,982	10,812	152	31	87	208
Asia:								
India	2,036		112		304	352	49	38
Israel and Palestine	60	34		[2] 11	55	9	[2] 16	[2] 1
Japan			28		3	11	4	11
Korea, Republic of	90	771	948	132		94	6	1
Pakistan	111			2	3	3		
Philippines	3		16	7	43	104	67	84
Other Asia	9	10	33		24	43	8	17
Total	2,309	815	1,137	152	432	616	150	152
Africa:								
Egypt	385							
Union of South Africa					45	18	14	38
Other Africa	3	1		2				(1)
Total	388	1		2	45	18	14	38
Oceania					5	(1)		5
Grand total	57,714	17,969	24,994	17,904	4,231	4,628	4,045	3,657

[1] Less than 1 ton. [2] Israel.

TECHNOLOGY

Technical progress was made in producing and using zinc, and much valuable technologic information was published by the technical staffs of companies, trade journals, Federal and State agencies, and various research units.

The Federal Bureau of Mines [13] [14] and the Geological Survey [15] [16] [17] published reports on several investigations relating to zinc.

[13] Bishop, O. M., and Mentch, R. L., Zinc; chap. in Mineral Facts and Problems: Bureau of Mines Bull. 556, 1955, 27 pp.

[14] Hamilton, W. H., and McLellan, R. R., Investigations of Kokomo Zinc Deposits, Summit County, Colo.: Bureau of Mines Rept. of Investigation 5138, 1955, 28 pp.

[15] Albritton, C. C., Jr., Richards, Arthur, Brokaw, A. L., and Reinemund, J. A., Geologic Controls of Lead and Zinc Deposits in Goodsprings (Yellow Pine) District, Nev.: Geol. Survey Bull. 1010, 1954, 111 pp.

[16] Bodenlos, A. J., and Ericksen, G. E., Lead-Zinc Deposits of Cordillera Blanca and Northern Cordillera Huayhuash, Peru: Geol. Survey Bull. 1017, 1955, 166 pp.

[17] Flint, A. E., and Brown, C. E., Exploratory Drilling for Evidence of Zinc and Lead Ore in Dubuque County, Iowa: Geol. Survey Bull. 1027-K, 1956, pp. 471–499.

TABLE 29.—Zinc ore and manufactures of zinc exported from the United States, 1946–50 (average) and 1951–55

[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
1946–50 (average)	[1] 1,821	[1] $279,100	58,211	$13,911,883	8,871	$3,562,273	(2)	(2)	820	$257,076
1951	[1] 3,090	[1] 792,800	36,510	15,592,994	6,579	4,360,689	4,613	$871,302	723	400,656
1952 [3]	[1] 3,370	[1] 899,162	57,714	24,508,568	4,231	2,960,769	972	282,816	(4)	(4)
1953 [3]	[1] 2,953	[1] 758,600	17,969	4,620,452	4,628	2,637,240	1,000	169,517	502	181,055
1954 [3]			24,994	5,393,938	4,045	2,183,170	16,689	2,023,493	509	150,756
1955 [3]			17,904	4,127,420	3,657	2,192,882	21,612	2,249,583	445	161,956

[1] Effective Jan. 1, 1949 "dross" included with "scrap."
[2] Classification established Jan. 1, 1949. Not included in 1946–50 averages, 1949—1,570 tons ($224,291) and 1950—6,212 tons ($674,235).
[3] Effective Jan. 1, 1952 zinc and zinc alloy semifabricated forms, n. e. c., were exported as follows: 1952—$191,746 (quantity not available); 1953—286 tons, $151,496; 1954—543 tons, $257,316; 1955—651 tons, $295,685.
[4] "Dust" included with "scrap."

Geologic studies by the Federal and State Governments have been carried on since 1942 in the Wisconsin–Illinois–Iowa zinc-lead district, according to a paper published in 1955.[18] The detailed stratigraphic studies made it possible to map the stratigraphic structural features that controlled the deposition of the zinc-lead ore. Prospecting on the basis of this mapping led to discovery of significant ore bodies.

Improvements in prospecting and drilling equipment and in adapting the equipment to specific jobs helped to reduce prospecting and mining costs in the Tri-State zinc-lead district (Kansas, Southwestern Missouri, Oklahoma).[19]

A dual-motor-design control system for mine hoists, using two AC motors geared to a common main-drive shaft, was operated successfully for several years at the Austinville, Va., zinc-lead mine of New Jersey Zinc Co., and similar-type controls have been installed at three other company mines.[20]

The use of the fluidization technique in roasting zinc concentrate has expanded. More than 80,000 tons of zinc metal per year was being produced from concentrate roasted by Fluo-Solids reactor systems for further treatment, either by pyrometallurgical or electrowinning methods.[21]

Research connected with the electrolytic production of zinc done by one company achieved significant results, which were described as follows: [22]

In the electrolytic production of "Special High-Grade" zinc, the restriction of lead content to 2 or 3 parts per 100,000 is essential, but most difficult to achieve owing to the need for employing lead anodes in the electrolysis. The Research Department discovered and patented a process of effecting this lead control very simply and cheaply by the addition of small amounts of strontium salts to the

[18] Agnew, A. F., Application of Geology to the Discovery of Zinc-Lead Ore in the Wisconsin-Illinois-Iowa District: Min. Eng., vol. 7, No. 8, August 1955, pp. 781–795 (A. I. M. E. Trans., vol. 202).
[19] Clarke, S. S., and Brockie, Douglas C., Jackleg Drilling in the Tri-State District; Longhole Prospecting and Production: Min. Eng., vol. 8, No. 1, January 1956, pp. 27–30.
[20] Newland, W. Trent, and Myles, A. H., Mine Hoists With Dual AC Motors Operated Successfully: Min. Cong. Jour., vol. 41, No. 9, September 1955, pp. 42–45.
[21] Counselman, Theodore B., How Fluidization Can Serve the Mineral Industries: Eng. Min. Jour., vol. 156, No. 3a, Mid-March 1955, pp. 70–75, 96.
[22] Asarco Products and Processes, brochure accompanying 57th Annual Report to Stockholders of the American Smelting & Refining Co. for the year ended Dec. 31, 1955.

electrolyte. This discovery has lead to increased production rates at our Corpus Christi refinery and, at the same time, yields a product of the very highest commercial grade. The process has now been licensed to several other electrolytic zinc producers both in the United States and abroad.

A zinc coating that is either sprayed or brushed on steel surfaces, in effect providing a "cold-galvanized" protective sheathing, was reported to offer excellent corrosion resistance at a variety of oilfield and refinery installations.[23] The inorganic coating consisting of finely ground zinc in a water-soluble silicate vehicle (which contains an additive to effect chemical curing), appears especially valuable in salt-water atmospheres. At several Gulf coast installations the material outperformed galvanized coatings.

According to a published paper,[24] forming dies made from a new zinc-base alloy last 3 to 4 times as long as dies made from conventional zinc alloys. The greater life results from dispersion of hard Ni_3 Ti particles in the die matrix to increase wear resistance (U. S. Patent 2,720,459) (SG–j, Zn).

Conversion coatings for cadmium and zinc, formed by chemical reaction between the metal surface and a suitable solution, are economical and versatile finishes for cadmium and zinc-plated parts and zinc-base die castings. With minor modifications in the processing conditions, a wide range of surface finishes can be obtained without using expensive equipment.[25]

The results of a study of metallic materials resistant to molten zinc were published.[26] Refractory boron compounds were shown to resist corrosion by molten zinc. Coatings of ferroboron and manganese boron were applied to steel by several methods. Mechanical failure of the diffusion coatings was partly eliminated when the coatings were applied to type-416 chromium steels rather than carbon steels. Welded coatings made with a tungsten arc proved better than those made of other welding methods. Sintered compacts of mixtures of iron and chromium borides resisted corrosion of zinc at 600° C. and oxidation at higher temperatures.

A new type of silver-zinc storage batteries that were being made for the United States Navy was described. Although only one-fifth as large and one-sixth as heavy, this type of battery is up to 20 times as powerful as conventional lead-acid storage batteries. The batteries were employed to power a wide range of electronic equipment used in certain classes of missiles.[27]

WORLD REVIEW

World mine production of zinc in 1955 was estimated at 83 percent more than in 1946. Annual increases over the preceding year were made in all years since 1946 except 1954. The United States continued to be the leading producer, followed in order by Canada, U. S. S. R., Mexico, Australia, and Peru. Together, these nations contributed

---

[23] Stormont, D. H., This Zinc Coating Can Be Applied in Field: Oil and Gas Jour., vol. 54, No. 31, Dec. 5, 1955, pp. 114–115.

[24] Holzwarth, J. C., and Boegehold, A. L., "Gmoodie"—A Low Cost Die Material: Metal Progress, vol. 69, No. 5, May 19, 1956, pp. 49–53.

[25] Foley, Edward F., Jr., Conversion Coatings for Cadmium and Zinc: Metal Progress, vol. 69, No. 2, February 1956, pp. 86–90.

[26] Hodge, Webster, Evans, R. M., and Haskins, A. F., Metallic Materials Resistant to Molten Zinc: Jour. Metals, vol. 7, No. 7, July 1955, pp. 824–832.

[27] American Metal Market, Yardney Electric Books Navy Battery Order: Vol. 62, No. 122, June 24, 1955, p. 7.

64 percent of the world output as listed in table 30. A major factor in the increased world mine production was the cooperation of the United States industry and Government in supplying capital, technical personnel, and equipment for many of the zinc and lead-mining enterprises abroad.

TABLE 30.—World mine production of zinc (content of ore),[1] by countries,[2] 1946–50 (average) and 1951–55, in short tons[3]

[Compiled by Augusta W. Jann

Country [2]	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	284,161	341,112	371,802	401,762	376,491	428,474
Guatemala	[4] 370	7,100	9,000	6,700	4,400	10,400
Honduras [5]	[6] 117	154	316	636	791	1,433
Mexico	202,012	198,486	250,638	249,715	246,441	296,961
United States [7]	611,799	681,189	666,001	547,430	473,471	514,671
Total	1,098,459	1,228,041	1,297,757	1,206,243	1,101,594	1,251,939
South America:						
Argentina	14,719	17,058	16,971	17,735	[8] 22,000	23,260
Bolivia (exports)	20,318	33,659	39,263	26,427	22,403	23,509
Chile	[4] 70	675	3,650	3,500	[8] 1,650	3,200
Peru	72,999	111,644	140,925	153,334	174,784	183,074
Total	108,106	163,036	200,809	200,996	[8] 220,840	233,043
Europe:						
Austria	2,476	3,698	5,496	4,826	5,140	5,787
Finland [8]	2,470	3,300	7,700	3,500	5,000	23,300
France	8,631	13,881	16,100	13,200	11,000	11,400
Germany, West	47,188	83,486	88,956	100,506	103,867	101,558
Greece	2,380	6,900	8,000	8,300	7,900	13,500
Ireland	[4] 450	1,387	1,892	1,819	1,680	[8] 1,650
Italy	70,961	111,039	124,466	111,929	118,792	131,891
Norway	6,300	6,029	6,160	5,661	5,917	7,193
Poland [8]	[9] 85,000	110,000	110,000	130,000	129,000	139,000
Spain	53,000	82,000	95,000	92,000	97,000	102,000
Sweden	40,016	42,238	51,987	49,706	64,407	64,816
U. S. S. R.[8 9]	126,000	182,000	226,000	279,000	303,000	330,000
United Kingdom	8	214	1,707	3,187	3,905	3,167
Yugoslavia	38,507	43,453	52,678	66,106	63,052	65,800
Total [2 8]	496,000	707,000	820,000	900,000	962,000	1,044,000
Asia:						
Burma	----	----	2,400	4,300	6,400	9,100
India	[4 8] 70	1,300	2,500	2,900	2,600	2,900
Iran [10]	----	13,200	5,500	6,200	5,800	[8] 5,500
Japan	39,261	71,011	96,418	106,507	120,504	119,486
Korea, Republic of	74	(11)	550	22		
Philippines	----	170	1,770	830	----	----
Thailand (Siam)	[6] 127	570	550	2,000	3,000	3,200
Turkey [8]	740	440	990	4,400	6,100	580
Total [2 8]	40,500	91,100	118,400	138,700	159,800	159,000
Africa:						
Algeria	6,817	10,886	12,337	21,120	29,700	34,200
Angola	----	390	50	110	----	----
Belgian Congo	56,032	97,780	109,071	138,661	94,015	74,700
Egypt	[12] 216	1,579	977	282	260	757
French Equatorial Africa	147	571	416	----	----	----
French Morocco	4,290	21,445	31,253	38,895	37,908	48,083
Nigeria	[12] 121	----	57	71	----	----
Rhodesia and Nyasaland, Federation of: Northern Rhodesia	[9] 23,759	40,616	41,140	43,353	38,672	38,070
South-West Africa	8,815	16,300	[7] 17,200	[7] 17,400	[7] 22,000	19,500
Tunisia	2,846	3,911	3,900	4,020	5,810	5,990
Total	103,043	193,478	216,401	263,912	228,365	221,300

See footnotes at end of table.

TABLE 30.—World mine production of zinc (content of ore),[1] by countries,[2] 1946–50 (average) and 1951–55, in short tons [3]—Continued

Country [2]	1946–50 (average)	1951	1952	1953	1954	1955
Oceania: Australia	206, 517	213, 706	220, 954	265, 481	282, 978	287, 352
World total (estimate) [2]	2, 050, 000	2, 600, 000	2, 870, 000	2, 980, 000	2, 960, 000	3, 200, 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, Rumania, China and North Korea 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. Data do not add to totals shown owing to rounding where estimated figures are included in the detail.
[4] Average for one year only, as 1950 was first year of commercial production.
[5] United States imports. [6] Average for 1948–50. [7] Recoverable. [8] Estimated.
[9] Smelter production. [10] Year ended March 21 of year following that stated.
[11] Data not available; estimate by senior author of chapter included in total. [12] Average for 1947–50.

World smelter production of zinc increased in 1955 for the 10th consecutive year and established an all time high of nearly 3 million tons compared with 2.7 million tons in 1954. Belgium and Australia were the only countries that did not exceed their 1954 slab-zinc output.

Tables 30 and 31 show the quantity of zinc mined and smelted throughout the world by individual countries. The United States, which consumed about 35 percent, of the total zinc used in the world in 1955, mined about 16 percent, and smelted approximately 32 percent of the total.

NORTH AMERICA

Canada.—Mine production of recoverable zinc in Canada rose from 376,500 tons in 1954 to 428,500 short tons in 1955, an alltime high. Smelter production of slab zinc from domestic and imported ores was about 257,000 tons, or 43,200 tons more than in 1954. Slab zinc was produced by Consolidated Mining & Smelting Co. of Canada, Ltd., at Trail, British Columbia, and Hudson Bay Mining & Smelting Co., Ltd., at Flin Flon, Manitoba.

The zinc industry of Canada [28] in 1955 exported 190,600 short tons of zinc in concentrate, of which 168,100 tons was shipped to the United States; and the remainder to the United Kingdom, Belgium, France, and Norway. Exports of refined zinc, mostly to the United States and the United Kingdom, totaled 213,800 tons. Domestic consumption of zinc was 58,500 tons. British Columbia produced 49 percent of Canada's mine output of zinc in 1955; Quebec, 24 percent; Saskatchewan, 12 percent; Newfoundland, 7 percent; Manitoba, 4 percent; and Yukon, Nova Scotia, and Ontario together, 4 percent.

The principal zinc-producing mine, the Sullivan mine of the Consolidated Mining & Smelting Co. of Canada, Ltd., at Kimberley, British Columbia, produced 2,836,600 tons [29] of zinc-lead-silver-gold ore, which was treated in its 11,000-ton concentrator at Kimberley. The mill also treated 52,000 tons of custom ore. The company also mined and milled 685,800 tons of ore from its H. B. zinc-lead mine

[28] Neelands, R. E., Zinc in Canada, 1955 (Preliminary): Canada Dept. of Mines and Tech. Surveys, Ottawa, No. 27, 10 pp.
[29] Consolidated Mining & Smelting Co. of Canada, Ltd., Annual Report, 50th Anniversary, for the year ending Dec. 31, 1955.

TABLE 31.—World smelter production of zinc by countries, 1946–50 (average) and 1951–55, in short tons [1] [2]

[Compiled by Augusta W. Jann]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America:						
Canada	194,187	218,578	222,200	250,961	213,810	257,006
Mexico	56,006	64,761	[3] 55,542	[3] 58,481	[3] 60,477	[3] 61,878
United States	795,354	881,633	904,479	916,105	802,425	963,504
Total	1,045,547	1,164,972	1,182,221	1,225,547	1,076,712	1,282,388
South America:						
Argentina	3,578	11,716	11,023	12,787	[4] 12,000	14,881
Peru	1,308	959	5,750	9,819	16,935	18,801
Total	4,886	12,675	16,773	22,606	[4] 29,000	33,682
Europe:						
Belgium [5]	158,765	221,439	205,910	213,217	234,481	232,840
Czechoslovakia	[4] 2,480	[4] 2,200	(6)	(6)	(6)	(6)
France	57,319	82,185	88,255	89,219	122,249	123,569
Germany, West	63,193	155,029	162,278	163,430	184,804	197,026
Italy	28,567	52,259	60,463	66,214	74,356	77,761
Netherlands	13,337	24,918	28,555	27,780	28,702	30,865
Norway	42,120	45,002	43,248	42,767	48,767	49,738
Poland [4]	85,000	125,000	132,000	152,000	157,000	172,000
Rumania	[4] 2,870	[4] 3,900	(6)	(6)	(6)	(6)
Spain	21,916	23,529	23,543	25,490	25,653	26,231
U. S. S. R. [4]	126,000	182,000	226,000	279,000	303,000	330,000
United Kingdom	76,200	78,100	76,984	81,433	90,989	91,108
Yugoslavia	8,178	14,576	15,943	16,038	15,040	15,176
Total [4]	686,000	1,010,000	1,071,000	1,165,000	1,293,000	1,355,000
Asia:						
China [4]	220	200	200	400	[5] 13,800	[5] 16,500
Japan	28,329	62,104	77,197	85,001	111,748	124,036
Total [4]	28,550	62,300	77,400	85,400	125,500	140,500
Africa:						
Belgian Congo				8,599	35,274	37,443
Rhodesia and Nyasaland, Federation of: Northern Rhodesia	23,759	25,301	25,636	28,370	29,736	31,248
Total	23,759	25,301	25,636	36,969	65,010	68,691
Australia	87,730	86,251	97,930	100,999	117,066	113,200
World total (estimate)	1,880,000	2,360,000	2,470,000	2,640,000	2,710,000	2,990,000

[1] 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 Mineral Industry Colonial Geological Surveys, London).
[2] This table incorporates a number of revisions of data published in previous zinc chapters. Data do not add to totals shown due to rounding where estimated figures are included in the detail.
[3] In addition other zinc-bearing materials totaling 3,746 tons in 1952; 30,288 in 1953; 18,545 in 1954; and 37,442 in 1955.
[4] Estimate.
[5] Includes production from reclaimed scrap.
[6] Data not available; estimate by senior author of chapter included in total.

near Salmo, Bluebell lead-zinc mine at Riondell, and Tulsequah zinc-lead-copper mines on the northwest coast.

Other British Columbia producers of zinc concentrate were Canadian Exploration, Ltd., near Salmo; Reeves Macdonald Mines, Ltd., near Nelway; Britannia Mining & Smelting Co., Ltd. (producing copper-zinc ore) on Howe Sound; Sheep Creek Gold Mines, Ltd., Lake Windermere district; Sunshine Lardeau Mines, Ltd., near Camborne; Violamac Mines, Ltd., near Sandon; Yale Lead & Zinc Mines, Ltd., Ainsworth; Silver Standard Mines, Ltd., near Hazelton; and Giant Mascot Mines, Ltd., near Spillimacheen.

At Flin Flon, Manitoba, the Hudson Bay Mining & Smelting Co., Ltd., ran its copper-zinc mine, 6,300-ton concentrator, and smelting-refining plant at a high level in 1955. The mine was developed to a vertical depth of 5,000 feet. Ore reserves at the end of the year were 16.5 million tons averaging 3.15 percent copper, 3.6 percent zinc, 0.068 ounce gold, and 0.143 ounce silver per ton. Additional zinc reserves included some 800,000 tons of zinc-plant residue, averaging 26.6 percent zinc. During the year, the company began production from 2 new properties—the North Star Mine, 12 miles east of Flin Flon; and the Schist Lake Mine, 3 miles northeast of Flin Flon. The company produced 67,400 tons of zinc from 1,620,600 tons of ore milled from its main Flin Flon and other nearby, wholly owned properties. In addition, 24,600 tons of direct smelting ore and 101,100 tons of zinc-plant residues were treated, and 22,300 tons of ore from the Don Jon Mines was milled.

In Ontario, Geco Mines, Ltd., began underground development of its copper-zinc deposits at Manitouwadge. Consolidated Sudbury Basin Mines, Ltd., continued exploration of zinc-lead-copper deposits northwest of Sudbury. Jardun Mines, Ltd., produced both zinc and lead concentrates from its mine 18 miles northeast of Sault Ste. Marie.

The leading Quebec producer of zinc concentrate continued to be Barvue Mines, Ltd., at its open-pit mine and 5,300-ton mill in Abitibi County. Other Quebec producers of zinc concentrate included East Sullivan Mines, Ltd., Normetal Mining Corp., Ltd., Quemont Mining Corp., Ltd., Waite Amulet Mines, Ltd., and Weedon Pyrite & Copper Corp., Ltd. (all treating copper-zinc ore); Ascot Metals Corp., Ltd., Golden Manitou Mines, Ltd. (treating zinc-lead-copper ore); and Anacon Lead Mines, Ltd., New Calumet Mines, Ltd., and West Macdonald Mines, Ltd. (zinc-lead and zinc ores).

In New Brunswick the Brunswick Mining & Smelting Corp., Ltd., exploration, development, and research, in connection with bringing its lead-zinc properties into production, cost about $1,575,000. The pilot mill began production in February 1955 and was shut down on June 1 because of unsatisfactory results; an extensive research program was begun with the assistance of Battelle Memorial Institute. Procedures were being developed, which will be tested in the pilot mill in 1956.[30] Heath Steel Mines, subsidiary of American Metals Co., Ltd., explored and developed its lead-zinc-copper-silver property at Little River, 30 miles from Newcastle, New Brunswick. Two shafts were sunk, a third deposit was being prepared for stripping, and a site was cleared constructing a mill. Prospecting and development were also carried on by the New Larder "U" Island Mines, Ltd., Kennco Explorations (Canada), Ltd. (subsidiary of Kennecott Copper Corp.), and Middle River Mining Co., Ltd. (subsidiary of Texas Gulf Sulphur Co.). Keymet Mines, Ltd., produced zinc and lead concentrates 15 miles north of Bathurst.

Newfoundland zinc output came from Buchans Mining Co., Ltd., properties at Buchans. Ore mined and treated in 1955 totaled 285,000 tons, yielding about 100,000 tons of lead, zinc, and copper concentrates. Output was reduced by a 5-week strike. The concentrate was shipped by rail to Botwood and from there by sea to European and United States markets. Ore reserves were estimated at 6 million tons.

[30] St. Joseph Lead Co., Ninety-Second Annual Report to the Stockholders, 1955.

In Yukon, United Keno Hill Mines, Ltd., 500-ton concentrator produced lead and zinc concentrates; Mackeno Mines, Ltd., carried out underground development and ran its 220-ton mill intermittently.

At Stirling, Cape Breton Island, Nova Scotia, Mindamar Metals Corp., Ltd., mined and produced zinc and bulk copper-lead concentrate.

Cuba.—Production of zinc concentrate began in Cuba in February 1955 with installation of a 50-ton copper-zinc flotation mill at the San Fernando mine, Las Villas Province, which had been idle many years. About 200 tons monthly of zinc concentrate, averaging 56–58 percent zinc, and a smaller tonnage of 25-percent copper concentrate were produced. The flotation mill at the "Los Cerros" copper mine in Las Villas Province also produced some zinc concentrate in 1955.

Greenland.—Nordic Mining Co., Ltd., worked on developing and equipping the Mestersvig lead-zinc mine in East Greenland. The mill and auxiliary facilities were installed underground in excavations in rock near the ore body. Annual output was expected to be about 11,000 short tons of lead concentrate and 8,800 tons of zinc concentrate when capacity is reached. The company concluded a 7-year contract with the shipping company of J. Lauritzen for transporting lead and zinc concentrates from Mestersvig, estimated at a total of 132,000 short tons, to various destinations in Europe and the United States.[31] Because of ice conditions, ships usually go into Mestersvig only 4 or 5 weeks a year, during the August-September season.

Guatemala.—The zinc- and lead-producing companies in Guatemala were Minerales Nacionales and Compania Minera de Guatemala, S. A. The total output of zinc (content of concentrate), was 10,400 short tons, the largest since 1952. The Compania Minera de Huehuetenango [32] installed a $1 million lead-zinc mill at its mine.

Mexico.—Zinc output from mines in Mexico increased 20 percent over 1954 to a record high of 297,000 short tons in 1955. The increase was attributed to a larger tonnage of ore mined from old lead and zinc properties and a more efficient zinc smelter recovery. Average zinc content of the ore mined also increased in comparison to lead.

A new law entitled, "Law of Taxes and Promotion of Mining,"[33] was published in the Diario Oficial on December 31, 1955, and became effective on January 1, 1956. Provisions of this law included reduced production taxes on certain types of metal-mining operations and increased surface taxes on mining claims. Certain stipulations affecting lead and zinc mining are given in the Lead chapter of this volume The 25-percent export tax ad valorem was not altered.

During the year collective labor contracts of most companies were revised to provide wage increases (estimated at 12 percent), in addition to various fringe benefits. Labor laws and regulations did not permit the mine and smelter companies to accomplish the labor-force reduction during the periods of weak market prices. They therefore hesitated to hire more men during periods of high prices.

American Smelting & Refining Co. properties producing zinc and lead in 1955 included the Charcas unit at Charcas, San Luis Potosi; Neustra Senora at Cosalá, Sinaloa; Parral, Santa Barbara, and Santa Eulalia units, Chihuahua; and Taxco, Guerrero. Mines leased or owned in part under American Smelting management were the Aurora-

[31] Metal Bulletin (London), No. 4078, Mar. 16, 1956, p. 17.
[32] Engineering and Mining Journal, vol. 156, No. 9, September 1955, p. 202.
[33] Bureau of Mines, Mineral Trade Notes: Special Suppl. 48, vol. 42, No. 1, January 1956.

Xichu unit, Guanajuato; Cia. Metalurgica Mexicana mines; and Montezuma Lead Co. mines at Santa Barbara and Polomas unit at Pichachoas in Chihuahua. Zinc fume was produced in the company slag-fuming plant at the Chihuahua lead smelter, and slab zinc was produced at the Rosita (Coahuila) zinc-retort smelter.

Zinc-producing subsidiaries and units of the American Metal Co., Ltd., were the Cia. Minera de Penoles, S. A., Avalos unit, Zacatecas (owned and leased lead-zinc-silver mines); Calabaza unit, Etzatlan, Jalisco (lead-zinc mines); and Topia unit, Topia, Durango (owned and leased silver-lead-zinc mines). The company zinc concentrate was shipped to the Blackwell smelter in Oklahoma, but the lead concentrate was smelted in the Cia. Metalurgica Penoles, S. A., lead smelter at Torreon, Coahuila. San Francisco Mines of Mexico, Ltd., (an American Metal Co. interest) at San Francisco del Oro, Chihuahua, was also a large producer of zinc and lead concentrates.

El Potosi Mining Co. (subsidiary of Howe Sound Co.) a producer of large quantities of lead and zinc concentrates, continued to work its El Potosi mine at Chihuahua and El Carmen at Batophilas, both in the State of Chihuahua.

Four mines of Fresnillo Co., Inc.,[34] were equipped with flotation mills having a daily capacity of 4,300 short tons of ore. On June 30, 1955, ore reserves were 3,977,800 tons assaying 3.5 percent lead, 4.5 percent zinc, 0.4 percent copper, 8.0 ounces of silver, and 0.4 dwt. of gold per ton. The Fresnillo mine delivered 576,100 short tons of ore to the mill during the fiscal year ended June 30, 1955. Ore milled at this plant, including that from other nearby mines, totaled 695,200 tons, yielding 50,900 tons of zinc concentrate, 36,400 tons of lead concentrate, 6,800 tons of copper concentrate, and 9,600 tons of iron-gold concentrate.

Minas de Iquala, S. A., subsidiary of Eagle-Picher Co., worked its zinc-lead-copper mine at Parral, Chihuahua. Mill schedules were geared to a run-of-mine ore output of 28,500 short tons per month.

The Zinc Nacional, S. A., Waelz plant at Monterrey, treated run-of-mine zinc carbonate and zinc oxide ores. The fume produced was shipped to the National Zinc Co. smelter at Bartlesville, Okla.

SOUTH AMERICA

Argentina.—The Aguilar mine of Compania Minera, Aguilar S. A. (subsidiary of St. Joseph Lead Co.) in the Province of Jujuy continued to be Argentina's only producer of large quantities of zinc and lead concentrates. Its output in 1955 [35] of 46,500 short tons of zinc concentrate and 30,700 tons of lead concentrate increased 16 and 23 percent, respectively, over 1954, largely because of utilizing new mining equipment, which began arriving late in 1954. Most zinc concentrate was shipped to Cia. Metalurgica Austral, S. A., Comodoro, Rivadavia, southern Argentina, for smelting in electrothermic furnaces. Working conditions and metallurgical results at Austral were much improved in 1955.

In San Juan Province development of the Mina Castano lead-zinc-silver mining property of National Lead Co., New York, progressed satisfactorily in 1955, according to the company annual report. The

[34] Metal Bulletin (London), No. 4046, Nov. 22, 1955, pp. 26–28.
[35] St. Joseph Lead Co. Ninety-Second Annual Report to the Stockholders, 1955.

new mill and other facilities were scheduled to be in use by mid-1956.

Bolivia.—Declining mineral production and inadequate investment and exploration characterized the Bolivian mining industry during 1954 and 1955. Neither the nationalized mines nor the medium and small privately owned mines have had adequate investment in recent years. Labor output has declined. Zinc production in 1955 (23,500 short tons), although 1,100 tons more than in 1954, was 15,800 tons less than in 1952.

In late 1955 a decision was made to invite bids from foreign firms to exploit the lead-zinc deposits at the nationalized Mathilde mine. A study to evaluate all factors and recommend measures to improve production was undertaken by the Ford, Bacon & Davis consulting firm (a United States company) with funds provided by the International Cooperation Administration at the request of the Bolivian Government.

Brazil.—Although no significant production of zinc was reported in Brazil in 1955, interest in the possibility of future large zinc-lead mining operations was aroused by a report of an important lead-zinc (and copper) discovery in western Minas Gerais, Municipality of Vasante (Paracatu).

Chile.—Most zinc concentrate produced in Chile in 1955 came from the mining and milling of Cia. Minera Aysen in the south of Chile. The only other reported zinc producer was Cia. Minera e Industrial "Bellavista", S. A., which produced zinc concentrate for its own use.

Peru.—Mine production of zinc in Peru increased in 1955 for the eighth year in succession; the mine ouptut (183,100 short tons or 5 percent more than in 1954) was more than 3 times that of 1947. Exports of zinc (mostly to the United States) totaled 161,500 short tons, of which 141,000 tons was contained in ore and concentrate and 20,500 tons was refined zinc.

Cerro de Pasco Corp., leading zinc producer in Peru, operated zinc-lead-copper-silver mines at Cerro de Pasco, Morococha, Casapalca, San Cristobal, and Yauricocha, witb mills at the first three mines and at Mahr; it also had smelting and refining works at La Oroya. The works at La Oroya include, besides the lead and copper smelters and refiners, an electrolytic zinc plant and a new Sterling-process electrothermic zinc plant. According to the annual report,[36] production of refined zinc was below expectations, due both to a lack of power in December and to a delay in the zinc-development program. Difficulties at the electrothermic zinc plant were expected to be overcome by modifications, which should be completed by the end of 1956. Meanwhile, the capacity of the electrolytic plant was being expanded to 90 short tons per day; construction work on the project was scheduled for completion in mid-1956. The combined plants, which complement each other technologically, were expected to attain full production in 1957 soon after the Paucartambo hydroelectric plant, under construction during the year, is completed. As a result of the increases in the zinc price, a somewhat larger proportion of low-grade zinc concentrate produced from the Cerro de Pasco zinc-lead ore body could be sold for export at a reasonable profit than in the previous 2

[36] Cerro de Pasco Corp., Annual Report, 1955

years. Nevertheless, there was a further increase in the corporation's stockpile of zinc concentrate during 1955.

Banco Minero del Peru 4 custom concentration mills continued active, and construction of the new 70-ton-per-day mill at Huarochiri, (officially opened, October 23, 1955)[37] was completed. The other four active mills were at La Virreyna, Province of Castrovirreyna; Haucho-colpa, Department of Huancavelica; Sacrachancha, near Morococha; and Hualgayoc, Department of Cajamarca. The total daily capacity of all the Banco Minero concentrators was 1,000 tons of ore.

Northern Peru Mining & Smelting Co. (American Smelting & Refining Co. subsidiary) continued to operate its Chilete silver-lead-zinc mine and 350-ton mill near Pacasmayo.

EUROPE

Austria.—Bleiberger Bergwerks Union, a nationalized mining company in the Province of Carinthia, was the only producer of primary zinc in Austria in 1955. The company lead-zinc properties at Bleiberg-Kreuth produced 194,600 short tons of ore, of which 56,400 tons was reclaimed from dumps. The flotation mill produced 11,800 tons of zinc concentrate, with 5,800 tons of metal content, and 7,300 tons of lead concentrate, with 5,300 tons of extractable metal content. In September 1955, the company new electroyltic zinc plant at Gailitz-Arnoldstein went into production. Its annual capacity was 11,000 to 12,000 tons of zinc, 99.99 percent pure. Output of electrolytic zinc in 1955 totaled 1,500 tons; an additional 1,000 tons of fire-refined zinc was produced at the plant from zinc scrap.

Belgium and France.—No zinc has been mined in Belgium since 1946, when the Vedrin mine closed. In France in 1955, output of zinc contained in concentrates from several zinc-lead mines was 11,400 short tons.

Belgian and French smelters together produced 353,900 short tons of slab zinc in 1955, compared with 357,800 short tons in 1954. The smelters produced from concentrate obtained in Belgian Congo, French Africa, Sweden, Australia, Spain, Peru, Canada, and other countries.

The leading producing company was the Societé Anonyme des Mines et Fonderies de Zinc de la Vieille-Montagne, with 4 smelters in Belgium (including 1 electrolytic plant) and 2 in France (1 electrolytic). Other smelting companies included the Cie. des Métaux d'Overpelt-Lommel et de Corphalie (2 active smelters), Soc. Anon. Métallurgique de Prayon, and Soc. Anon. de Rothem in Belgium and the Soc. Minière et Métallurgique de Penarroya and Cie. Royale Asturienne des Mines (2 smelters) in France.

Finland.—With a full year operation of the Outokumpu Co. new Vihanti mine in central Ostrobothinia, which began producing ore in November 1954, output of zinc concentrate in Finland rose from 10,100 short tons in 1954 to 44,900 tons in 1955. Of this total, the Vihanti mine contributed 39,200 tons (averaging 52.31 percent zinc) and the Metsämonttu mine, another Outokumpu property, produced 5,600 tons (averaging 49.1 percent zinc). The average assay of 193,200 tons of ore mined from the Vihanti was 11.27 percent zinc, 0.49 percent copper, and 0.63 percent lead. The concentrate was shipped outside the country for smelting.

[37] Engineering and Mining Journal, vol. 156, No. 12, December 1955, p. 166.

Germany, West.—Mines in West Germany produced 101,600 short tons of recoverable zinc in 1955, a 2-percent decrease from 1954. Output declined in midsummer but increased in the latter part of the year. Most of the mines are marginal producers at the lower prices prevailing during 1955. The major zinc- (and lead-) producing areas are the Harz Mountains and the Rhineland, but some mines in southern Germany produced both zinc and lead. The principal mines included the Erzbergwerk Rammlesberg and Erzbergwerk Grund[38] mines in the Harz area and the Auguste Viktoria, Ramsbeck, Maubacher Bleiberg, and Leuderich in the Rhineland.

Smelter production of zinc totaled 197,000 short tons against 184,800 tons in 1954. The 6 active smelters were all retort plants, 1 having the continuous smelting vertical retorts of the New Jersey Zinc Co. type. Imports of zinc ore increased almost 50 percent to 114,300 tons in 1955. The chief suppliers were Peru, Sweden, Italy, and Spain, in the order named. Imports of zinc metal and scrap totaled 75,200 tons compared with 62,900 tons in 1954. Exports increased from 15,500 tons in 1954 to 33,600 tons in 1955. Domestic consumption rose 6 percent to 253,500 tons.

Italy.—Smelter output of zinc in Italy increased 5 percent over 1954 to 77,800 short tons in 1955, and mine production of zinc rose 11 percent to 131,900 tons. Most of the mine output came from the island of Sardinia. The larger producers on Sardinia were the mines of Montevecchio Societa italiana del piombo e dello zinco and Societa di Monteponi. The Sapez Co. of Nossa (part of the Italian Metal Ores Agency, AMMI, a Government-owned corporation) mines produced chiefly calamine ores in Sardinia and at Bergamo on the mainland. Slab zinc was produced by electrolytic plants at Monteponi in Sardinia and at Crotone, Nossa (Bergamo), and Porto Marghera (Venice) on the mainland; and by a retort smelter at Vado Ligure. The capacities and operators of the plants were given in the 1954 Minerals Yearbook Zinc chapter.

Norway.—In Norway the Mofjelletsand and Bleikvassli mines produced 7,200 short tons of zinc (contained in concentrate) in 1955. The electrolytic zinc plant of Det Norske Zinkkompani, A. S., near Odda produced 49,700 short tons of slab zinc.

Poland.—Zinc output in Poland has increased in recent years. According to European press reports, a new Polish electrolytic zinc refinery at Boleslowie began producing at end of May 1955. When fully productive, the plant is expected to double Polish electrolytic zinc output.

Spain.—By far the leading producer of zinc concentrate and the only producer of slab zinc in Spain in 1955 was the Real Compania Asturiana de Minas at its Reocin and Arditurri mines near the north coast and Arnao zinc-retort smelter near Aviles. La Florida mine was discontinued during the year, owing to high production cost. The Penarroya zinc smelter near Cordoba in southern Spain remained idle. Most of Spain's output of zinc concentrate was exported to Belgium, France, Norway, and Holland. Production of zinc metal was 26,200 short tons, an increase of 600 tons over 1954. Total mine production of zinc was 102,000 short tons compared with 97,000 tons

[38] Mining Magazine (London), A Lead-Zinc Concentrator in the Harz Mountains: Vol. 93 No. 5, November 1955, pp. 273, 275–278.

in 1954. The petition of the Minera Celdran, S. A., zinc mines near Cartagena, Province of Murcia, southern Spain, to the Ministry of Industry for permission to build a zinc smelter was approved on January 25, 1956.

Sweden.—Production of zinc concentrate in Sweden was 115,300 short tons in 1955. Swedish concentrate was shipped to other countries for smelting; the quantity exported in 1955 was 115,900 tons, compared with 121,700 tons in 1954. Producing companies in recent years were Boliden Mining Co., the Government-owned AB Statsgruvor, Falu Kopparverk, and AB Zinkgrubor.

United Kingdom.—Zinc concentrate produced from ores mined in the United Kingdom in 1955 contained 3,200 short tons of zinc. The output came from small lead-zinc mines in Northern England and Wales. Smelters produced a total of 91,100 tons of slab zinc (almost the same as in 1954) from concentrate imported from Australia. Output of zinc oxide was 41,000 tons. Imports of metal, mostly from Canada, United States, Belgium, and Australia, totaled 179,600 tons. Consumption of slab zinc was 281,600 tons (including secondary), a 5-percent increase over 1954. Exports and reexports of slab zinc totaled about 1,700 tons.

U. S. S. R.—Official data on zinc production in the U. S. S. R. are not available for 1955, but an estimate is given in table 31. The United Kingdom marketed some high-grade zinc from the U. S. S. R. during 1955.

Yugoslavia.—Output of zinc contained in concentrate produced in Yugoslavia increased 4 percent over 1954 to 65,800 short tons in 1955. The quantity of ore mined was 1,818,800 tons. Concentrate smelted in Yugoslavia yielded 15,200 tons of slab zinc, or nearly the same as in 1954. Exports of zinc concentrate totaled 49,100 tons. The Trepca group of lead-zinc mines in Serbia (leading lead producer in Europe) was the leading Yugoslav zinc producer. The ore produced was transported 18 kilometers by aerial tramway to the flotation mill at Zvecan for concentration. The lead concentrate was smelted at Zvecan, but the zinc concentrate was smelted elsewhere. Other lead-zinc mines and flotation mills in Serbia, Macedonia, Slovenia, and other places produced a substantial tonnage of zinc concentrate.

The zinc-retort smelter at Celje, Slovenia, has a rated annual capacity of 19,800 tons of slab zinc. Work progressed during the year on the new 13,200-ton electrolytic zinc plant under construction at Sabac, Serbia.

ASIA

Burma.—The Burmese output of zinc was from the Bawdwin silver-lead-zinc mine of Burma Corp., Ltd., in the Shan States of northern Burma. During the year ended June 30, 1955, the mine produced 112,400 short tons of ore, which was treated in the company mill. The mill and smelting and refining works are at Namtu, 13 miles from the mine. The ore yielded 14,300 tons of zinc concentrate and 12,700 tons of refined lead, 1,036,800 fine ounces of silver, 300 tons of copper matte, 600 tons of nickel speiss, and 400 tons of antimonial lead. Immediately before World War II the mine produced about 529,100 tons of ore a year. The ore reserve was estimated in 1951 to be 3,100,000 tons containing 12.5 percent zinc, 20 percent lead, and 15.5 ounces of silver per ton.

India.—Metal Corp. of India, Ltd., worked the lead and zinc mines at Zawar in Rajasthan and operated a lead smelter at Tundoo. The zinc concentrate containing 2,900 tons of zinc was shipped to Japan for smelting.

Japan.—Although mine production of zinc in Japan declined slightly in 1955, smelter output of slab zinc rose to a record high of 124,036 short tons, compared with the previous high of 111,700 tons in 1954. Mine production (zinc content of ore) was 119,500 tons, compared with 120,500 tons in 1954. Imports of zinc concentrate, mostly from India and Australia, and slab zinc totaled 12,000 and 5,800 short tons, respectively. The principal zinc producers, active mines and smelters, were the Mitsui Metal Mining Co., Ltd., Nippon Mining Co., Ltd., and Mitsubishi Metal Mining Co. Dowa Mining Co., Ltd., an iron- and copper-ore producer, also produced electrolytic zinc. The zinc ores contain some lead and were the source of most of Japan's mine output of lead. Electrolytic zinc was produced by 8 plants and distilled zinc by 2 plants.

AFRICA

Mine production of zinc in Africa decreased 3 percent from 1954 to 221,300 short tons in 1955. A substantial decline in Belgian Congo output more than offset substantial increases in Algeria and French Morocco. Belgian Congo contributed 34 percent of the African total; French Morocco, 22 percent; Northern Rhodesia, 17 percent; Algeria, 15 percent; South-West Africa, 9 percent; and Tunisia (plus a small tonnage from Egypt), 3 percent.

Belgian Congo.—Congo zinc production continued to come solely from the rich copper-zinc ores of the Prince Leopold mine of Union minière du Haut Katanga at Kipushi. According to published data,[39] the Kipushi concentrator treated 1,198,000 short tons of ore from the Prince Leopold mine in 1955, producing 68,700 tons of concentrate averaging 22.71 percent copper and 257,100 tons averaging 29.02 percent copper; and 125,800 tons of zinc concentrate averaging 59.59 percent zinc. A large part of the zinc concentrate was roasted in the Sogechim works at Jadotville to produce sulfuric acid. Some of the calcined concentrate was sold to the METALKAT electrolytic zinc plant at Kolwezi and some was shipped to Belgium for smelting. The METALKAT plant, at near capacity, produced 37,500 tons of exportable ingots, compared with 35,300 tons the previous year. Exports of zinc concentrate, however, dropped from 132,900 tons to 113,600.

French Africa.—Mines in French Africa produced 40 percent of Africa mine output of zinc in 1955 compared with 32 percent in 1954.

French Morocco output of zinc concentrate was 86,000 short tons (metal content, 47,700 tons) in 1955, compared with 69,300 tons in 1954. Stocks at the end of 1955 were 12,100 tons. Exports of zinc concentrate (according to customs statistics) were 89,900 tons to France, 5,100 tons to Netherlands, 2,400 tons to West Germany, 1,700 tons to Belgium-Luxembourg, and 11 tons to Algeria. The Bou Beker mines group of the Société des mines de Zellidja continued to be the leading Moroccan producer of zinc (and lead also). The

[39] Metal Bulletin (London), No. 4108, July 6, 1956, p. 14.

group is in eastern Morocco 25 miles south of Oudjda on the Algerian border. The Touissit properties of the Compagnie Royale Asturienne des Mines just south of the Bou Beker ranked second. About seven other mines contributed to the output of zinc concentrate.

Nearby but across the border in Algeria, production of zinc also increased. The Société Algerienne du Zinc (Algerian branch of Zellidja) continued to be an important producer; the ore was concentrated in a 1,000-ton-capacity gravity concentrator at the Bou Beker mine on the Moroccan side of the border. Other mines in Algeria produced substantial quantities of zinc ore. The concentrate produced was shipped to plants in Europe for smelting.

The El-Akhouat and Sakiet-Sidi-Yousseff mines in Tunisia produced 10,800 short tons of zinc sulfide concentrate containing 6,000 tons of zinc. The mines are said to be high-cost, requiring a zinc price higher than that prevailing in 1955 for production expansion.

Rhodesia and Nyasaland, Federation of.—Rhodesia Broken Hill Development Co., Ltd., in northern Rhodesia was the only producer of zinc in the Federation. Mining activity at Broken Hill included the zinc-lead mine and mill, lead smelter, and electrolytic zinc plant. Both oxide and sulfide ores were mined. The output of zinc and lead in 1955 was the largest in the history of the company. Slab-zinc production, at 31,200 short tons was 1,500 tons more than in 1954, and refined lead at 18,000 tons, was 1,100 tons more.

South-West Africa.—Tsumeb Corp., Ltd., controlled by Newmont Mining Corp. and American Metal Co., Ltd., worked its large lead-copper-zinc mine and flotation mill at Tsumeb. All the output was in concentrate, which was exported to Belgium and the United States for smelting. The concentrates produced comprised 136,904 tons of lead-copper concentrate and 42,800 tons of zinc concentrate. Ore milled totaled 595,000 tons. Total metals contained in concentrate exported in 1955 were: Zinc, 23,200 short tons; lead, 83,700 short tons; copper, 23,600 short tons; cadmium, 700 tons; germanium, 5 tons; and silver, 1,279,200 ounces.

OCEANIA

Australia.—Australian mine output of zinc, at 287,400 short tons in 1955, was larger than in any previous year. Although the production increase over 1954 was less than 2 percent, larger increases in the 2 preceding years brought about a total gain of 30 percent in 1955 over 1952. Costs of production rose as a result of general increases in wages and salaries. Technological improvements, particularly in ore treatment, were an important factor in maintaining efficiency. Production of refined zinc was 113,200 tons, slightly less than in 1954 because of reduced power supply at the Risdon electrolytic plant in Tasmania.

The principal producing mining districts were Broken Hill and Captain's Flat in New South Wales, Cloncurry (Mount Isa field) in Queensland, and Read-Rosebery in Tasmania. The Broken Hill district with 4 large zinc-lead-silver mines and mills, produced more than two-thirds of Australia's total mine output of zinc. The New Broken Hill Consolidated, Ltd., mined 595,200 short tons of ore in

1955,[40] averaging 8.9 percent lead, 13.8 percent zinc, and 2 ounces of silver per ton. Of the total ore treated, 383,600 tons was handled in the company-owned mill, and 187,564 tons was treated in the Zinc Corp., Ltd., mill. Ore reserve at the end of 1955 was 3 million tons against 2.8 million tons in 1954. Zinc Corp., Ltd., mined 731,400 tons of ore [41] yielding 93,500 tons of lead concentrate, 131,000 tons of zinc concentrate, and 1,833,000 ounces of silver.

Broken Hill South, Ltd., (Broken Hill south and Barrier Central properties) milled 435,300 short tons of crude ore yielding 72,100 tons of zinc concentrate and 59,400 tons of lead concentrate (carrying 39 ounces of silver to the ton) during the fiscal year ended June 30, 1955, according to the company annual report. North Broken Hill, Ltd., was also a large producer of zinc, lead, and silver.

In the Captain's Flat district, Lake George Mines (Pty.), Ltd., resumed its zinc-lead-copper mining on February 1 after more than a 7-month shutdown caused by a labor dispute. As all but 5 days of the shutdown occurred in the company fiscal year ended June 30, 1955, output of ore in that fiscal year was only 61,400 tons, compared with 196,300 tons in the preceding fiscal year. Ore milled in the 1955 fiscal year averaged 10.4 percent zinc, 6.02 percent lead, and 0.64 percent copper.[42]

In North Queensland, Mount Isa Mines, Ltd. (52-percent-owned by American Smelting & Refining Co.), continued mining its copper-lead-zinc-silver group, 2,000-ton concentration mill, and copper and lead smelters at Mount Isa. Output of metals during the fiscal year ended June 30, 1955,[43] aggregated 3,648,000 ounces of silver, 47,700 tons of lead, 20,900 tons of zinc, and 25,000 tons of copper, which were extracted from a total of 1,393,500 tons of ores treated.

In the Read-Rosebery district, Tasmania, mines of Electrolytic Zinc Co. of Australasia, Ltd., produced 203,100 short tons of ore in the fiscal year ended June 30, 1955, compared with 212,100 tons in the preceding fiscal year, according to the company annual report (No. 35). The ore yielded 58,200 tons of zinc concentrate, 9,900 tons of lead concentrate, and 7,500 tons of copper concentrate. The zinc concentrate was shipped to the company Risdon electrolytic-zinc plant, and the lead and copper concentrates were exported.

The Risdon zinc plant ran continuously throughout the fiscal year but not at full capacity at all times owing to restriction of electric power supply. Production of slab zinc was 112,600 short tons, compared with 111,100 tons in the fiscal year 1953–54. Production of cadmium was 200 tons. Sales of zinc were 68,500 tons to Australian consumers and 37,700 tons to consumers in India, United Kingdom, United States, and New Zealand. Construction of the third flash roaster and much of the ancillary equipment, including that for treatment of gases and handling of roasted products, was completed. This plant was brought into schedule early in 1955. Construction of a fourth flash roaster was begun just before the close of the year. Arrangements were made during the year for the long-term purchase of zinc concentrate from North Broken Hill, Ltd.; Broken Hill South, Ltd., Zinc Corp., Ltd., and New Broken Hill Consolidated, Ltd.

[40] Metal Bulletin (London), No. 4100, June 8, 1956, p. 21.
[41] Mining World, vol. 18, No. 3, March 1956, p. 73.
[42] Metal Bulletin (London), No 4059, Jan. 10, 1956, p. 20.
[43] American Smelting & Refining Co., Fifty-Seventh Annual Report, for the Year Ended December 31, 1955.

Zirconium and Hafnium

By Kenneth B. Higbie[1]

ZIRCONIUM and hafnium are closely related chemically; zirconium minerals usually contain a small percentage of hafnium. Their separation is relatively difficult and expensive but fortunately is not necessary for many uses. Private enterprise accepted complete responsibility for zirconium-metal production during 1955. Carborundum Metals Co., Inc., with facilities at Akron, N. Y., operated at capacity and exceeded its Atomic Energy Commission (AEC) contract commitment for the metal. Excess zirconium metal was available for increasing civilian applications. Once the sole producer of commercial and reactor-grade metal, the Bureau of Mines zirconium production plant in its Northwest Electrodevelopment Laboratory, Albany, Oreg., shut down in May after the AEC determined that zirconium stocks and current industry production could temporarily supply its needs. Some of the Bureau's production facilities were converted to research and the rest put in standby condition for resumption of zirconium production within 60 days, if necessary.

Hafnium production also increased in 1955 as a result of its recovery as a byproduct from the processing of hafnium-free zirconium.

Zirconium metal was an expensive laboratory curiosity until 1945, when development work on the Kroll magnesium-reduction process was begun by the Bureau of Mines at its Northwest Electrodevelopment Experiment Station, Albany, Oreg. Because of promising preliminary results, in February 1947 a pilot plant with a weekly capacity of 60 pounds of zirconium sponge began operating. This plant produced about 4,500 pounds of zirconium sponge, 2,700 pounds of which was melted and fabricated into sheet metal. Based upon information obtained from this plant, production facilities were expanded rapidly in cooperation with the AEC and the Navy Bureau of Ships. A pilot plant having a capacity of 500 pounds a week began producing in June 1949 and a larger plant in May 1950. The latter plant was enlarged in January 1951 and was again expanded in October 1951 to a final rated capacity of 275,000 pounds of clean zirconium sponge annually.

About 6,000 pounds of hafnium-sponge metal was also recovered annually as a byproduct of zirconium production.

Meanwhile in 1949 scientists at the Y–12 plant of Carbide & Carbon Chemicals Corp., at Oak Ridge, Tenn., had developed a solvent

[1] Commodity specialist.

extraction process for removing hafnium from zirconium, which could be expanded economically to a large-scale operation. With the hafnium removed, zirconium metal could be used as a structural material within atomic reactors, then in the planning stage. In April 1951 the Bureau of Mines Northwest Electrodevelopment Laboratories at Albany, Oreg., began construction of a plant to separate these two metals on a production scale; in January 1952 commercial production of high-purity zirconium metal became available for defense uses.

In the construction of nuclear reactors, the use of low-neutron cross-section materials improved neutron economy and utilized effectively the available supply of fertile and fissionable nuclear-fuel material. Pure zirconium metal has a low neutron-absorption cross section. Of the metallic elements with melting points above 500° C., only beryllium and magnesium have lower neutron-absorption cross sections; that of aluminum is nearly the same. Retention of strength at higher temperatures, coupled with excellent corrosion resistance and relative low cost, makes zirconium a desirable metal for cladding and as a structural material in nuclear powerplants.

In 1955 atomic applications of zirconium completely overshadowed its other uses and became the impetus of the new industry. Future expansion for these purposes was indicated late in the year when the AEC announced tentative plans to solicit proposals from private industry for delivery of 2 million pounds of zirconium over a 5-year period or 1.2 million pounds over a 3-year period. This quantity, in addition to 200,000 pounds already obligated annually, was to supply only Government requirements. Zirconium for privately financed nuclear powerplants and other industrial uses was not to be furnished by the Commission.

The Navy's atomic submarine *Nautilus* employed large quantities of zirconium metal within its reactor. The first full-scale electric power generating plant utilizing atomic energy, at Shippingport, Pa., will derive its power from a reactor containing zirconium-clad plates of uranium highly enriched with U^{235} isotope surrounded by a 12-ton blanket of natural uranium (U^{238}) in zirconium-alloy tubing. High-purity hafnium metal will be employed as control rods within the reactor.

The market for commercial-grade zirconium metal, which contains about 2 percent hafnium, is significant. Metal output and product sales increased in 1955. Chemical equipment requiring fabrication of corrosion-resistant metal, vacuum tubes, electrolytic condensers, rectifiers, and various metal alloys all required increased quantities of zirconium.

A comprehensive picture of the zirconium-metal industry in 1955 was presented at the first technical meeting of the Atomic Industrial Forum, Inc., November 17–18, 1955.[2]

Zircon, principal mineral source of zirconium and zirconium compounds, was employed extensively in foundry, refractory, ceramic, and porcelain industries; metal production requires only a small fraction of the total consumed in the United States.

---

[2] Atomic Industrial Forum, Inc., Zirconium Technology and Economics: New York 16, N. Y., 1955, 113 pp.

DOMESTIC PRODUCTION

Mine Production.—Domestic mine production of zircon increased from 16,300 short tons, valued at $745,300 in 1954, to 28,110 short tons, valued at $1,425,641, an increase of 72 percent in quantity and 91 percent in value. All marketed zircon of domestic origin was produced in Florida as a coproduct of titanium-mineral mining by the following companies: Florida Ore Processing Co., Palm Bay mine, Brevard County; Humphreys Gold Corp., Trail Ridge mine of E. I. du Pont de Nemours & Co., Clay County; and Humphreys Gold Corp., Jacksonville mine of National Lead Co., Duval County. Zircon derived from processing Idaho placer deposits was not marketed because of unfavorable freight rates for shipment to eastern markets. The quantity of zircon produced in Idaho is not included in domestic production figures.

Refinery Production.—Two grades of zirconium metal were produced in 1955. Reactor-grade metal containing less than 0.02 percent hafnium was produced by Carborundum Metals Co., Inc., Akron, N. Y., and by the Bureau of Mines, Albany, Oreg. The AEC was the principal contracting agency for this type of metal. Commercial-grade metal containing approximately 2 percent hafnium was produced by Carborundum Metals Co., Inc., Akron, N. Y., and Zirconium Metals Corp. of America, a subsidiary of National Lead Co., Niagara Falls, N. Y.

Production of zirconium metal sponge decreased 23 percent under 1954 figures. About 325,000 pounds of reactor-grade metal and 50,000 pounds of commercial-grade or high-hafnium metal were produced. Production of hafnium-sponge metal exceeded 7,500 pounds, all for consumption by the AEC.

In May 1955 the Bureau of Mines plant at Albany, Oreg., stopped its zirconium output for the AEC in line with the Government policy of ceasing commercial-scale production when private industries are prepared to supply the requirements. Carborundum Metals Co., Inc., recipient of an AEC contract for delivery of 200,000 pounds of zirconium and 4,000 pounds of hafnium per year, became the sole producer of reactor-grade metal for the remainder of the year. Late in 1955 Carborundum Metals Co., Inc., announced plans for expanding its zirconium-metal production facilities at Akron, N. Y., to a capacity of 325,000 pounds per year by February 1, 1956.

As the year ended, AEC planned to solicit proposals for delivering 2 million pounds of reactor-grade zirconium metal over a 5-year period or 1.2 million pounds over a 3-year period. The proposals also covered delivery of as much hafnium metal as can be derived from the processed zirconium. Any process meeting specifications for the end products was considered.

Keeping pace with the expanding metal-production industry, Allegheny-Ludlum Steel Corp. announced that zirconium melting capacity had increased from 17,000 pounds to 25,000 pounds per month. Firth Sterling, Inc., also was melting zirconium sponge.

Processors of zircon and manufacturers of zirconium and hafnium products were:

Producer and plant location	*Products*
Allegheny-Ludlum Steel Corp., Watervliet, N. Y., and West Leechburg, Pa.	Zirconium ingots and shapes; melting and rolling mills.
Bureau of Mines, Northwest Electrodevelopment Experiment Station, Albany, Oreg.	Hafnium-free zirconium sponge, zirconium-alloy ingots, and hafnium sponge.
Bridgeport Brass Co., Bridgeport 2, Conn	Zirconium fabricated shapes.
Brooks & Perkins, Inc., Detroit, Mich	Do.
Carborundum Metals Co., Inc., Akron, N. Y	Hafnium-free zirconium sponge and zirconium compounds.
Chase Brass & Copper Co., Waterbury, Conn	Zirconium fabricated shapes.
Ceramic Color & Chemical Mfg. Co., New Brighton, Pa.	Zirconium porcelains, enamels, refractories, glass, pottery, and compounds.
Corhart Refractories Co., Louisville, Ky	Refractories.
DeRewal International Rare Metals Co., Philadelphia 5, Pa.	High-purity zirconium-metal powder, oxide, and compounds; hafnium-metal powder, oxide and compounds.
Electro Metallurgical Division, Union Carbide & Carbon Corp., New York 17, N. Y. (Plants at Niagara Falls, N. Y., Sheffield, Ala., and Alloy, W. Va.)	Zirconium alloys and briquets.
Firth Sterling, Inc., 3113 Forbes St., Pittsburgh 30, Pa.	Zirconium ingots and shapes; melting and rolling mills.
Foote Mineral Co., Philadelphia, Pa	Iodide-process zirconium crystal bar, hafnium crystal bar, and zirconium-metal shapes.
Foundry Services, Inc., 2000 Bruck Street, Columbus 7, Ohio.	Foundry facings.
Kawecki Chemical Co., New York 17, N. Y	Zirconium fluorides.
Massillon Refractories Co., Massillon, Ohio	Refractories.
Metal & Thermite Corp., New York 17, N. Y	Zirconium compounds for pottery industry.
Metal Hydrides, Inc., Beverly, Mass	Zirconium-metal powder, zirconium hydride, and zirconium alloys.
Norton Co., Worcester 6, Mass	Fused, stabilized zirconia refractories and granular zirconia.
Orefraction, Inc., Pittsburgh, Pa	Granular and milled zirconium silicate and zirconium porcelains, enamels, refractories, glass, and pottery.
Pacific Graphite Co., Inc., 40th and Linden, Oakland, Calif.	Foundry facings.
Rohm & Haas Co., Philadelphia 5, Pa	Zirconium sulfate solution (tanning agent).
Shieldalloy Corp., New York 17, N. Y	Milled and granular zircon.
Simonds Saw & Steel Co., Lockport, N. Y	Zirconium fabricated shapes.
Stauffer Chemical Co., New York 17, N. Y	Zirconium tetrachloride (custom chlorination).
Superior Tube Co., Morristown, Pa	Zirconium tubing.
Chas. Taylor & Sons (subsidiary of National Lead Co.), Cincinnati, Ohio.	Refractories.
Thompson Products, Inc., Cleveland, Ohio	Zircon abrasives.
Titanium Alloy Mfg. Division of National Lead Co., New York 6, N. Y.	Stabilized zirconia refractories and ground zircon.
Titanium Zirconium Co., Inc., Flemington, N. J.	Zirconium salts and compounds.
Westinghouse Electric Corp., Pittsburgh, Pa	Zirconium crystal bars and metal shapes.
Zirconium Corp. of America, Solon, Ohio	Stabilized zirconia and zirconium compounds.

Producer and plant location	*Products*
Zirconium Metals Corp. of America (subsidiary of National Lead Co.), New York 6, N. Y.	Ductile zirconium and zirconium compounds.

CONSUMPTION AND USES

Zirconium-minerals consumption in the United States, estimated at 58,000 short tons, increased about 38 percent over 1954 estimated consumption. Information furnished by the principal dealers and consumers of zircon indicated that the distribution for 1955, by uses, was as follows: Foundry facings and foundry sand, 37 percent; refractories, 22 percent; pottery, porcelains, enamels, and glazes, 16 percent; metals and alloys, 16 percent; abrasives, 6 percent; and miscellaneous, 3 percent.

The use of zircon in foundry sand and facings increased. Zircon flour, as the basis of a mold, core paint, or wash, gives remarkable results in the stripping and finishing of all types of steel, iron, brass, bronze, aluminum, magnesium, etc., castings requiring an exceptionally smooth finish. By replacing silica paint in foundry applications, the possibilities of silicosis were greatly reduced.

Zirconia, because of its high melting point (approximately 2,750° C.), chemical stability, hardness, low thermal conductivity, and inertness to attack by many metals, is an ideal material for many refractory uses. It will withstand temperatures up to 2,600° C. and has a better insulating quality than alumina and magnesia.[3]

Use of zircon and/or zirconia products as opacifying compounds for vitreous enamels and ceramic glazes increased steadily. A harder, more elastic, heat-corrosion resistant, shock-resistant, and color-stabilized surface results when varying amounts are employed in the manufacturing processes.

Zirconium citrate was investigated as an aid in removing plutonium contamination from the blood streams of animals. Some chemical and physical properties of zirconium metal and its alloys lend themselves to uses in surgery and orthopedics. Zirconium hemostatic brain clips, cranial plates, sutures, intramedullary pins, and bone screws were tested. The resistance of zirconium to body-tissue reaction proved to be equal to or better than the metals used now.[4] Zirconium boride can withstand temperatures up to 6,000° F., and may find use as a structural material in rocket combustion chambers.

Zirconium metal has important applications in certain types of nuclear-power reactors. The advantages of this metal in nuclear-power applications are (1) low thermal-neutron capture cross section (0.18 Barns), (2) strength at moderately high temperature, (3) outstanding corrosion resistance to heat-transfer mediums such as water, heavy water, or fused sodium at temperatures exceeding 500° F., and at water pressures as high as 2,000 p. s. i. The thermal-neutron absorption cross section of hafnium is 105 Barns, making necessary as complete removal as possible of the hafnium content, when zirconium metal is used for reactor applications. Probably the most widely known application of the metal was as structural or cladding

[3] Steel, vol. 136, No. 8, Feb. 21, 1955, p. 73.
[4] Schrenk, H. H., Industrial Hygiene: Ind. Eng. Chem., vol. 46, No. 12, December 1954, p. 99A.

material in the atomic submarine U. S. S. *Nautilus*. The first full-scale powerplant for electricity, under construction at Shippingport, Pa., was to contain uranium fuel elements clad with a zirconium alloy. The reactor was to employ hafnium metal as control rods to dampen the rate of the nuclear reaction. Zirconium was also employed as structural material in the Sodium Graphite Reactor.[5]

Added to iron and steel, zirconium metal acts as a deoxidizer, and, like titanium, stabilizes carbon, nitrogen, and sulfur in these alloys. The addition of zirconium to steel results in improved yield strengths, impact resistance, and resistance to underbead cracking in welds, machinability, and hardenability and prevents aging and blue brittleness.

The zirconium-metal-powder properties of relatively low ignition point, rapid burning, and high heat of combustion made it useful in ammunition-priming compounds, electric blasting caps, Very signals, airplane landing flares, and movie flares.

Zirconium was employed as a "getter" in radio vacuum tubes, absorbing any gases liberated from the walls of the tube or leaking into the tube, thus increasing the life and efficiency of the tube.

Magnesium-base alloys containing zirconium, thorium, and rare-earth elements were finding increased high-temperature applications in jet engines. Zirconium refines the grain size and improves the physical properties.[6]

STOCKS

Industry stocks of zircon and other zirconium concentrates containing more than 65 percent ZrO_2 totaled about 8,800 short tons at the close of 1955, a decline of about 8 percent from 1954 year-end stocks. Nearly 1,500 tons of baddeleyite (impure zirconium dioxide) was included in 1955 year-end stocks.

Zircon and baddeleyite, held in the National Stockpile, were included in Group II materials, acquired principally through transfer of Government-owned surpluses pursuant to Section 6 (a) of Public Law 520, 79th Congress. None was procured in 1955.

PRICES

E&MJ Metal and Mineral Markets quoted zircon concentrate (65 percent ZrO_2), c. i. f. Atlantic ports, at $48–$49 per long ton throughout 1955. Domestic zircon prices were largely nominal, and individual transactions and contracts were negotiated. No quotations were published for baddeleyite ore and concentrate. The market was small, and prices depended upon individual contracts. The price for one transaction was reported at approximately $129 per short ton for material containing a minimum of 70 percent ZrO_2. All of the baddeleyite was imported from Brazil.

Zirconium-metal powder was quoted in E&MJ at $7 for 1 week in January only. The quotation was changed to $10 per pound of metal sponge and remained at that price throughout the year.

---

[5] Siegel, S., A Closeup Look at North American's Nuclear Reactor: Western Ind., May 1955, pp. 27-29.
[6] Bohn, Stewart A., The History of the Magnesium, Zirconium, Rare Earth, Thorium Alloys in the Foundries of the United States: Metallurgia, vol. 52, No. 310, August 1955, pp. 75-78.

Zirconium alloy, 12–15 percent Zr and 39–43 percent Si, bulk, carload lots, was quoted at 8¢ per pound through September 15, when the price increased to 8½¢ per pound and remained constant thereafter. Alloy containing 35–40 percent Zr and 47–52 percent Si was quoted at 20.25¢ per pound to September 15 and 21.25¢ per pound to the end of the year.

During June Carborundum Metals Co., Inc., Akron, N. Y., dropped the price of zirconium metal for nuclear reactors and for the chemical industry. Commercial-grade zirconium metal (high-hafnium) decreased from $22 per pound to $14.40 per pound in ingots of 500 pounds and over. Reactor-grade sponge (low-hafnium content) decreased from $22 to $14 per pound, and low-hafnium ingot material was priced at $23.07 per pound in 500-pound quantities, as compared with the previous price of $33 per pound. Price reductions were attributed to improved production, greater demand, and larger volume.

Commercial quotations were as follows:

Zirconium Metals Corp. of America (subsidiary of National Lead Co.), late 1955

Zirconium-metal sponge and briquets, per pound	$10.00
Zirconium hot-rolled plate and bars, per pound, base price	18.40
Zirconium cold-rolled strip, per pound, base price	32.00
Zirconium cold-drawn wire 0.060–0.375 inch in diameter, per pound	42.50–32.50

Foote Mineral Co., December 31, 1955

Iodide-process ductile zirconium metal:	
Zirconium crystal bar, lots over 100 pounds, per pound	$70.00
Zirconium wire annealed, 0.050–0.005 inch in diameter, per kilogram	450.00–600.00
Zirconium sheet, 0.010–0.002 inch thick, per kilogram	425.00–750.00
Zirconium powder, pyrotechnic grade, 100-pound lots or over, per pound	10.50

Electro Metallurgical Division of Union Carbide & Carbon Co., late 1955, f. o. b. railroad freight cars at destination

Zirconium-ferrosilicon:	
12–15 percent Zr, per pound, depending on quantity and quality	$0.085–0.1195
35–40 percent Zr, per pound, depending on quantity and quality	0.2625–0.3165
Zirconium briquets (11 percent Zr, 38 percent Si), per pound, depending on quantity	0.078–0.109
Nickel-zirconium (40–50 percent Ni, 25–30 percent Zr), per pound, depending on quantity	1.25–1.35

DeRewal International Rare Metals Co., late 1955

Hafnium-metal powder (99.3 percent), per gram	$23.00
Hafnium oxide (99.5 percent), per gram	12.00
Hafnium tetrachloride (99 percent), per gram	12.00
Hafnyl sulfate, nitrate, and chloride (99 percent), per gram	10.00

FOREIGN TRADE [7]

Zirconium minerals were obtained from Australia and Brazil. Zircon concentrate imported from Australia reached a record high, exceeding the previous year by 60 percent. Its average declared value was $25.18 per short ton, an increase of $4.86 over 1954 values. The average declared value of baddeleyite concentrate, imported from Brazil, was $77.52 per short ton, a decrease of $19.18 per ton

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

under 1954 values. The United States imported 142 pounds of zirconium metal valued at $4,003 from Canada.

Exports of zirconium ore and concentrate to Canada, Mexico, France, and the Philippines weighed 779 short tons valued at $58,480. Exports of zirconium metals and alloys in crude form and scrap to Canada, France, West Germany, Austria, and Switzerland weighed 52.8 short tons valued at $61,746. A total of 1,132 pounds of semifabricated zirconium forms valued at $39,007 were shipped to Canada, Netherlands, France, and Switzerland.

TABLE 1.—Zirconium ore (concentrates)[1] imported for consumption in the United States, 1946–50 (average) and 1951–55, by countries, in short tons

[U. S. Department of Commerce]

Country	1946–50 (average)	1951	1952	1953	1954	1955
North America: Canada	30					
South America: Brazil	2,659	2,084	1,972	1,206	1,408	1,549
Asia: India	892					
Oceania: Australia [2]	17,084	25,208	21,935	23,461	17,249	27,542
Total: Short tons	20,665	27,292	23,907	24,667	18,657	29,091
Value	$596,683	$664,428	$630,559	$571,783	[3] $486,555	$813,448

[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: 1949, 14,623 tons; 1950, 15,098 tons; 1951, 24,577 tons; 1952, 21,500 tons; 1953, 23,377 tons; 1954, 17,154 tons; and 1955, 27,542 tons.
[3] Owing to changes in tabulating procedures by the U. S. Department of Commerce, data are not comparable to those of other years.

Reexports of ore and concentrate to Canada in 1955 totaled 968 short tons, valued at $48,262. Importers of Zirconium Minerals were as follows:

New York, N. Y.
- Berkshire Chemicals, Inc.
- Derby & Co.
- Metallurg, Inc.
- Metal Traders, Inc.
- Phillip Bros., Inc.
- C. Tennant Sons & Co.

Philadelphia, Pa.
- Foote Mineral Co.
- Frank Samuels & Co.

Pittsburgh, Pa.
- Orefraction, Inc.

Statistics for quantities of zirconium ore imported for consumption in the United States during 1955 are presented in table 1.

TECHNOLOGY

Because increased quantities of zirconium metal were destined for nuclear-energy applications, attention was placed on the study of the chemical and physical impurities of pure zirconium metal and zirconium alloys, improvements in metal preparation, and development of new techniques in preparing useful forms and objects. Perhaps the most comprehensive collection of technical information on the subject of zirconium metallurgy was released in 1955 as a volume in the National Nuclear Energy series.[8] This book presented de-

[8] Lustman, B., and Kerze, F., Jr., The Metallurgy of Zirconium: McGraw-Hill Book Co., Inc., New York, 1955, 776 pp.

tailed information on all phases of zirconium production, fabrication, uses, and chemical and physical metallurgy data.

Improvements in the magnesium-reduction technique, Kroll process, were made by several investigators.[9] [10] The techniques of consumable-electrode arc melting and remelting in producing zirconium alloys were advanced.[11]

Details of the primary zirconium alloy, Zircaloy-2, which was developed in 1952 for use in water-cooled reactors, were declassified and released late in the year. The alloy contains 1.5 percent tin, 0.12 percent iron, 0.10 percent chromium, and 0.05 percent nickel. The combination of these metals results in an alloy of better design strength than pure zirconium and consistently good corrosion resistance in high-temperature water, yet it retains enough ductility to be fabricated and shows little change in neutron absorption.[12]

Equilibrium diagrams for the vanadium-zirconium [13] and columbium-zirconium [14] alloy systems were developed. Preferred orientations in unalloyed zirconium were determined by the Geiger-counter spectrometer X-ray diffraction technique.[15]

As more and varied zirconium metal shapes are required, the technology of forming metal objects is developing rapidly.[16]

Powder-metallurgy methods of processing zirconium parts were studied on a more intensive scale as a possible method of overcoming many of the difficulties of conventional fabrication processes which require special crucibles and protective atmospheres.[17]

Zirconium hydride powder compacted in air at 50 tons per square inch and sintered in high vacuum at 1,260° C. for 3 hours resulted in a metal of 100-percent theoretical density.[18]

Purification of zirconium tetrachloride by employing anhydrous fused mixtures of sodium chloride or potassium chloride and zirconium tetrachloride resulted in a product containing as little as 25 to 200 p. p. m. of metallic impurities. Alkali chlorozirconates formed in the process are thermally decomposed to high-purity zirconium tetrachloride at 500° to 600° C. at atmospheric pressure.[19] A process for producing zirconium diboride and a suitable furnace design were developed by the Bureau of Mines.[20]

Processes for converting zircon to stabilized zirconium oxide [21] and

---

[9] Block, F. E., and Abraham, A. D., Recent Innovations in the Control and Operation of Zirconium Reduction Furnaces: Jour. Electrochem. Soc., vol. 102, No. 6, June, 1955, pp. 311–315.

[10] Gilbert, H. L., and Morrison, C. Q., Variations and Modifications of the Kroll Process for Production of Zirconium Metals: Chem. Eng. Prog., vol. 51, No. 7, July 1955, pp. 320–325.

[11] Beall, R. A., Borg, J. O., and Gilbert, H. L., Production of Zirconium Alloys by Consumable-Electrode Arc Melting: Jour. Electrochem. Soc., vol. 102, No. 4, April 1955, pp. 187–192.

[12] Thomas, D. E., and Forscher, F., A Zirconium Alloy for Water Systems: Materials and Methods vol. 42, No. 6, December 1955, pp. 115–117.

[13] William, J. T., Vanadium-Zirconium Alloy System: Jour. Metals, vol. 7, No. 2, February 1955, pp. 345–350.

[14] Rogers, B. A., and Atkins, D. F., Zirconium-Columbium Diagram: Jour. Metals, vol. 7, No. 9, September 1955, pp. 1034–1041.

[15] Keeler, J. H., and Geisler, A. H., Preferred Orientations in Beta-Annealed Zirconium: Jour. Metals, vol. 7, No. 2, February 1955, pp. 395–400.

[16] Steel, How to Form Zirconium: Vol. 137, No. 24, Dec. 12, 1954, pp. 113–114.

[17] Hausner, H. H., and Michaelson, H. B., How to Fabricate Zirconium and Beryllium: Iron Age, vol. 174, No. 25, Dec. 16, 1954, pp. 123–126.

[18] Hirsch, H. H., Fabrication of Zirconium by Powder-Metallurgy Techniques: Metal Prog., vol. 68, No. 6, December 1955, pp. 81–85.

[19] Horrigan, R. V., Preparation of High Purity $ZrCl^4$ from Alkali Chlorozirconates: Jour. Metals, vol. 7, No. 10, October 1955, pp. 1118–1120.

[20] Baroch, C. T., and Evans, T. E., Production of Zirconium Diboride from Zirconia and Boron Carbide: Jour. Metals, vol. 7, No. 8, August 1955, pp. 908–911.

[21] Schoenlaub, R. A., Process of Recovering Zirconium Oxide in the Form of Cubic Crystals: U. S. Patent, 2,721,115, Oct. 18, 1955.

calcium zirconate[22] were patented. Other patents were issued for a method of applying adherent electroplates to zirconium surfaces[23] and for a process of manufacturing zirconium by electrolysis from a salt bath containing a low-melting alkali metal halide.[24]

A patent for a process of arc-melting zirconium was issued.[25]

Toxicity of zircon and zirconium compounds in rats was investigated. In general, the results indicated low toxicity for zirconium compounds when administered orally.[26]

HAFNIUM

Hafnium metal, which possesses chemical-corrosion properties similar to its sister element zirconium but with diametrically opposite thermal-neutron absorption characteristics, gained prominence in the atomic-energy field as a material for control devices in nuclear reactors. The metal was employed as control rods to adjust the reactivity of the reactor core. The rods, completely inserted in the core of the reactor fuel mass, prevent the chain reaction from starting or continuing because of the high thermal-neutron absorption properties of hafnium.

The Bureau of Mines released details of the production of Kroll-process hafnium by reducing the tetrachloride with magnesium.[27] An alternate procedure of making hafnium metal by the iodide process was also described. Further purification of Kroll-process metal by the iodide process resulted in a soft ductile metal.[28]

Data on the properties of hafnium carbide have been provided by work conducted by the Ceramics Department of Oak Ridge National Laboratory. Hafnium carbide tested for use as a refractory material was synthesized from carbon and pure hafnium oxide heated in a graphite crucible at temperatures ranging from 2,000° to 3,000° C.[29]

All published data on the hafnium content and hafnium to zirconium metal ratio in minerals and rocks have been compiled in a bulletin released by the Federal Geological Survey. The average ratio is about 0.02 in the earth's crust.[30]

RESERVES

Zirconium ranks eleventh in the list of elements in the earth's crust, estimated to be more than 0.028 percent, or greater than such common metals as copper, lead, nickel, and zinc. Zirconium ores are distributed widely throughout the world. Domestic reserves of zircon, the principal source of zirconium, have been estimated to be as high as

---

22 Schoenlaub, R. A., Production of Calcium Zirconate: U. S. Patent, 2,721,117, Oct. 18, 1955.

23 Beach, J. G., Schickner, W. C., and Faust, C. L., Method of Applying Adherent Electroplates to Zirconium Surfaces, U. S. Patent, 2,711,389, June 21, 1955.

24 Pych, S. C., Process for Manufacturing Titanium, Zirconium, and Similar Metals; Canadian Patent 511,842, April 1955.

25 Gilbert, H. L., Cavett, A. D., and Brennan II, W. E., Process of Arc-Melting Zirconium; U. S. Patent 2,702,239, April 1955.

26 Work cited in footnote 3, p. 102.

27 Holmes, H. P., Barr, M. M., and Gilbert, H. L., Production of Hafnium: Bureau of Mines Rept. of Investigations 5169, 1955, 33 pp.

28 Goodwin, J. G., Hurford, W. F., Iodide Process Produces Ductile Hafnium for Fabrication: Jour. Metals, vol. 7, No. 11, November 1955, pp. 1162–1168.

29 Curtis, C. E., Doney, L. M., and Johnson, J. R., Properties of Hafnium Oxide, Hafnium Silicate, Calcium Hafnate, and Hafnium Carbide: Jour. Am. Ceram. Soc., vol. 37, October 1954, pp. 458–465.

30 Fleischer, M., Hafnium Content and Hafnium-Zirconium Ratio in Minerals and Rocks. Geol. Survey Bull. 1021-A, 1955, 13 pp.

15 million short tons, based upon information concerning deposits in Florida, California, Oregon, and Idaho. The principal domestic source is in Florida where zircon is recovered as a coproduct in producing ilmenite, rutile, and monazite from both inland and shore deposits of beach and dune sands. Additional reserves are continually being evaluated during the search for new deposits of each of the four minerals.

The principal reserves of zircon outside the United States were found in Australian beach sands extending over a distance of 300 miles along the eastern coast from Coff's Harbor in New South Wales to North Stradbroke Island in Queensland. The Australian Bureau of Mineral Resources released a report estimating reserves in the area between Southport, Queensland, and Woody Head, New South Wales, to be approximately 3 million long tons of zircon.[31] Deposits, found in Western Australia, south of Fremantle, and on King Island in Bass Strait, have been examined but have not been worked commercially.

WORLD REVIEW

Australia.—Titanium and Zirconium Industries planned a $1,125,000 expansion of its beach-mining activities on Stradbroke Island off the coast of Queensland; the black-sand deposits will be mined at the rate of 30 tons of crude concentrate per hour. Involved in this program is installation of an overhead conveyor two-thirds mile long, a larger separation plant, a diesel power station of 1,500-kw. capacity, and erection of a small town for the staff.[32]

Canada.—Zircon has been found in the black sands of British Columbia, but no commercial deposit has been developed to date. Canada consumes more than 20 tons of ferrozirconium per year in manufacturing tool steel.[33]

TABLE 2.—World production of zirconium ores and concentrates, by countries, 1946–55, in short tons [1]

[Compiled by Augusta W. Jann]

Country	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955
Australia [2]	13,891	24,165	25,017	23,486	24,120	47,006	32,893	30,081	45,830	48,993
Brazil [3]	[4] 4,909	[4] 4,385	[4] 4,011	2,977	3,325	3,854	4,378	3,409	4,173	[5] 4,000
Egypt	4	-------	104	141	105	4	133	263	109	126
French West Africa	-------	43	211	270	243	32	-------	1,047	1,012	(6)
India	522	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)	(6)
Madagascar	-------	-------	-------	-------	-------	-------	5	-------	-------	-------
United States [2]	7,946	(6)	(6)	(6)	(6)	(6)	(6)	23,904	16,322	28,110

[1] This table incorporates a number of revisions of data published in previous Zirconium and Hafnium chapters.
[2] Estimated zirconium content of all zircon-bearing concentrates.
[3] Chiefly baddeleyite.
[4] Exports.
[5] Estimate.
[6] Data not available for publication.

[31] Gardner, D. E., Beach-Sand Heavy Mineral Deposits of Eastern Australia: Bureau of Min. Res., Commonwealth of Australia, Bull. 28, 1955, 103 pp.
[32] Mining World, vol. 17, No. 4, April 1955, p. 68.
[33] Northern Miner, Widening Market for Zirconium Blossoms from Atomic Research, vol. 40, No. 50, Mar. 2, 1955, pp. 1, 2.

Chile.—Zircon found in placer deposits at Hualgin, south of Concepcion, Chile, contained 10 percent zirconium and traces of gold, magnetite, rutile, and other substances.[34]

Egypt.—Production of zirconium ores derived from black sands amounted to 114 short tons or 15 percent more than in 1954.

Japan.—Two hundred pounds of zirconium metal was produced during the year by a calcium-reduction process. Metal is employed in "gas filtering" uses.

South Africa.—A new plant under construction near Joal, north of the mouth of the Saloum River, will treat sand from the Senegalese Coast to produce both titanium and zirconium ores. Approximately 60,000 tons of sand per year will yield 30,000 tons of ilmenite, 2,000 tons of rutile, and about 4,000 tons of zirconium ore.[35]

[34] United States Consulate, Santiago, Chile, State Department Dispatch 259, Sept. 29, 1955.
[35] Chemical Engineering News, vol. 33, No. 47, Nov. 21, 1955, p. 5064.

Minor Metals

By Frank D. Lamb,[1] Donald E. Eilertsen,[2] Elmo G. Knutson,[2] and James Paone[2] [3]

CESIUM AND RUBIDIUM[4]

CESIUM AND RUBIDIUM are both very active alkali metals and usually are associated in nature. Cesium is the heaviest of all known members of the alkali series of metals—the most compressible and softest.

Production.—Demand for cesium and rubidium in 1955 was approximately the same as in 1954. Cesium was produced from the mineral pollucite, and rubidium was derived from lepidolite—a complex lithia-mica mineral, most of which was imported from South-West Africa and the Union of South Africa in 1955. Some companies also produced cesium and rubidium from raw materials obtained years ago. Small quantities of cesium and rubidium metals and compounds were produced by DeRewal International Rare Metals Co., Philadelphia, Pa.; King Products, Arlington, N. J.; Fairmount Chemical Co., Inc., Newark, N. J.; and Harshaw Chemical Co., Cleveland, Ohio. Other former producers reported no production but shipped cesium and rubidium metal and compounds from inventory. Several companies are reported to have large stocks of raw material from which cesium and rubidium could be produced for any accelerated demand for the metals by industry.

Uses.—Cesium was used in photoelectric cells that respond to minutely varying intensities of visible light and are utilized in photometry, television, and sound films. It was also employed as a getter in radio vacuum tubes, in vapor lamps adapted for infrared signaling by the military services, and in scintillator counters and various optical and detecting devices.

Rubidium was used for much the same applications as cesium in 1955. Rubidium compounds were used to a greater extent than the metal. They were employed in medicine for treating goiter and syphilis, and rubidium-mercury amalgams have been used as catalytic agents in hydrogenating certain compounds.

Prices.—Cesium metal was quoted by producers at $1.90 per gram and cesium compounds from 20 to 50 cents per gram. Rubidium-metal prices varied from $2.95 to $3.50 per gram, and rubidium compounds were sold for 35 to 50 cents per gram.

---

[1] Assistant Chief, Division of Minerals.
[2] Commodity specialist.
[3] Unless otherwise noted, figures on imports compiled by Mae B. Price and Elsie D. Page, Division of Foreign Activities, Bureau of Mines, from records of the U. S. Department of Commerce.
[4] Prepared by Elmo G. Knutson.

GALLIUM[5]

Gallium—metallic gray, soft, and brittle—is an unusual metal. It is a solid at ordinary room temperature, melts to a mercurylike liquid when placed in the palm of a hand, and like, water expands on solidifying.

Domestic Production.—Although gallium is geochemically as abundant as lead in the lithosphere, it is usually found only in minute quantities scattered throughout the earth crust. Slight concentrations occur in some ores of aluminum and zinc. Aluminum Co. of America, East St. Louis, Ill., and Anaconda Co., Great Falls, Mont., produced gallium as a byproduct in their refining processes. Production of gallium in 1955 exceeded 1954, but shipments were less.

Uses.—A little gallium usually goes a long way in most commercial uses of the element. No new large use of the element was reported in 1955. As a liquid, it was used as a sealant for glass joints and valves in vacuum equipment. Other uses included thermometers and optical mirrors.

Prices.—Gallium metal was quoted in E&MJ Metal and Mineral Markets at $3.25 per gram in lots of 1 to 999 grams and $3 per gram in 1,000-gram lots.

Technology.—Gallium of greater purity than commercial metal was reported to have been made by acid-leaching to thoroughly remove surface oxides, followed by zone-refining to remove metallic impurities.[6]

The gallium-antimony binary system has been investigated by thermal, X-ray, and metallographic methods.[7]

GERMANIUM[8]

Production of electrical devices utilizing semiconductor materials established new records in 1955. Germanium continued to be the preferred semiconductor material for manufacturing transistors and diodes. The supply of germanium was adequate to meet the increasing demand for the metal.

Domestic Production.—Germanium production in the United States in 1955 was approximately 15 percent greater than in 1954. This increase was attributed principally to the record production of zinc in 1955, from which germanium was recovered as a byproduct. Domestic producers were: American Zinc Co. of Illinois, Fairmont City, Ill.; American Smelting & Refining Co., Perth Amboy, N. J.; The Eagle-Picher Co., Miami, Okla.; and Sylvania Electric Products, Inc., Towanda, Pa.

Consumption and Uses.—Most of the germanium sold in 1955 was consumed in manufacturing electrical devices. Production of germanium transistors and diodes increased from 1.3 and 10.7 million, respectively, in 1954 to approximately 3.6 and 15.9 million in 1955. The output of diodes from other semiconductor materials in 1954 totaled 2.5 million, compared with an estimated 4.3 million in 1955. The use of germanium in rectifiers continued upward.

Germanium diodes, transistors, and rectifiers were used in the electronics industry in television sets, radios, hearing aids, phono-

[5] Prepared by Donald E. Eilertsen.
[6] Detwiler, D. P., and Fox, W. M., Purification of Gallium by Zone-Refining: Jour. Metals, vol. 7, No. 1, January 1955, p. 205.
[7] Greenfield, I. G., and Smith, R. L., Gallium-Antimony System: Jour. Metals, vol. 7, No. 2, February 1955, pp. 351–353.
[8] Prepared by Elmo G. Knutson.

graphs, computers, radar, guided missiles, aircraft-control systems, and telephone equipment. Outside the electronic field germanium rectifiers in use or being installed included a 24-volt, 40,000-ampere unit for an anodizing line; a 65-volt, 16,000-ampere unit for a hydrogen-oxygen cell; a 40-volt, 8,000-ampere unit for an arc-melting furnace; and a 125-volt, 800-ampere unit in use for reclaiming tin from tin-plate.[9] Germanium rectifiers were also used in such industries as electroplating, electrochemicals, battery charging, sintering furnaces, and powerplants.

A substantial quantity of germanium was used as a deep-red phosphor for lamps. Minor applications were in dentistry and in the production of glass capable of transmitting infrared radiation.[10]

Stocks.—Stocks of refined germanium held by germanium producers at the end of 1955 were estimated to represent approximately a 2-year supply.

Prices.—Prices for germanium continued the same in 1955 as throughout 1954. Germanium metal was quoted at $295 per pound and germanium dioxide at $142 per pound in 1955 by the E&MJ Metal and Mineral Markets.

Foreign Trade.—Imports of germanium dioxide increased appreciably in 1955 compared with the reported 3,630 pounds imported in 1954.[11] Data on exports of germanium were not available.

Technology.—A continuous zone-melting technique has been developed, utilizing apparatus that delivers ultrapure material from one exit and ejects impurities from another.[12]

A review of the application of germanium power rectifiers was published in 1955.[13]

Flotation practice at the Tsumeb Corp. in South-West Africa, was described.[14]

A publication providing general information on germanium and silicon was released.[15]

A special transistor, called a photodiode, at least 10,000 times more sensitive to light than a conventional photoelectric cell, has been reported.[16]

A method for the rapid determination of germanium in coal, soil, and rock was published during 1955.[17]

Optical filters fabricated from highly purified germanium single crystals were reported to be available.[18]

World Review.—*Belgium.*—The Société Générale Métallurgique de Hoboken reports producing germanium at its plant at Oolen. Germanium oxide was recovered from flue dusts of the Union Minière du Haut Katanga copper-zinc smelting operations in the Belgian Congo.[19]

---

[9] Caldwell, Van, Revolution in Rectifiers: Steel, vol. 136, No. 12, Mar. 21, 1955, pp. 116–119.
[10] Aldington, J. N., and Cumming, H. W., Germanium and Its Uses: Endeavour, vol. 14, No. 56, October 1955, pp. 200–204.
[11] U. S. Tariff Commission.
[12] Pfann, W. G., Develops Continuous Zone-Melt Technique: Materials and Methods, vol. 41, No. 4, April 1955, p. 210, 212.
[13] Crenshaw, R. M., Application of Germanium Power Rectifiers: Electrical Eng., vol. 74, No. 5, May 1955, pp. 418–422.
[14] Ratledge, J. P., Ong, J. N., and Boyce, J. H., Development of Metallurgical Practice at Tsumeb: Min. Eng., vol. 7, No. 4, April 1955, pp. 374–382.
[15] Rugare, A. S., Germanium and Silicon for Electronic Devices: Metal Progress, vol. 67, No. 2, February 1955, pp. 87–91.
[16] American Metal Market, Westinghouse Develops New Way to Make Germanium Transistors: Vol. 62, No. 249, Dec. 29, 1955, pp. 1, 10.
[17] Almond, H., Crowe, H. E., and Thompson, C. E., Rapid Determination of Germanium in Coal, Soil, and Rock: Geol. Survey Bull. 1036-B, 1955, pp. 9–17.
[18] Journal of the Electrochemical Society, Germanium Optical Filter: Vol. 102, March 1955, p. 70 C.
[19] Mining World, Europe: Vol. 17, No. 1, January 1955, p. 66.

Canada.—Spectrographic determination of the germanium content of nine seams in the Sydney coalfield, Nova Scotia, shows an average of 0.004 percent in the ash or 5 grams per ton in the coal as a whole. Smaller quantities were found in two other seams—the St. Rose and Port Hood.[20]

Japan.—Germanium production was reported by The Mitsubishi Metal Mining Co.[21]

INDIUM[22]

Indium is a silvery white, soft, ductile metal. It is found in small quantities in some ores of tin, tungsten, and iron, but principally in certain zinc-lead ores. Most of the domestic supply of the element has been obtained as a byproduct in refining flue dusts and residues from smelting zinc-lead ores.

Domestic Production.—American Smelting & Refining Co., Perth Amboy, N. J., and Anaconda Co. at Great Falls, Mont., were the only two producers of indium in the United States. Production and shipments of indium were greater in 1955 than in 1954.

Uses.—No new large use for indium was reported in 1955. Indium was used in plating to reduce corrosion and friction in bearings for some aircraft and other engines. Some indium was also used in sprinkler heads, solders and brazing compounds, reflector coatings, and germanium rectifiers and in developing button-size batteries[23] for electric wrist watches, photoflash units, hearing aids, and portable radios.

Price.—Indium, 99.9 percent pure, was quoted by E&MJ Metal and Mineral Markets at $2.25 per troy ounce.

Technology.—Alloys of In-As-Sb over the entire composition range have been investigated by thermal analysis, microscopic, and X-ray methods. No ternary compounds were found to exist. Many phase and section diagrams with some microscopic photographs were published.[24]

World Review.—The Consolidated Mining & Smelting Co. of Canada, Ltd., Trail, British Columbia, is said to have expanded its indium installations in 1955 to increase production of that element.

RADIUM[25]

Radium continued in demand in 1955, despite the growing rise of radioisotopes as a source of radiation. Imports of radium and radium salts in the United States increased approximately 13 percent over the quantity imported in 1954. Eldorado Mining & Refining, Ltd., Canada, which was a principal producer of radium, retired from the radium business during the year after selling all of its stocks of refined radium to the Atomic Energy of Canada, Ltd.[26]

Attention of some of the major consumers of radium was directed to radioactive substitutes such as cobalt–60, strontium–90, thallium–204, cesium–137, krypton–85, and tritium.

---

[20] Hawley, J. E., Germanium Content of Some Nova Scotian Coals: Econ. Geol., vol. 50, No. 5, August 1955, pp. 517–532.

[21] Metal Industry, Germanium: Vol. 86, No. 23, June 10, 1955, p. 500.

[22] Prepared by Donald E. Eilertsen.

[23] Science Newsletter, vol. 68, No. 5, July 30, 1955, p. 72.

[24] Shih, C. H., and Peretti, E. A., The Constitution of Indium-Arsenic-Antimony Alloys (preprint published in 1955): Trans. Am. Soc. Metals, vol. 48, 1956, pp. 706–725.

[25] Prepared by James Paone.

[26] Eldorado Mining & Refining, Ltd., Annual Report for the Year Ended Dec. 31, 1955, 18 p

Sales representatives for foreign producers of radium continued to make the material available for domestic consumption. Prices remained steady during 1955. It was revealed that the U-235 used in the early atomic bomb came from pitchblende stored in New York, N. Y., sent by Union Minière du Haut Katanga, a Belgian firm, to Radium Chemical Co., Inc. The pitchblende, enough for the recovery of about 100 grams of radium, came from the Belgian Congo.

Domestic Production.—A few tons of radium-bearing slimes, originally produced from western carnotite ores, constituted the sole traffic of domestically produced radium-containing raw material. A minor part of domestic production resulted from the re-treatment of consumer's wastes.

Radium and its derivatives were distributed in the United States by Radium Chemical Co., New York, N. Y., and United States Radium Corp., Morristown, N. J. Canadian Radium & Uranium Corp., New York, N. Y., operated a refinery at Mount Kisco, N. Y., principally for secondary recovery.

Consumption and Uses.—One of the principal uses of radium continued to be telecurietherapy applications by the medical profession. A significant quantity of radium was employed in radium-beryllium compounds, which are a moderately intense source of neutrons and are used in oilwell logging, in subcritical nuclear-reactor experiments, in neutron studies, and in related applications in the realm of nuclear energy.

Radium was used in industrial radiography, particularly in nondestructive testing and inspection of metal castings, in zinc sulfide compounds to make self-activated luminescent paint for watch, clock, meter, and other dials and signs that must be observed in the dark, and in radium foil for application in static-elimination equipment for industrial operations where static is undesirable.[27]

Prices.—Radium was quoted by E&MJ Metal and Mineral Markets throughout 1955 at $16 to $21.50 per milligram of radium content, depending on quantity.

The price of radium is quoted in terms of the amount of the element by weight in a purified salt; radium and its derivatives are generally sold in the United States on the basis of Government certification of radium content, which is conducted by the National Bureau of Standards, Washington, D. C.

Foreign Trade.—Statistics shown indicate that 65,545 milligrams of radium salts was imported for consumption in the United States in 1955, representing a 13-percent increase over the quantity imported in 1954.

A major part of the radium salts came from Belgium, where rich pitchblende and radium-bearing slimes from the Union Minière du Haut Katanga operations in the Belgian Congo were processed.

---

[27] United States Radium Corp., Functioning, Installation, and Maintenance of Ionotion Static Eliminators: 1955, 8 pp.

TABLE 1.—Radium salts and radioactive substitutes imported for consumption in the United States 1946–50 (average), and 1951–55

[U. S. Department of Commerce]

	1946–50 (average)	1951	1952	1953	1954	1955
Radium salts:						
Milligrams	69, 859	89, 805	173, 711	85, 055	57, 879	65, 545
Total value	$1, 234, 248	$1, 225, 564	$2, 873, 688	$1, 474, 625	$856, 822	$974, 982
Average value per gram	$17, 668	$13, 600	$16, 500	$17, 337	$14, 804	$14, 875
Radioactive substitutes	$2, 550	$5, 399	$85, 849	$169, 762	$149, 759	$188, 729

RARE-EARTH MINERALS AND METALS [28]

The rare-earth metals continued to attract worldwide attention in 1955, as research begun in previous years yielded early results and the strange names of these unfamiliar elements appeared more and more frequently in popular and technical publications. The changing world of the "atomic age" no longer considered the rare-earths to be mysterious elements of interest only to scientists and students of chemistry. Critical needs for new alloys and structural materials to meet the exacting requirements of new engineering developments forced metallurgists and physicists around the world to review the known properties of the rare-earth metals and to ask for additional data.

Monazite, a rare-earth and thorium phosphate mineral, was again the major commercial source of rare-earth metals and compounds. The Atomic Energy Commission's continuing need for thorium for research purposes [29] resulted in a surplus of the byproduct rare-earth salts in the United States. Production from bastnaesite, a fluocarbonate of the rare earths, continued to supply the need for rare-earth oxides for some experimental studies, particularly in the steel industry. Euxenite, a niobate and titanate of uranium and the rare earths, was mined commercially in 1955 for the first time. Other rare-earth minerals (such as gadolinite, fergusonite, xenotime, and pyrochlore) aroused equal or even greater interest in 1955, but commercial deposits of these minerals were either unknown or were not sufficiently developed to permit exploitation.

Domestic Production.—Monazite-production statistics were classified by AEC, as in previous years, because of the thorium content of the mineral, and their publication was prohibited. Production from placer deposits near Cascade, Idaho, was reported by Baumhoff-Marshall, Inc., and Idaho-Canadian Dredging Co., both of Boise, Idaho. This ended in August 1955, when scheduled deliveries under contracts with the Emergency Procurement Service and Lindsay Chemical Co. were completed. Because of the completion of National Stockpile objectives for rare-earth minerals and the increased availability of foreign monazite with a higher thorium content and lower price, contracts with the Idaho producers were not renewed. The output of monazite as a byproduct of titanium-mineral production from Florida beach and dune sands continued, minor quantities being reported by Humphreys Gold Corp., Jacksonville, Fla., and Florida Ore Processing Co., Melbourne, Fla. In South Carolina

[28] Prepared by Frank D. Lamb.
[29] See chapter on Thorium.

the dredging operations of Marine Minerals, Inc., got underway on a large, alluvial deposit near Aiken. A mixed heavy-mineral concentrate containing important percentages of monazite and xenotime, with ilmenite, rutile, and zircon, was recovered and stockpiled, awaiting the availability of a separation plant under construction at Bath, S. C., and scheduled for completion in 1956.

Molybdenum Corp. of America continued to process bastnaesite ore from its mine at Mountain Pass, Calif., 60 miles southwest of Las Vegas, Nev. Although the processing plant was reported to be treating 160 tons of ore per day assaying 7 to 10 percent rare-earth oxides, it was operated only intermittently to furnish concentrate for experimental-use studies.

Porter Bros. Corp. of Boise, Idaho, had one bucketline dredge in operation and a second one under construction on its placer deposits in Bear Valley, Idaho. Black-sand concentrate obtained from the Bear Valley operation was processed in the Porter Bros. new separation plant at Lowman, Idaho. Euxenite and monazite concentrates were produced and stockpiled awaiting completion of chemical-processing facilities under construction at St. Louis, Mo., by Mallinckrodt Chemical Works.

Monazite and bastnaesite were processed commercially for the extraction of rare-earth salts by Lindsay Chemical Co., West Chicago, Ill.; Rare Earths, Inc., Pompton Plains, N. J.; Maywood Chemical Works, Maywood, N. J.; and Molybdenum Corp. of America, New York, N. Y. Lindsay Chemical Co. put into operation in 1955 an ion-exchange separation plant as an adjunct to its facilities in West Chicago, Ill. Announcements were also made of completion of other smaller plants of a pilot nature by the United States Yttrium Co., Laramie, Wyo.; Michigan Chemical Co., Saint Louis, Mich.; and Research Laboratories of Colorado, Inc., Newtown, Ohio. A program of expanded production and development of rare earths was announced by the W. R. Grace Co. to be conducted jointly by its Davison Chemical Co. division and Rare Earths, Inc., a wholly owned subsidiary. Construction was begun on a large new monazite-processing plant expected to be ready for operation in 1956 at the Curtis Bay Works of Davison Chemical Co. in Baltimore, Md.[30]

Misch metal, a mixture of various combinations of the rare-earth elements in metallic form, was produced by Cerium Metals Corp., Niagara Falls, N. Y., New Process Metals Corp., Newark, N. J.; General Cerium Corp., Edgewater, N. J.; American Metallurgical Products Co., Pittsburgh, Pa.; and Mallinckrodt Chemical Works, St. Louis, Mo.

Uses.—The annual consumption of rare-earth ores for production and commercial use of rare-earth metals and compounds in the United States was estimated in 1955 to be equivalent to about 3,000 short tons of monazite, containing 60 percent rare-earth oxides.[31] For most commercial uses the rare-earth group was not separated into its individual elements or groups but was used collectively in unseparated forms as misch metal, rare-earth oxides, chlorides, fluorides, sulfates, or other salts. Cerium, lanthanum, neodymium, and praseodymium—the more abundant rare-earth elements in monazite and bastnaesite—

[30] Chemical and Engineering News, W. R. Grace Divisions Join in Rare-Earths Program: Vol. 33, No. 35, Aug. 29, 1955, p. 3570.

[31] Kremers, H. E., Rare Earth and Thorium Ores: Mines Magazine, vol. 45, No. 4, April 1955, pp. 27-28, 44.

were separated and purified on a relatively small but commercial scale, while the other 10 rare earths in monazite and bastnaesite were separated only in laboratory and pilot-plant equipment. Promethium, the 15th rare-earth element shown on periodic charts and tables, is not known to occur in nature. About one-fourth of the quantity of rare earths used commercially in 1955 was employed as salts in manufacturing carbon-arc electrodes for intense-lighting applications; another fourth of the consumption was in the form of cerium, lanthanum, neodymium, praseodymium and "didymium" (cerium-free rare earths) salts used for a number of applications in the glass industry. Some rare-earth salts have important uses for coloring and decolorizing glass.

High-purity cerium oxide and some other specially prepared rare earths are used for polishing better grades of optical lenses, mirrors, and other glass specialties. A third quarter of the rare earths used by industry was in the form of cerium metal, ferrocerium, misch metal, and rare-earth oxides. These materials were used in manufacturing of pyrophoric alloys for lighter flints, magnesium and aluminum alloys for aircraft use, and some stainless steels and other ferrous alloys. Other miscellaneous uses to which rare earths in various forms were applied were: Granite and lapidary polishing, sunglasses, welders' and glass-blowers' goggles, windows for radiation protection, neutron absorbers, television picture tubes, ceramic coloring and opacifying, paint driers, activators for fluorescent lighting, catalysts, textile waterproofing, scavengers in explosives manufacture, capacitors for electronic equipment, and nausea preventives.

Prices.—Quotations for monazite in the E&MJ Metal and Mineral Markets from January 1, 1955, through November 2, 1955, follow: Total rare-earth and thorium oxides, c. i. f. U. S. ports, massive, 55-percent grade, 13 cents per pound; sand, 55-percent, 18 cents per pound; 66-percent, 20 cents per pound; 68-percent, 22 cents per pound. From November 3, 1955, to December 31, 1955, E&MJ Metal and Mineral Markets quoted the following prices: Massive, 55-percent grade, 13 cents per pound; sand, 55-percent, 15 cents per pound; 66-percent, 18 cents; 68-percent, 20 cents.

Prices for bastnaesite were not quoted in trade journals in 1955, but the rare-earth compound (essentially rare-earth oxides) made from bastnaesite by Molybdenum Corp. of America sold for $1 per pound throughout the year.

The price of misch metal ($4.50 per pound at the beginning of the year) was reduced to $3.50 per pound in 1955, while ferrocerium remained at $8 per pound throughout the year. High-purity cerium metal continued to be quoted at $18 per pound. Rare-earth sulfates sold at 20–30 cents per pound; rare-earth chlorides, 30–40 cents per pound; rare-earth fluorides, $1 per pound; cerium oxide, $2 per pound; and cerium hydrate, $1.75 per pound. For the first time prices were quoted by producers for small lots of each of the 14 natural occurring rare-earth elements as oxides or salts. These prices ranged from 3 cents per gram for lanthanum nitrate (99-percent purity) in 1,000-gram lots to as high as $450 per gram for thulium oxide (99-percent purity) in 1-gram lots. The prices were not significant, except to indicate the relative difficulty of separating the individual elements from each other and purifying them.

Foreign Trade.—Receipts of misch metal and ferrocerium in the United States in 1955 totaled 6,200 pounds valued at $25,100. West

Germany and Austria were the principal sources, with the United Kingdom furnishing a minor quantity. Ten tons of Canadian cerium ore valued at $680 was imported from Canada during the year.

Exports totaled 19,300 pounds of cerium ores, metals, and alloys valued at $75,400 and 10,800 pounds of lighter flints valued at $82,700.

United States tariff rates on rare-earth materials follow: Cerium ore or cerite, free; cerium metal, $1 per pound; ferrocerium and other cerium alloys, $1 per pound plus 12½ percent ad valorem; and cerium compounds (chemical), 30 percent ad valorem.

Technology.—Announcement in July 1955 by the Lindsay Chemical Co. of completion of an addition to its processing facilities in West Chicago, Ill., which would utilize ion-exchange techniques to separate individual rare earths from each other, marked the first commercial use of this process in the rare-earth field. Through the new process Lindsay Chemical Co. was expected to offer all of the separated rare earths in pure form at prices reduced substantially below those prevailing previously.

The monazite and radioactive black-mineral exploration program conducted by the Bureau of Mines, in cooperation with the AEC and Geological Survey, beginning in 1948 was completed in 1955. This program included examination and investigation of over 100 alluvial deposits containing monazite and radioactive black minerals. All were low-grade; but many, containing 1 to 3 pounds of monazite per cubic yard, were found to be potentially valuable sources of rare-earth minerals. Several could in an emergency be utilized as domestic sources of important strategic metals, including the rare earths, thorium, columbium, tantalum, titanium, and zirconium.

Important deposits of pyrochlore and other rare-earth minerals in Canada and Africa were investigated by United States, Canadian, and British concerns. Preliminary estimates of reserves in deposits in Quebec and Saskatchewan, Canada,[32] and in Tanganyika and Kenya, British East Africa,[33] emphasized the fact that rare-earth minerals are not rare in the world, and research on developing ways to increase the utilization of these metals appeared justified.

Research on the effect of rare-earth additions in steelmaking continued to show promise, and several papers concerning this work were published during the year.[34]

The use of thulium–170 as a source of radiation for studying castings attracted attention.[35]

A new rare-earth mineral, discovered in a deposit near Dover, N. J., attracted attention. The mineral, named doverite for the city of Dover, was found to be a fluocarbonate of the rare earths and yttrium occurring in aggregates with xenotime, hematite, and quartz.[36]

World Review.—The output of monazite in several countries continued to be kept secret in 1955; consequently, little information was available concerning commercial supplies of rare-earth minerals in the world. The largest producing countries before 1946 (India and

[32] Chemical and Engineering News, vol. 33, No. 49, Dec. 5, 1955, p. 5290.

[33] South African Mining and Engineering Journal, Large Pyrochlore Reserves in Tanganyika and Kenya: Vol. 66, No. 3249, May 21, 1955, p. 479.

[34] Schwartzbart, H., and Sheehan, J. P., Rare Earths Improve Impact Properties of 4330: Iron Age, vol. 175, No. 21, May 26, 1955, pp. 103–106.
Breen, J. E., and Lane, J. R., Effect of Rare-Earth Additions on High-Temperature Properties of a Cobalt-Base Alloy: ASTM tech. paper, June 1955, 9 pp.
Cheetham, G., Rare Earths in Steelmaking: Iron and Coal Trades Rev., vol. 171, No. 4551, July 1, 1955, pp. 15–22.

[35] Révue métallurgique (France), The Use of Thulium-170 for Gamma Radiography of Light Alloy Castings: Vol. 52, No. 6, June, 1955, pp. 457–466.

[36] Chemical and Engineering News, vol. 33, No. 28, July 11, 1955, p. 2898.

Brazil) continued the restrictions placed on exports of monazite. It was reported that 2,700 metric tons of monazite was produced in Brazil in 1954.[37]

No information was available on 1955 monazite production in Brazil.

The Malaya Government restored the 10-percent ad valorem export duty on monazite on January 1, 1955, which had been reduced to M$0.50 per picul in 1950.[38] Partly because of the reduction but principally because of improvements in mining and processing methods, production of monazite was reported to have increased appreciably in Malaya, and it was believed that the current rate of production would continue, despite the increased export duty.

Production of monazite was also reported from Australia, Ceylon, Korea, Madagascar, and Union of South Africa. The lode deposit of monazite near Van Rhynsdorp, Cape Province, Union of South Africa, continued to expand production in 1955, and about 90 percent of its output was exported to the United States.

Bastnaesite was produced in the United States, Madagascar, and Ruanda-Urundi.

RHENIUM[39]

Rhenium is a silvery metal with a density almost twice that of lead and a higher melting point than all other metallic elements except tungsten.

Domestic Production.—Rhenium is found with molybdenum in flue dusts and residues when some copper ores are processed. Only recently has the metal come into domestic commercial production. Kennecott Copper Corp. was the only producer in 1955.

Uses.—Rhenium, almost forgotten since its discovery 30 years ago, is beginning to find applications in industry. Several potential uses are as contacts for marine-engine magnetos, filaments and other parts in electron tubes, and fountain-pen nibs. Other applications in vacuum tubes, photographic lamps, circuit breakers, and X-ray tubes are being investigated.

Technology.—A rhenium-crystal bar was found to have a tensile strength of 75,000 p. s. i., whereas an annealed rod indicated a tensile strength of 165,000 p. s. i. combined with excellent ductility. With increased amounts of coldwork, rhenium was found to have a tensile strength approaching 340,000 p. s. i.[40]

Vickers hardness for annealed rhenium and tungsten was found to be about 250 for each; worked, rhenium hardness reached 800 compared to 500 for tungsten.[41]

A comprehensive review of rhenium was published in 1954.[42]

A discussion of some properties of rhenium and the fabrication of the metal by powder-metallurgy techniques was published.[43]

---

[37] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 5, May 1955, p. 27.
[38] Bureau of Mines, Mineral Trade Notes: Vol. 41, No. 3, March 1955, p. 19.
[39] Prepared by Donald E. Eilertsen.
[40] Sims, C. T., Craighead, C. M., Jaffee, R. I., Gideon, D. N., Wyler, E. N., Todd, F. C., Rosenbaum, D. M., Sherwood, E. M., and Campbell, I. E., Investigations of Rhenium: Battelle Memorial Inst., Wright Air Development Center Tech. Rept. 54-371, June 1954, pp. 60, 65.
[41] Sims, Chester T., Rhenium Metal: Materials and Methods, vol. 41, No. 3, March 1955, p. 111.
[42] Melaven, A. D., Rhenium: Rare Metals Handbook, Reinhold Publishing Corp., New York, N. Y., 1954, pp. 347-364.
[43] Sims, Chester T., Craighead, Charles M., and Jaffee, Robert I., Physical and Mechanical Properties of Rhenium: Jour. Metals, vol. 7, No. 1, January 1955, pp. 168-179.

SELENIUM [44]

Heavy demands for selenium continued to exceed the supply throughout 1955. The critical supply situation for selenium began in the late months of 1950 and continued throughout the intervening years. Strikes in the copper industry reduced the selenium output an estimated 80,000 pounds in 1955. This decrease was partly offset by an increase in the production of secondary selenium from spent catalysts and rectifier scrap.

Domestic Production.—Domestic plant production of primary selenium and selenium compounds in 1955 totaled 699,300 pounds of contained selenium, compared with 713,200 pounds in 1954. Both years had a reduction in primary selenium output, owing to labor troubles in the copper industry. The most important source of primary selenium was anode mud produced in the electrolytic refining of blister copper with a lesser amount produced from lead flue dusts.

Producers of primary selenium and selenium compounds in 1955 were American Smelting & Refining Co., Baltimore, Md.; American Metal Co., Ltd., Carteret, N. J.; Kennecott Copper Corp., Garfield, Utah; and International Smelting & Refining Co., Perth Amboy, N. J.

The production of secondary metallic selenium and selenium compounds from rectifier scrap and spent catalysts totaled 152,300 pounds of contained selenium in 1955 compared with 126,500 pounds in 1954. The production of secondary selenium has been steadily increasing at the rate of approximately 30,000 pounds a year since 1952. In an effort to increase the production of secondary selenium further, the Business and Defense Services Administration sent out a press release urging television and radio repairmen to salvage as many discarded selenium rectifiers as possible.[45]

Producers of secondary selenium and selenium compounds in 1955 were Kawecki Chemical Co., Boyertown, Pa.; American Smelting & Refining Co., Baltimore, Md.; Vickers Electric Division, Vickers, Inc., St. Louis, Mo.; and Eastern Metal Converters, Inc., Woodbridge, N. J.

Consumption and Uses.—Apparent consumption (producers' domestic shipments plus imports, minus exports) of selenium and selenium compounds in 1955 totaled 1,050,800 pounds of contained selenium, compared with 1,021,300 pounds in 1954.

The consumption of selenium in 1955 was distributed as follows: [46]

	Percent	Percent
1. Rectifiers		48.9
2. Chemical:		
a. Pigments	21.1	
b. Pharmaceuticals	5.5	
c. Rubber	2.8	
d. Blasting caps	1.0	
e. Miscellaneous	.3	
		30.7
3. Glass		14.6
4. Steel		5.3
5. Miscellaneous		.5
Total		100.0

[44] Prepared by Elmo G. Knutson.
[45] Waste Trade Journal, vol. 100, No. 8, Nov. 12, 1955, p. 3.
American Metal Market, vol. 62, No. 217, Nov. 10, 1955, pp. 1-8.
[46] Statistics furnished by U. S. Department of Commerce.

The principal uses of selenium in 1955 were in manufacturing rectifiers, as a colorant and decolorant in glass; in producing red, orange, pink, and maroon pigments for paint, ceramics, printing ink, dyes, and plastics; and as an agent to promote resistance to heat, oxidation, and abrasion in rubber. Selenium was also used as a chemical reagent and catalyst; as an alloying agent in machinable stainless steels and copper alloys; in storage batteries and to clean glass molds; as an antioxidant in printing ink, paint, and mineral oil; and in insecticides, fungicides, parasiticides, and bactericides. Some minor uses for selenium were: In photoelectric devices and xerographic applications; as a gelation retardant in tung oil, as a nondrying agent in linseed, oiticica, and tung oils; and in blasting caps, fireproofing agents, and flotation reagents.

Stocks.—Beginning stocks of metallic selenium and selenium compounds held by producers in 1955 totaled 93,900 pounds (revised figure) of contained selenium compared with 75,800 pounds at the end of the year, a decrease of 19 percent. Year-end stocks of selenium represented less than a 1-month supply on the basis of apparent consumption for 1955. The National Strategic Stockpile received no additional quantities of selenium during 1955.

Prices.—The producers' price of commercial grade selenium advanced from $5 to $6 a pound and the distributors price of commercial-grade selenium increased from $6 to $7.25 a pound in 100-pound lots, effective January 3, 1955. The price of selenium remained unchanged until August 18, 1955, when the producers' price advanced to $9–$10 a pound and the distributors price increased to $10.50 a pound for commercial-grade selenium. High-purity metal sold for $3 to $5 a pound more than commercial grades throughout 1955. The European prices of selenium continued to be 2 or 3 times more than the domestic quotations.

Foreign Trade.—Canadian imports of metallic selenium and selenium compounds in 1955 totaled 191,900 pounds of contained selenium valued at $1,468,100. Selenium-bearing concentrates imported from Mexico and Northern Rhodesia were sent to bonded smelters in the United States, and the selenium recovered from these concentrates was reported as domestic plant production. The exportation of selenium was limited to 24,000 pounds in 1955.

Technology.—The Bureau of Mines continued selenium investigations throughout 1955 on contract with the General Services Administration (GSA). The Bureau investigated mines and prospects in North Dakota, South Dakota, Arizona, New Mexico, California, Nevada, and five widely separated sections of the Phosphoria formation in Idaho, Utah, and Wyoming. Some encouraging indications were discovered but no selenium deposit of economic value was found.

Metallurgical research work was done by the Bureau of Mines on composite samples of seleniferous uranium ores from Temple Mountain, near Marysvale, Utah, and Lucky Mc mine, Riverton, Wyo. Cursory tests were made of other ores from the Colorado Plateau, and preliminary tests were conducted on samples of direct-shipping ore and lead concentrate from the Darwin mine in California.

The study of the possibility of the commercial extraction of selenium from seleniferous vegetation was continued on a contract between the GSA and Battelle Memorial Institute, Columbus, Ohio.

A review of selenium prospects was published in 1955.[47]

A new coast plant for assembling selenium rectifiers was announced by Dr. Frank H. Driggs, president of Fansteel Metallurgical Corp. The plant was expected to be in full operation by August 1, 1955.[48]

Two publications issued in 1955 provided general information on selenium.[49]

A paper discussing the microstructural changes observed on polished cross sections of single layers of selenium after various heat treatments was released.[50]

World Review.—*Argentina.*—Argentina reported a production of 330 pounds of selenium in 1955.

Australia.—Australia produced 2,460 pounds of selenium in 1955.

Belgium-Luxembourg.—These countries exported 56,960 pounds of selenium in 1955 to the following countries: France, 16,700 pounds; Netherlands, 6,600 pounds; United Kingdom, 25,960 pounds; and West Germany, 7,700 pounds.

Canada.—Canadian production of selenium in 1955 totaled 431,000 pounds valued at $3,009,000. The output was approximately 33 percent greater than the 1954 production of 323,500 pounds (revised figure). Selenium in Canada was recovered by the Canadian Copper Refiners, Ltd., Montreal East, Quebec, from the electrolytic refining of copper anodes produced at the Noranda smelter and from blister copper produced by the Hudson Bay Mining & Smelting Co., Ltd. Selenium was also recovered by the Copper Cliff copper refinery from the copper-nickel deposits of International Nickel Co. of Canada, Ltd., Sudbury, Ontario.

The gross weight and value of selenium and selenium salts exported from Canada in 1955 follow: United States, 191,900 pounds valued at Can$1,468,100; United Kingdom, 141,500 pounds, Can$1,051,400; Australia, 7,000 pounds, Can$75,150; West Germany, 325 pounds, Can$5,170; and Netherlands, 80 pounds, Can$560.

Finland.—Finland produced 7,580 pounds of selenium in 1955.

Japan.—Japan produced 100,000 pounds of selenium in 1955.

Netherlands.—The Netherlands imported 12,900 pounds of selenium in 1955 from the following countries: United States, 1,180 pounds; Belgium, 6,600 pounds; Sweden, 4,400 pounds; West Germany, 240 pounds; Great Britain, 400 pounds; and Canada, 80 pounds.[51]

Peru.—Peru produced 7,425 pounds of selenium in 1955.

Sweden.—Approximately 160,000 pounds of selenium was produced in Sweden during 1955.

Swedish exports in 1955 follow: East Germany, 4,400 pounds; West Germany, 94,800 pounds; Netherlands, 4,400 pounds; Great Britain and Northern Ireland, 6,600 pounds; France, 13,200 pounds; Italy, 2,200 pounds; Switzerland, 4,400 pounds; and Australia, 2,200 pounds.

---

47 Engineering and Mining Journal, vol. 156, No. 12, December 1955, p. 116.
48 American Metal Market, vol. 62, No. 131, July 8, 1955, p. 1.
49 Sargent, J. D., Selenium Data: Bureau of Mines Inf. Circ. 7715, 1955, 29 pp.
Elkins, E. M., Selenium: Canadian Metals, October 1955, vol. 18, No. 11, pp. 30–35.
50 Brown, N. E., and Versnyder, F. L., Some Aspects of the Crystallization and Recrystallization of Vapor-Deposited Vitreous Selenium: Jour. Metals, vol. 7, No. 2, February 1955, pp. 379–381.
51 Cheney, Edward R., The Hague, Netherlands, Foreign Service Despatch 223: Oct. 15, 1956, 4 pp.

TELLURIUM[52]

Supplies of tellurium in 1955 were more than ample to satisfy all requirements for the metal. A strong effort was continued by producers to increase the demand for tellurium, which was reflected in shipments being greater than production for the third consecutive year. Additional tellurium shipped consumers was drawn from stocks of refined tellurium held by producers. An increase in the consumption of ferro-tellurium was reported in 1955.

Domestic Production.—In 1955 the production of primary tellurium was 143,800 pounds, representing a 48-percent increase over the 1954 production of 97,100 pounds. Tellurium producers were: International Smelting & Refining Co., Perth Amboy, N. J.; United States Smelting, Refining & Mining Co., East Chicago, Ind.; American Smelting & Refining Co., Baltimore, Md.; and American Metal Co., Ltd., Carteret, N. J. Most tellurium production in 1955 was obtained as a byproduct of the lead and copper-refining process. A small quantity came from flue dust resulting from treatment of telluride-gold ores.

Consumption and Uses.—Shipments of tellurium in 1955 totaled 164,800 pounds, representing a 63-percent increase over the 1954 shipments of 100,800 pounds. The principal uses for tellurium were in rubber to enhance the resistance to heat, abrasion, and aging and in lead to improve the resistance to corrosion, fatigue, and wear. Minor uses were as an additive and core wash to induce chill in manufacturing, iron castings and as a coloring agent in ultramarine pigments, ceramics and glass. Tellurium was also used as an alloying agent in copper and tin. An increase occurred in the consumption of ferro-tellurium, used to improve the crystal structure and machinability of iron or steel alloys. Tellurium was also used in photographic toning baths, electronic semiconductors, and in the removal of cobalt from zinc.

Stocks.—Stocks of refined tellurium decreased from 103,600 pounds in 1954 to 76,200 in 1955. At the close of the year overall stocks, including the metal content of producers stocks of compounds and unprocessed anode slimes, exceeded a 4-year supply of metal on the basis of apparent consumption for 1955.

Prices.—Tellurium was quoted throughout 1955 by E&MJ Metal and Mineral Markets at $1.75 a pound, a price that has remained unchanged for the past 16 years. Ferrotellurium, 50–58 percent tellurium, sold for $2 per pound of contained tellurium.

Technology.—A study of the crystal structures of the rhodium-tellurium phases was published in 1955.[53]

A method for the gravimetric determination of small quantities of tellurium in sulfur was recently published.[54]

World Review.—*Canada*—In 1955 the production of tellurium in Canada was 6,000 pounds, representing 27 percent less than the 1954 production of 8,200 pounds. Exports plus domestic shipments totaled 14,300 pounds of tellurium or nearly 2.5 times the 1955 production. However, stocks of refined tellurium were more than adequate to supply the increased shipments. Approximately 8,300

[52] Prepared by Elmo G. Knutson.

[53] Geller, S., Crystal Structures of RhTe and $RhTe_2$; Am. Chem. Soc. Jour., vol. 77, May 5, 1955, pp. 2641–2644.

[54] Aaremae A., and Assarsson, G. O., Gravimetric Determination of Small Amounts of Tellurium in Sulfur; Anal. Chem., vol. 27, July 1955, pp. 1155–1156.

pounds of tellurium was exported to the United Kingdom, and the domestic shipments increased to 6,000 pounds from 2,800 pounds in 1954. Tellurium producers in Canada during 1955 were International Nickel Co. of Canada, Ltd., Copper Cliff, Ontario; and Canadian Copper Refiners, Ltd., Montreal, Quebec.

Japan.—Japan produced 990 pounds of tellurium in 1955.

Peru.—Preliminary estimates placed Peru's tellurium production at 2,300 pounds.

THALLIUM [55]

Thallium is bluish white and resembles lead but is softer. The metal and its compounds are so toxic to humans and animals that special precautions are required for handling them.

Domestic Production.—The American Smelting & Refining Co. Globe cadmium refinery, Denver, Colo., was the only domestic producer. Shipments and consumption of thallium and thallium sulfate were about the same in 1955 as in 1954.

Uses.—No new large use for thallium was reported in 1955. Thallium sulfate, which is odorless, tasteless, and extremely poisonous, has been used extensively to exterminate rodents, insects, and other pests. Crystals of thallium bromide have been developed for infrared optical instruments for detecting and signaling where visible means must be absent. Other uses for thallium products are for photoelectric cells, thermometers, glass colorizers, pigments, incandescent lamps, and green flares. Thallium alloys of silver have been found to be very resistant to corrosion by hydrochloric acid, hold a high luster which resists tarnish on contact with air, and have antifriction qualities in bearings.

Price.—Thallium was quoted at $12.50 per pound throughout 1955.[56]

Technology.—An unusual alloy of mercury and thallium freezes at minus 60° C., about 20° C. lower than mercury.[57]

---

[55] Prepared by Donald E. Ellertsen.

[56] E&MJ Metal and Mineral Markets, vol. 26, Nos. 1–52, 1955.

[57] Howe, Herbert E., Thallium, Rare Metals Handbook, Reinhold Publishing Corp., New York, N. Y. 1954, p. 424.

Minor Nonmetals

By D. O. Kennedy [1] Albert Schreck [2] and Annie L. Marks [3]

GREENSAND

GREENSAND (glauconite) production in 1955 totaled 5,695 short tons, according to reports of producers to the Bureau of Mines. The following firms reported production of greensand: The Permutit Co., Birmingham, N. J.; Zeolite Chemical Co., Medford, N. J.; Inversand Co., Sewell, N. J.; and the Kaylorite Corp., Dunkirk, Md. Open-pit operations in Burlington and Gloucester Counties, N. J., and Calvert County, Md., supplied all the production. As in previous years, the bulk of the production was used for soil conditioning as a source of potassium and for water softening and purification.

Prices of greensand (f. o. b. shipping point) ranged from $15 per short ton to $140 per short ton, with an average value of $38.16 per ton.

TABLE 1.—Greensand marl sold or used by producers in the United States, 1946–50 (average) and 1951–55

Year	Short tons	Value	Year	Short tons	Value
1946–50 (average)	6,162	$366,345	1953	6,821	$193,404
1951	5,067	263,944	1954	2,838	198,909
1952	4,600	177,847	1955	5,704	217,671

MEERSCHAUM

No domestic production of meerschaum has been reported for many years. Domestic deposits have yielded only small tonnages in the past. All meerschaum imported in 1955 came from Turkey, where it is produced in Eski-Shehir Province (which is midway between Istanbul and Ankara) and Bilecik Province. Small imports have been reported in the past from Italy, Austria, and Union of South Africa, but the bulk has always come from Turkey. Imports usually range between 6,000 to 12,000 pounds a year.

The major use for meerschaum was in smokers' accessories, such as pipe bowls and cigar and cigarette holders.

Imports of meerschaum into the United States are listed in the following table.

[1] Assistant chief, Branch of Construction and Chemical Materials.
[2] Commodity specialist.
[3] Statistical assistant.

TABLE 2.—Meerschaum imported for consumption in the United States, 1946–50 (average) and 1951–55 [1]

[U. S. Department of Commerce]

Year	Pounds	Value	Year	Pounds	Value
1946–50 (average)	7,738	$14,967	1953	8,568	$12,600
1951	11,289	13,384	1954	12,068	26,357
1952	10,479	12,344	1955	5,102	15,285

[1] 1946–49, 1951, and 1954–55, all from Turkey. 1950: Italy—20 pounds, $120; Turkey—9,601 pounds, $18,429. 1952: Austria—18 pounds, $40; Turkey—10,461 pounds, $12,304. 1953: Turkey—8,168 pounds, $11,911; Union of South Africa—400 pounds, $689.

MINERAL WOOL

The output of mineral wool produced from rock, slag, and glass in the United States in 1955 had a total value of $204,600,000, according to the Bureau of the Census—an increase of 28 percent in value compared with the 1954 production figure of $160,383,000. Use statistics are not available for 1955, but the 1947 report of the Bureau of the Census on mineral wool gave the following percentages for the broad classifications of its uses: Structural insulation, 56 percent; equipment insulation, 23; industrial insulation, 17; and unspecified, 4.

In 1955 the average number of people employed in the mineral-wool industry was 12,300, compared with 10,244 in 1954. The number of production workers in 1955 was 9,411; in 1954, 7,555; and in 1953, 8,661.

Exports of mineral-wool products from the United States during 1955 were valued at $4,180,000, compared with $2,669,000 in 1954.

The new plant of the Texas Rockwool Corp. at Belton, Tex., was put into operation in 1955. The design of the plant incorporated a combination of spinning discs and high pressure steam for fiberizing the melt. The operations at the plant were described.[4]

Laboratory experiments were conducted on several materials to determine their suitability for the production of mineral wool. By blending raw charges in the proper proportion and in some instances by adding lime, acceptable wools were made from samples originating in Alaska, Florida, Texas, and Virginia.[5]

Ten patents were issued during 1955 covering special uses of mineral wool as insulation for bomb shelters, pipes, and kilns, as a constituent in abrasive products, as a coating for structural articles and metal, and in making building boards and shingles.[6]

[4] Nordberg, Bror, Spinning Process for Manufacture of Rock Wool Products: Rock Products, vol. 58, No. 7, July 1955, pp. 40–43, 102.

[5] Kenworthy H., and Moreland, M. L., Laboratory Results on Testing Mineral-Wool Raw Materials: Bureau of Mines Rept. of Investigations 5203, 1956, 18 pp.

[6] Dronkelaar, J. J., Atom-Bombproof Shelter: U. S. Patent 2,704,983, Mar. 29, 1955.

Goff, D. C. (assigned to Zonolite Co.), Method of Insulting Underground Pipe: U. S. Patent 2,707,984, May 10, 1955.

Bergstrom, E. V. (assigned to Socony Mobile Oil Co., Inc.), Kiln Insulating Lining: U. S. Patent 2,716,054, Aug. 23, 1955.

Price, J. E., and Groves, K. D. (assigned to American Viscose Corp.), Abrasive Articles and Method of Making: U. S. Patent 2,711,365, June 21, 1955.

Christinsen, J. C., and Fair, W. F., Jr. (assigned to Koppers Co., Inc.), Composite Coated Structural Articles: U. S. Patent 2,727,832, Dec. 20, 1955.

Bjorkman, E. B., Method of Producing Uncombustible Building Boards: U. S. Patent 2,717,830, Sept. 13, 1955.

Bierly, L. A. (assigned to Presque Isle Laboratories & Manufacturing Inc.), Asphalt Coated Sheet: U. S. Patent 2,718,479, Sept. 20, 1955.

A patent was issued covering the preparation of a mineral wool from kyanite and silica for high-temperature insulation.[7]

Four patents were issued in 1955 for apparatus for manufacturing mineral wool.[8]

Two patents were issued on methods of cleaning mineral wool fibers,[9] and a treatment method to make mineral wool water-resistant was patented during the year.[10]

WOLLASTONITE

The Cabot Carbon Co. continued to produce wollastonite from its Willsboro, N. Y., deposit. Output was small, and attempts were made to develop a greater market for this mineral.

A patent was granted in 1955 on a ceramic composition, containing 70 to 90 percent wollastonite by weight, which is claimed to have improved properties, such as dielectric strength and dielectric loss, improved mechanical strength, and resistance to thermal shock, corrosion, and contamination.[11]

The Western Development Co. mined a wollastonite talus deposit near Blythe, Riverside County, Calif., for the Melvin L. Jontz Co. of Los Angeles. Because of weathering, this wollastonite float resembles drift or waterworn wood and was used as interior and exterior ornamental stone.

The December 26, 1955, issue of Oil, Paint and Drug Reporter listed the following prices for wollastonite: Fine, bags, carlots, works $39.50 per ton; l. c. l., ex warehouse, $56 per ton; medium, bags, carlots, works $27 per ton; l. c. l., ex warehouse, $44 per ton.

---

7 Hahn, W. P. (assigned to Johns-Manville Corp.), Refractory Mineral Fiber: U. S. Patent 2,699,397, Jan. 11, 1955.

8 Downey, R. M. (assigned to U. S. Gypsum Co.), Spinning Rotor for Making Mineral Wool and the Like: U. S. Patent 2,701,388, Feb. 8, 1955.

Anliker, C. A. (assigned to American Rock Wool Corp.), Means for Treating Mineral Wool Fibers: U. S. Patent 2,707,847, May 10, 1955.

Novotny, E. H., and Hislges, L. M. (assigned to Johns-Manville Corp.), Method and Apparatus for Fiber Collection: U. S. Patent 2,711,381, June 21, 1955.

Richardson, C. D. (assigned to Charles Richardson Corp.), Apparatus for Forming Mineral Wool: U. S. Patent 2,724,859, Nov. 29, 1955.

9 Meader, R. C. (assigned to Carborundum Co.), Method of Refining Inorganic Fibrous Materials: U. S. Patent 2,704,603, March 22, 1955.

Mills, L. H. (assigned to Garlock Packing Co.) Mineral Wool Depelletizing Apparatus: U. S. Patent 2,711,247, June 21, 1955.

10 Landes, C. G. (assigned to American Cyanamid Co.), Mineral Wool Impregnated With a Condensation Product of Epichlorohydrin and a Fatty Amine and Process of Preparing Same: U. S. Patent 2,714,276, Aug. 2, 1955.

11 Jackson, W. M., II (assigned to Godfrey L. Cabot, Inc., Boston, Mass.), ceramic composition: U. S. Patent 2,726,963, Dec. 13, 1955.

Commodity Index

Because nearly all commodity chapters in Minerals Yearbook, volume I, follow a standard outline (Introductiory Summary, Domestic Production, Consumption and Uses, Prices (and specifications), Foreign Trade, Technology, and World Review), references to such data have been omitted under the various commodity headings.

Readers wanting information on mine production for States, Territories, or possessions should refer to tables in the Statistical Summary chapter, starting on page 53. These tables show the commodities produced in each area, thus guiding the reader to the appropriate commodity chapters. The reader should refer to volume III, however, for complete area information.

As a supplement to the commodity index to the 1955 volume there is an index to historical mineral statistics tables published in the yearbooks from 1934–55.

Historical Mineral Statistics (excluding Mineral Fuels) in Minerals Yearbooks 1934–55 (Vol. I, 52–55)

Commodity	*Table title*	*Yearbook*	*Page*
Calcium	Calcium metal and calcium-silicon imported for consumption in the United States, 1937–50.	1950	1323
Cement	Production and percentage of total output of portland cement in the United States, 1906–14, 1926, 1929, 1933, 1935, and 1941–54, by raw materials.	1954	280
Cerium and other rare-earth metals.	Cerium and other rare-earth compounds imported for consumption in the United States, 1922–50.	1950	1325
	United States foreign trade in mischmetal and ferrocerium alloys, 1924–50.	1950	1325
Chromium	Chromite shipped from mines in the United States, from before 1880 through 1955.	1955	319
	Consumption of chromite and tenor of ore used by primary consumer groups in the United States, 1942–51, in short tons.	1951	278
	Chromite shipped from mines in the United States, 1880–1950.	1950	238
	World production of chromite, by countries, 1943–50, in metric tons.	1950	243
	Consumption of chromite and tenor of ore used by primary consumer groups in the United States, 1941–49, in short tons.	1949	237
	World production of chromite, 1939–46, by countries, in metric tons.	1946	245
Cobalt	Cobalt imported for consumption in the United States, 1923–53, in pounds.	1953	359
	Cobalt ore produced and shipped in the United States through 1952.	1952	316
	Cobalt produced in Belgian Congo from earliest production through 1952.	1952	326
	World mine production of cobalt, by countries, 1941–50, in metric tons of contained cobalt.	1950	399
	Cobalt contained in ores produced in Belgian Congo and Canada and cobalt alloy produced in Northern Rhodesia, from earliest production to 1950.	1950	400
	World production (partly estimated) of cobalt, 1938–45, by countries, in metric tons.	1945	634
Columbium and tantalum.	Columbium and tantalum concentrates shipped from mines in the United States, 1941–51.	1951	1353
	Columbite imported for consumption in the United States, 1934–50, in pounds.	1950	1330
	Columbite imported for consumption in the United States, 1941–50, by countries, in pounds.	1950	1330
	Tantalum imported for consumption in the United States, 1917–50, in pounds.	1950	1331
	Tantalite, imported for consumption in the United States, 1941–50, by countries, in pounds.	1950	1331
	World production of columbite concentrates, 1931–50, in pounds.	1950	1333
	World production of tantalite concentrates, 1901–50, in pounds.	1950	1334
Copper	Copper ore and recoverable copper produced by open-pit and underground methods, 1939–54, percent of total.	1954	383
	Mine production of recoverable copper in the United States, 1944–54, with production of maximum year, and cumulative production from earliest record to end of 1954, by States, in short tons.	1954	384
	Copper produced (smelter output from domestic ores) in the United States, 1845–1954.	1954	388

Commodity	*Table title*	*Yearbook*	*Page*
Mercury	Mercury produced in the United States, 1910–55, by States, in flasks of 76 pounds.	1955	775
	Mercury ore treated and mercury produced therefrom in the United States, 1927–55.	1955	776
	Salient statistics of the mercury industry, 1910–53.	1953	771
	Mercury produced in the United States, 1944–45, by months, and 1946–51, by quarters, in flasks of 76 pounds.	1951	832
	Mercury consumed in the United States, 1944–45, by months, and 1946–51, by quarters, in flasks of 76 pounds.	1951	836
	World production of mercury, 1943–51, by countries, in flasks of 34.5 kilograms (76 pounds).	1951	841
	World production of mercury, 1938–45, by countries, in flasks.	1945	719
	Mercury produced in, imported into, and exported from Germany, 1935–44, in flasks of 76 pounds.	1945	720
Mica	Production and apparent consumption of sheet mica in the United States, 1941–52, in pounds.	1952	731
	Mica sold or used by producers in the United States, 1935–39 (average) and 1943–50.	1950	789
	Sheet mica sold or used by producers in the United States 1908–39.	1940	1405
	Ground mica sold by producers in the United States, 1923–39, by methods of grinding.	1940	1408
	Mica imported for consumption in the United States, 1909–39, by classes.	1940	1413
	Mica and manufactures of mica exported from the United States, 1910–39.	1940	1415
Molybdenum	World production of molybdenum in ores and concentrates, by countries, 1905–54 in thousand pounds.	1954	848
	Molybdenum in ore and concentrates produced and shipped from mines in the United States, 1942–51.	1951	858
	Molybdenum in ore and concentrates shipped from mines in the United States, 1914–41.	1941	629
	Molybdenum (element) contained in concentrates produced from the climax deposit in Colorado, 1918–41.	1941	630
Nickel	Nickel metal production, apparent consumption, and foreign trade in France, 1947–54, in short tons.	1955	855
	World mine production of nickel, 1944–51, by countries, in metric tons of contained metal.	1951	918
	World production of nickel (content of ore), 1937–44, by countries, in metric tons.	1944	623
	Production, imports, exports, and apparent consumption of nickel in the United States, 1911–38, nickel content in short tons.	1939	604
Potash	Potash produced and sold in the United States, 1915–34.	1935	1148
Phosphate rock	Production of elemental phosphorus in the United States, selected years, 1930–50, in millions of pounds (including TVA).	1952	803
	Phosphate rock mined in the United States, 1942–51, by States, in long tons.	1951	1055
	Phosphate rock mined in the United States, 1932–41, by States, in long tons.	1941	1372
Quartz crystal	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.	1952	852

○